AVIATION NUMBER

What Plane to Buy—Airplane Diesel Details

SCIENTIFIC AMERICAN

May 1930

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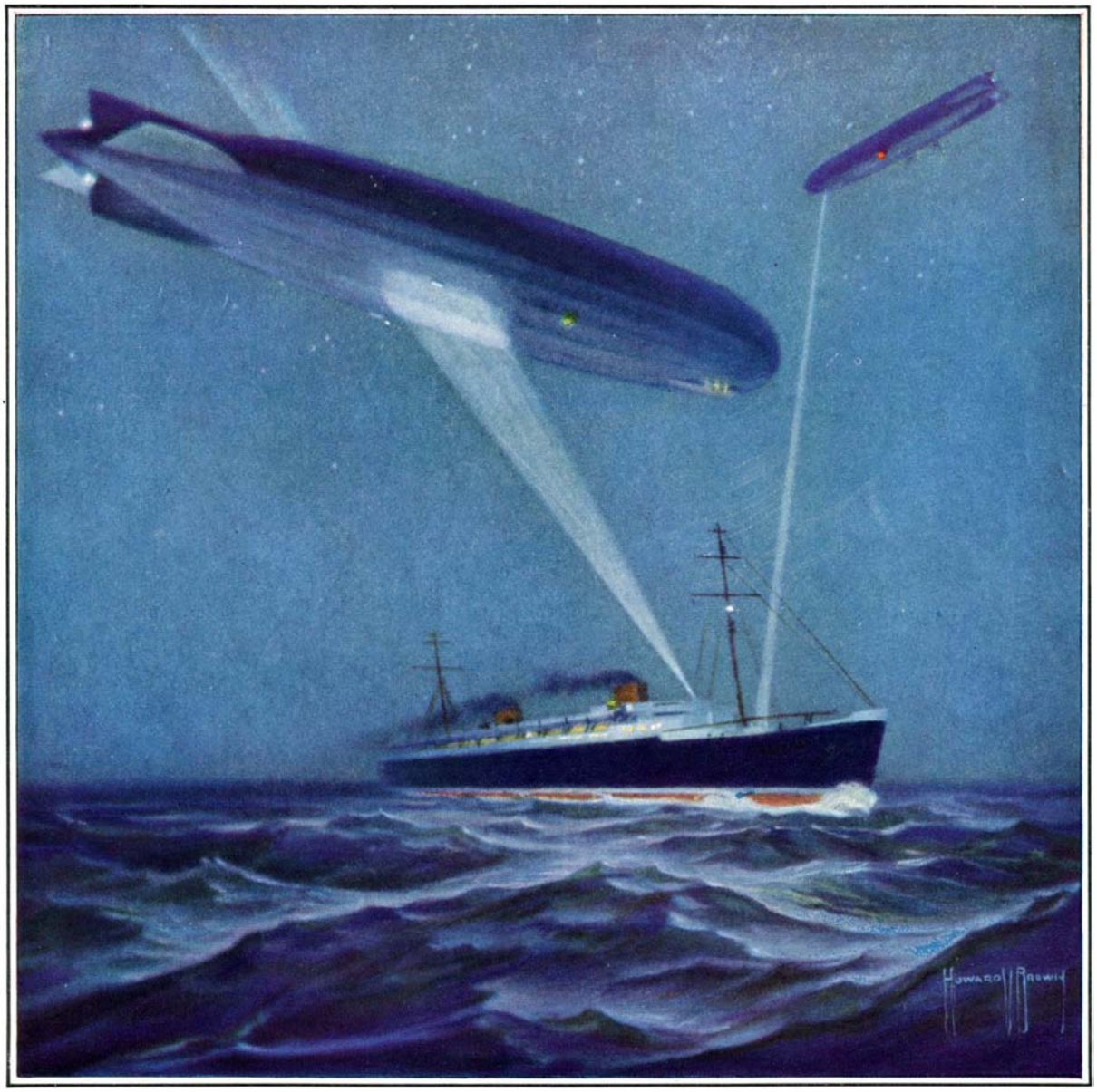
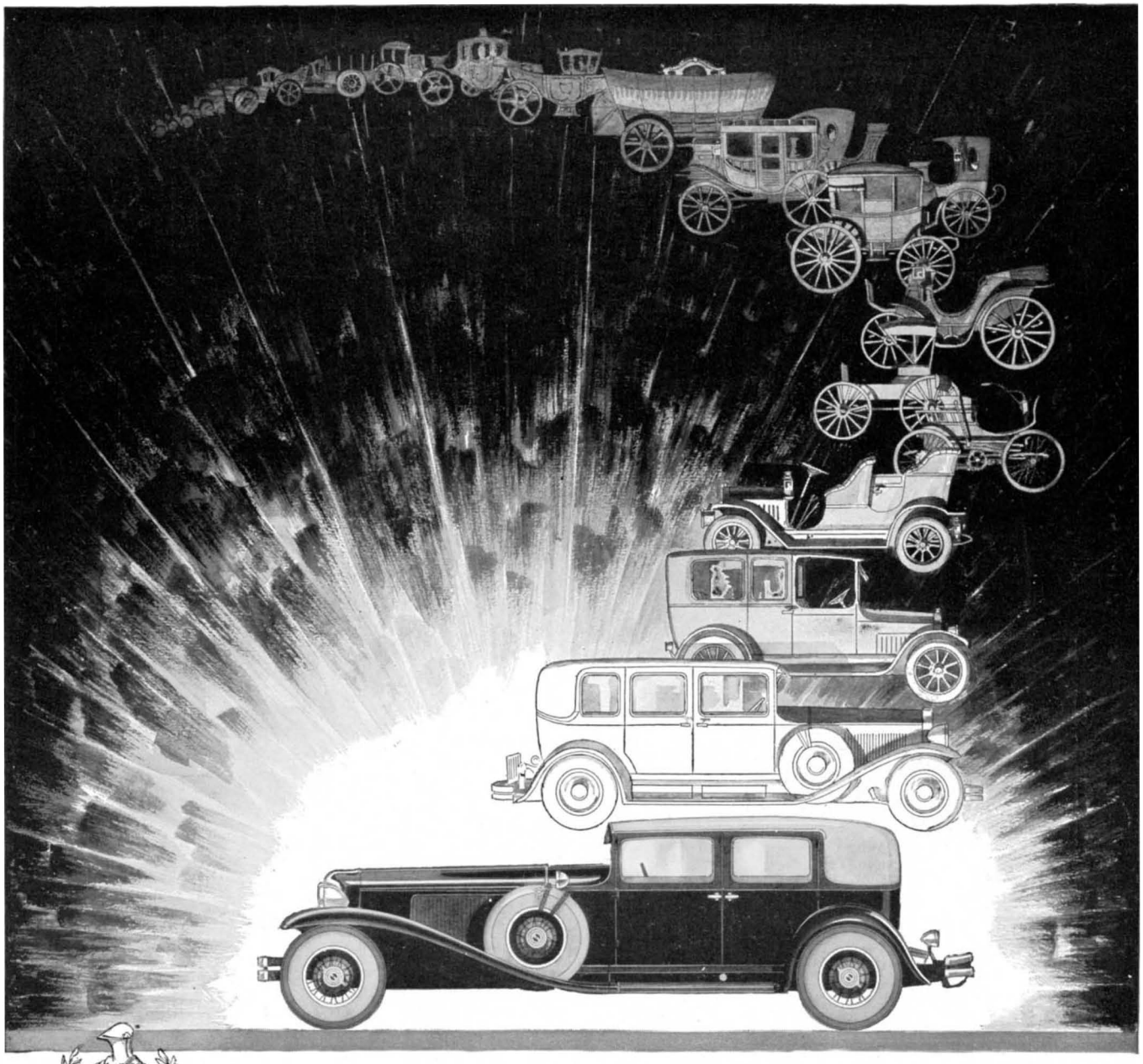


Cross-roads of the Air



It is our belief that the most important "specifications" of the Cord front-drive are: Do you like its design? Does its comfort appeal to you? Does it do what you want a car to do better and easier? When a car, built by a reputable and experienced company, meets these three requirements, you can safely depend upon that company to adequately provide for all mechanical details—E. L. CORD

CORD FRONT DRIVE

SEDAN $3095 . . BROUGHAM $3095 . . CABRIOLET $3295 . . PHAETON $3295 Prices F. O. B. Auburn, Indiana. *Equipment other than standard, extra*

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SCIENTIFIC AMERICAN

May, 1930 *ORSON D. MUNN, Editor* *Eighty-sixth Year*

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John P. Davis, Treasurer; I. Sheldon Tilney, Secrey; Orson D. Munn, President; Louis S. Treadwell, Vice-President;

IN THIS ISSUE

COVER

Our cover illustration this month, done in oils by Howard V. Brown, is a conservatively idealistic conception of future travel. The fast ocean liner, at "The Cross-roads of the Air," salutes its still faster competitor, the dirigible, as it speeds majestically toward its destination. Several crossings of the Atlantic by lighter-than-air craft indicate that this picture may become, within a few years, a true reflection of a generally common method of ocean travel.

Looking Ahead *With the* Editor

Is There an Ether?

THE concept of an ether (of physics) to explain how a body can act "where it is not," e.g. the earth's gravitational action on the moon, dates from Newton. Why and what it is, many scientists have attempted to explain. Many people think the ether theory is no more, but in a coming article, Dr. Heyl says he believes the 20th Century has changed the form rather than the function of the ether, and that we'll always have it; he also reviews all the ramifications of the question.

Super Magnetism

THIRTY thousand amperes for one hundredth of a second! It seems impossible to switch on and off so much current in so little time but it is being done in England in the research on super magnetic fields. The development of the intricate and almost infinitely exact equipment for this work makes a story that is informative to scientists, professional and amateur, and significant to all. This article is now ready for release.

The Aluminum Age

A CHEMICAL curiosity at 545 dollars a pound 78 years ago, two dollars a pound in 1882, and now 24 cents a pound—with a production of 225,000,000 pounds in 1929—such is the history of aluminum. The universal use of this metal and its incomparable alloys lead some to predict that our era will later be called the "Aluminum Age." The interesting history and wide use of aluminum will be discussed in an early issue.

Aviation's Future

OUR present planes incorporate features that make for safe, dependable operation. What, then, does the future hold in store? Both the layman and the investor in aviation stocks are anxious to know. Predictions will, of course, be vague but the author of a coming article looks for improvements and spectacular experiments in the next few years, and the settling of the aviation industry on a stable business basis this year.

Interstate Rivalry on the Roads

AUTOMOBILES necessitated the construction of extensive highway systems. In the rush of building good roads, however, little thought was given to roadside beauty. Local pride is now changing this and roads are being beautified by the planting of trees and flowers. It is hoped, therefore, that our coming article on the subject will help to inspire a rivalry between states in this matter of making roads attractive.

Every Issue Fully Illustrated

¶ *Men are known by the magazines they read. What easier road to distinction could there be than reading the* SCIENTIFIC AMERICAN*—at four dollars a year?*

Among Our Contributors

Clarence M. Young

HAVING received his law degree at Yale, Mr. Young entered the Army Air Service when the United States declared war, and served 18 months overseas. He was shot down by anti-aircraft guns and taken prisoner. In 1926, he was appointed Chief of the Air Regulations Division of the Aeronautics Branch, Department of Commerce. He was promoted to the post of Director of Aeronautics and later was appointed by the President as Assistant Secretary of Commerce for Aeronautics. Mr. Young is a colonel in the Air Corps Reserve, an active pilot, and, when possible, flies his plane on official business.

W. D. Puleston

THERE are few men in the naval service today who have so complete a grasp of naval questions as Captain Puleston. A graduate of the Naval Academy, the Naval War College, and the Army War College, he served 17½ years at sea, also on the Naval War College staff, and published the authoritative study: "The Dardanelles Expedition."

P. G. Johnson

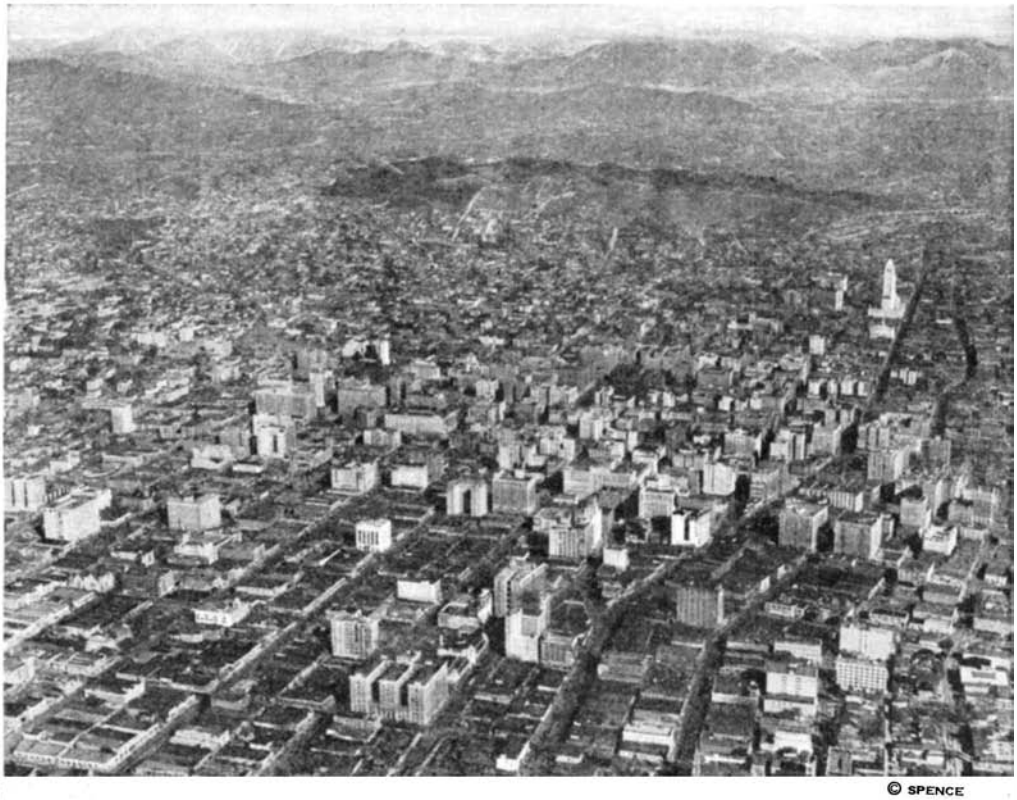
UPON graduating from the University of Washington, Mr. Johnson entered the Boeing Airplane Company, then a small organization, as a draftsman. He advanced to the positions of Production Manager, Superintendent and Secretary, Vice President and General Manager, and finally to President and General Manager. Mr. Johnson is also a vice president of the United Aircraft and Transport Corporation of New York, a holding company which has 13 subsidiaries, including the Boeing aeronautical enterprises.

William H. Crew

LIKE the great physicist about whom he writes a splendid appreciation beginning on page 376, Dr. Crew is a graduate of the United States Naval Academy, later receiving his doctorate at Johns Hopkins. Since 1925, he has been Assistant Physicist at the Naval Research Laboratories.

Industrial . . .

LOS ANGELES COUNTY



© SPENCE

The Ford Factory at Los Angeles-Long Beach Harbor, nearly completed.

United States Steel Corporation enters Los Angeles County in 1929.

The Willard Storage Battery new factory to serve the Western States.

The Continental Can Corporation's new factory serves the Pacific Southwest.

OFFERS to manufacturers a local market of 2,500,000, of the same metropolitan character as Chicago and New York,—a large central city surrounded by smaller communities,—with adequate space for economic, well balanced growth:

—**With** highest income, savings deposits, purchasing power and automobile ownership per capita in the United States.

—**With** quick and economical transportation by motor truck, rail and airplane lines to nearby markets which comprise 40 per cent of the population of the Coast States, and 175 steamship companies to and from Los Angeles Harbor in foreign and domestic trade;

—**With** more local, basic raw materials of industry than any Coast community, and imports at low cost;

—**With** *the only local supplies of petroleum and natural gas among cities of the coast,* abundant cheap water and electric power;

—**With** unsurpassed labor supply and efficiency, working under ideal climatic and living conditions;

—**With** a present *manufactured output exceeding a billion dollars* annually, and $35,000,000 invested in new factories and expansions last year, at lowest costs of building and maintenance;

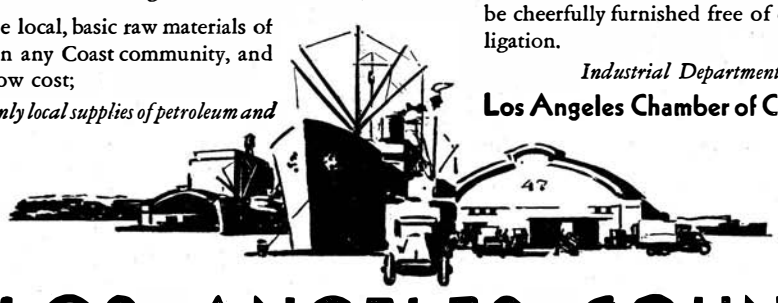
—**With** a program of general development in 1930 of $400,000,000—

The Eastern manufacturer finds here the dominant industrial and distribution center and most marked progress in the West, with the highest average of advantages for the location of his Pacific Coast factory.

Detailed information for any specific industry will be cheerfully furnished free of cost or obligation.

Industrial Department

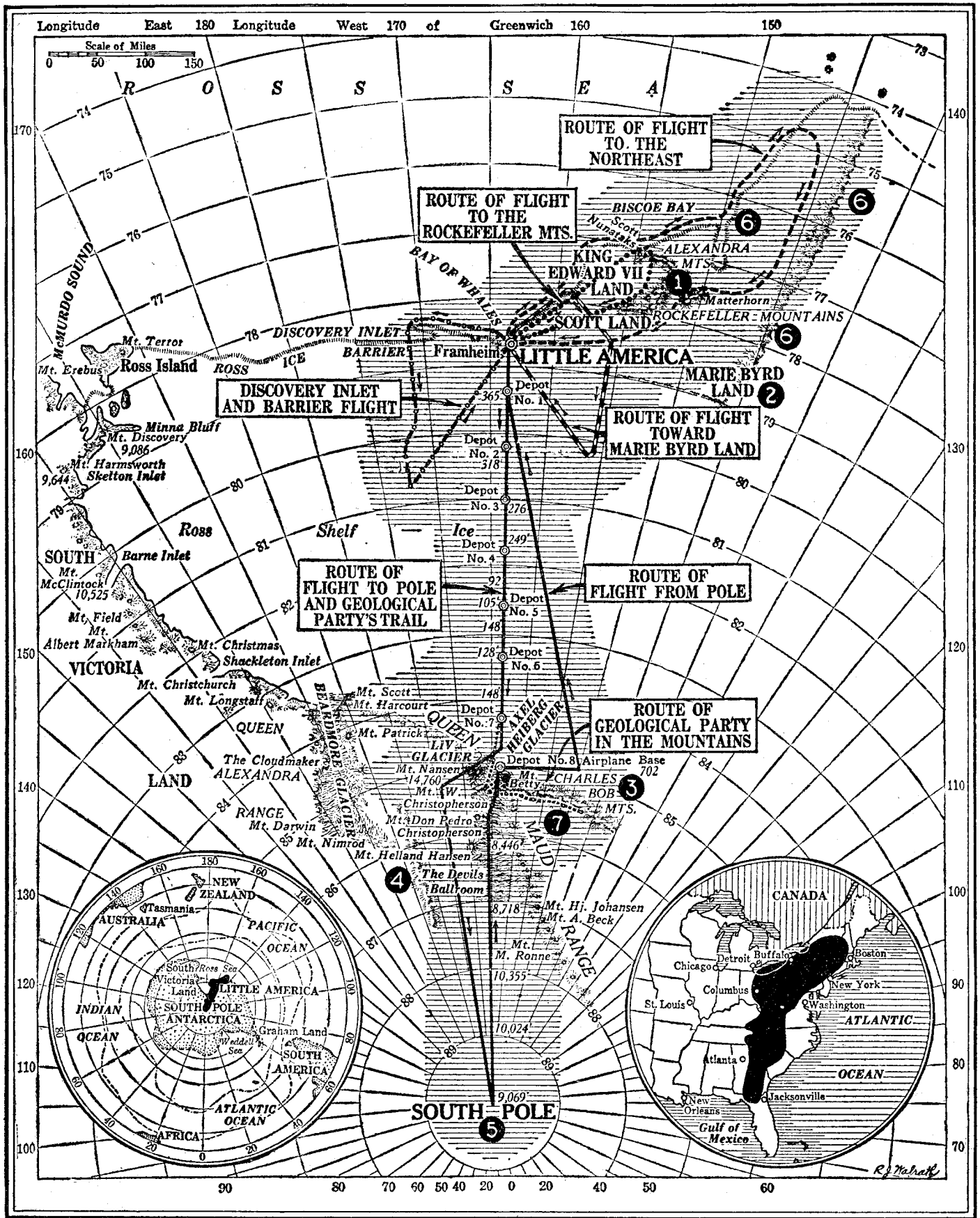
Los Angeles Chamber of Commerce



INDUSTRIAL LOS ANGELES COUNTY

Walter Franklin Prince

ELIMINATING entirely all the vast welter of unrelated "occult" hocus-pocus with which the name of genuine psychic research unfortunately has been linked by the muddled fraction of the public, Dr. Walter Franklin Prince. Research Officer of the Boston Society for Psychic Research, is a leader in the attempt to investigate without prejudice or preconception certain unexplained happenings which have the appearance of being psychic. Most men of science have chosen other fields—physics, chemistry and so on—for investigation because it is less difficult in these to obtain unequivocal findings, while valid research in psychic phenomena from first to last has been carried on among a host of besetting difficulties. Despite adverse judgments from many of the uncritical who have little or no idea of the rigorous discipline of the scientific method, or of what science means by a "proof," Dr. Prince has hewn to the line in his work. He has now been honored signally by election as President of the Society for Psychical Research (London) and will sail shortly to deliver his Presidential Address. The chair of the British organization previously has been occupied by many famous men—Sidgwick the sceptic, William James of Harvard, Crookes the physicist, Bergson, and others. For several years Dr. Prince has been a Corresponding Editor of this journal.



Courtesy *The New York Times*. Copyright

Admiral Byrd's Antarctic Expedition—Its Accomplishments

THE Byrd Expedition to Antarctica, recently concluded, explored and observed the shaded territory. Black inset at right shows the same area superimposed on a map of the United States. Besides flying to the South Pole, the Expedition discovered: Rockefeller Mountains, Marie Byrd Land, Charles Bob Mountains, a new mountain range on the polar flight, Barrier Inlet, and a vast coastal range. The geological party gathered much scientific data and erased Amundsen's supposed Carmen Land from the map of Antarctica.

All photographs courtesy Aeronautical Chamber of Commerce of America

WHERE THEORY ENDS AND PRACTICE BEGINS

What Is a Good Flying School?

The Department of Commerce Has Worked Out Regulations for Rating Aviation Schools and Has Approved Many

By CLARENCE M. YOUNG*
Assistant Secretary of Commerce for Aeronautics

PARENTS ask, "Where shall we send our boy for his aviation training? Claims of various schools are puzzling, and we know that the promises of some are misleading, even fraudulent. How, then, are we to decide?"

Colonel Young has answered these questions by a concise and direct explanation of what constitutes a high-rating air school. Information on those that have been rated by the Department of Commerce—at the request of the schools—is obtainable from the Department. The intelligent parent will "rate" others by a careful consideration of equipment, plan of operation, and honesty of purpose in comparison with the ideal school system described by Colonel Young.—*The Editor.*

WHEN, on February 28, 1929, the President approved the Bingham amendment to the Air Commerce Act of 1926, authorizing the Secretary of Commerce to provide for the examination and rating of civilian flying schools, upon their voluntary application, as to the adequacy of the course of instruction, the suitability and airworthiness of the equipment and the competency of the instructors, an important obstacle—the lack of a unified, government-approved system of flight training—was removed from the path of the development of civil aeronautics in the United States.

PRIOR to the approval of the Bingham amendment, Congress had authorized the Aeronautics Branch of the Department of Commerce to examine and license airplanes, pilots, and mechanics; examine and test engines and propellers; examine and approve airplanes as to airworthiness for manufacture under the Department's approved type certificate; to establish and chart airways, properly lighted and equipped with other aids to air navigation—in fact every provision had been made for the Government's assistance to the development of aeronautics and the protection of the public except in the case of the young man or woman who desired to become a pilot and make aeronautics a career or an avocation.

Up until the time authority was extended the Department of Commerce to examine and rate flying schools upon their own application, the Aeronautics Branch was deluged constantly with requests for information as to reliability, adequacy, and suitability of this and that commercial flying school. It was impossible for official replies to be given because of the absence of a known method under which some or all of the schools were operating. Consequently, the aspiring pilot was forced to choose for himself; sometimes he made a good choice and sometimes he did not.

The various schools and individuals giving courses in flying naturally adopted a method which, in their opinion, was the best; and often the course of one school embodied direct contrasts in theory and fact to the course of another, although both were intended to produce the same results. The beginner naturally was quite bewildered. Such a widespread condition could not help working a hardship on those upon whom we will rely in the future to contribute actively to the advancement and development of civil aeronautics in the United States.

ONCE the authority to examine flying schools was received, and facilities to handle this increased activity became available, we undertook the preparation of a supplement to the Air Commerce Regulations dealing

*See "Among Our Contributors," page 341

HIS FIRST SOLO

Final instructions before the student takes off on his first solo: "Remember, don't get rattled"

entirely with the requirements to be met by the schools applying for an Approved School Certificate. This school supplement was prepared in cooperation with the schools themselves.

The first step in the preparation of the School Supplement to the Air Commerce Regulations, as it is known, was to classify the schools. Those giving instruction in flying are classed as flying schools, ground schools, or ground and flying schools. The approved flying schools are rated as follows: private pilot's flying school, limited commercial pilot's flying school, and transport pilot's flying school. Approved ground schools are rated as: private pilot's ground school, limited commercial pilot's ground school, and transport pilot's ground school, if operated in conjunction with an approved flying school.

Thus in the beginning the schools were classified according to their facilities and qualifications, so that no institution bearing the Department's approval would attempt to conduct a course in a subject for which it had not received a rating.

THE "suitability and airworthiness of the equipment" of a school applying for an approved certificate were defined in the regulations as follows:

All planes used for flight instruction in an approved school shall be planes licensed by the Department of Commerce for that purpose.

The minimum-sized field shall be one having at least 2000 feet of effective landing space in all directions, with clear approaches; or it shall have landing strips not less than 500 feet wide, permitting landing in at least eight directions at all times, the landing strips not to cross or converge at angles less than 40 degrees nor any one of the landing strips to be less than 2000 feet in effective length with clear approaches; or it shall have two landing strips, one aligned with the general direction of the prevailing wind, permitting at least four-way landing at all times and having clear approaches, the landing strips to be at least 500 feet wide and not less than 3000 feet in effective length and not to cross or converge at an angle of less than 60 degrees. The dimensions of the effective landing area and the effective lengths of the landing strips shall be increased at altitudes above 1000 feet, in accordance with accepted practice.

There shall be hangar space sufficient to house all airplanes used for instruction purposes and sufficient equipment and personnel to maintain such airplanes in an airworthy condition as required by the Air Commerce Regulations.

The total number of planes engaged in actual instruction from a given field shall not exceed 10 planes per hundred acres at any one time. The entire field should be available for take-offs and landings. Operations shall be limited solely to instruction during instruction periods where runways only are available.

Not more than 15 students shall be enrolled in flying courses for each airplane normally available for flying-instruction purposes.

Schools approved for ground instruction shall be equipped with one classroom for each hundred students enrolled, capable of seating 20 students. The classroom shall be furnished with suitable classroom equipment and facilities. Where the ground school is not under the management of, or connected with the flying school, it shall have at least three types of aviation motors in current use and three types of modern airplanes for demonstration and practical experience purposes.

The "competency of the instructors" was set forth in the following provisions:

ALL flying instructors shall hold a rating from the Department of Commerce as flying instructors before being permitted to give instruction in approved schools.

A flying instructor's rating will run concurrently with his transport pilot's license and may be renewed semi-annually upon satisfactory evidence that he has served as a flying instructor in an approved school for not less than 50 hours in dual instruction during the preceding six months.

No flying instructor shall be allowed to exceed six hours of dual instruction in any one day, nor shall he give flying instruction more than six days per week. The school shall be responsible that the efficiency of the instructors is not impaired by continued dual instruction at or near the maximum daily allowable time.

All ground instructors, before being permitted to give instruction in approved ground schools, shall hold ratings from the Department of Com-

UNITED STATES DEPARTMENT OF COMMERCE

Approved School Certificate

This is to certify that DOE SCHOOL OF FLYING

Located at AIRVILLE *is an*

Approved TRANSPORT-LIMITED COMMERCIAL-PRIVATE - GROUND AND FLYING *School*

Pursuant to the authority of Sec. 3-D of the Air Commerce Act of 1926, as amended February 28, 1929, and the School Supplement, Air Commerce Regulations, the provisions of which are made a part hereof as though written herein.

ISSUED May 1, 1930.

EXPIRES May 1, 1931.

BY DIRECTION OF THE SECRETARY.

Clarence M. Young
Assistant Secretary of Commerce for Aeronautics.

INDEX TO A SCHOOL'S CHARACTER

Colonel Young prepared this sample Approved School Certificate to show how a school that has been rated by the Department of Commerce may be identified. It is nine by twelve inches

merce as ground instructors. Ground instructors' ratings may be issued to those qualified to instruct in one or more ground-school subjects after successfully accomplishing examinations in such subjects prescribed by the Department of Commerce.

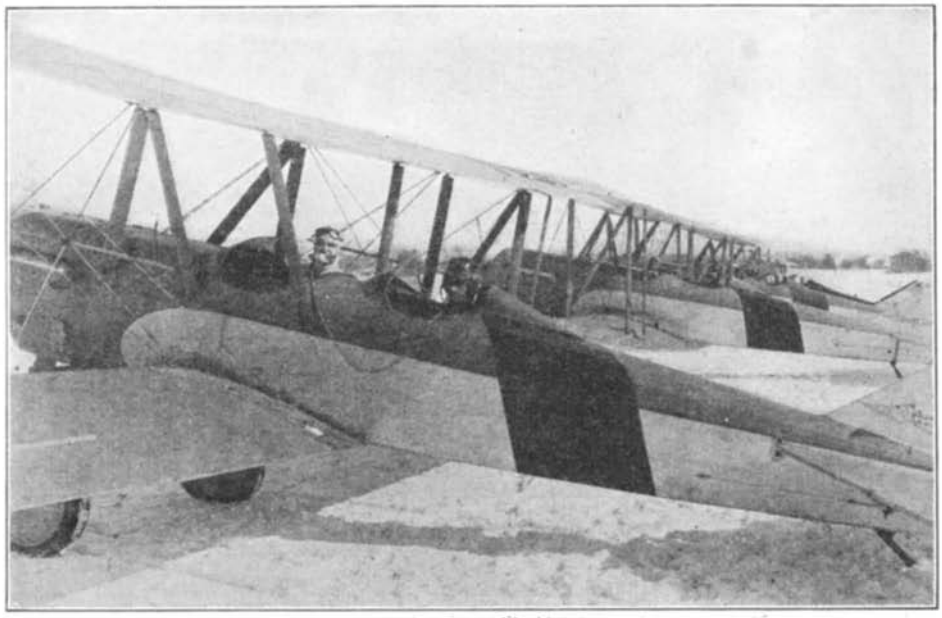
The minimum standards as to adequacy of the course of instruction are: When a student applies for license as a graduate of an approved school, such graduate may be privileged to count a portion of his dual and check time toward the solo-flying experience required for the Department of Commerce license, subject to the restrictions set forth in the regulations, provided he applies for license within 10 days from the date of graduation.

THE entire course, both ground and flight, shall be completed within a minimum length of time, the maximum allowable being four months for private school, six months for limited commercial school, and 18 months for transport school. There shall be a regularity of procedure of instruction, both ground and flight.

The school shall keep an adequate individual record of each student which shall include a chronological log of all instruction, both ground and flight, the entire record to be certified to by an authorized official of the school.

Upon completion of the course in each ground-school subject the student shall be given an examination on the subject matter covered, and all grades attained in all examinations shall be made a part of the student's individual record.

A complete outline of all flying-school and ground courses shall be submitted to and approved by the Department of Commerce. A monthly report shall be submitted to the Department of Commerce by the school showing the total number of students enrolled, with a chronological log of all instruction given each student in both flying and ground courses; the names of all graduates; the names of all students dropped from enrollment, with the reason therefor.



FLYING INSTRUCTOR AND STUDENT

Several planes, each with an instructor and a student, ready to take off on practice flights. In the air the instructor communicates with the student by means of the system shown

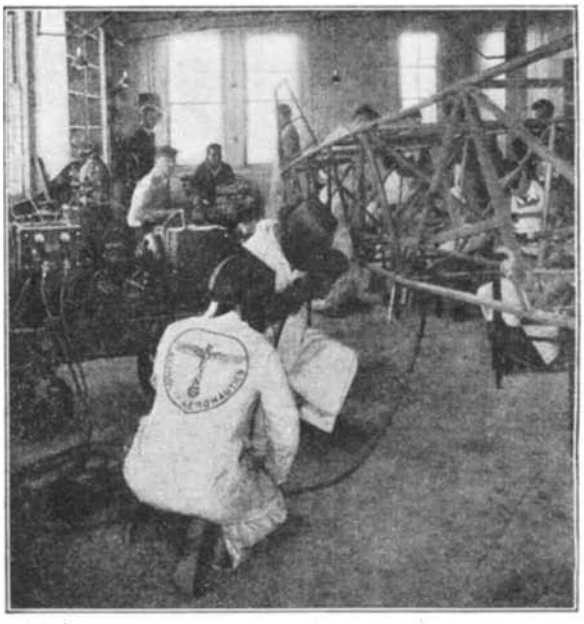
The school shall maintain a standard of ground and flying instruction to assure that nine out of 10 graduates who apply for license satisfactorily pass the Department of Commerce tests; and shall maintain sufficient personnel and equipment to assure that the student will complete the course within the prescribed time limit. It shall maintain such standards that 66 2/3 percent of the students accepted for instruction are graduated from the course for which they have enrolled, exclusive of removal for due cause prior to completion of the course.

An approved school will be privileged to give refresher courses in both flight and ground subjects for the purpose of qualifying pilots who already have had the necessary total flying time for the grade of license for which they intend to apply. Such pilots shall be subject to the same guaranty to the Department of Commerce as has already been outlined. All dual instruction shall be around the airport area, and no cross-country shall be counted as dual. Every student must be given instruction in the recovery from stalls and spins prior to his first solo. In a private pilot's flying school, the school shall give the student a minimum of 18 hours total flying time, of which 10 hours shall be dual and eight hours solo. In a limited commercial pilot's flying school, the school shall give the student a minimum of 50 hours total flying time, of which not less than 15 hours nor more than 25 hours shall be dual and check time, and as such, be counted toward the solo-flying experience required for limited commercial license.

Each graduate of a private pilot's or limited commercial pilot's flying school shall have a minimum of two hours solo experience in flying each of two distinct types of planes other than those used for primary dual instruction, one of which shall be a cabin type. In a transport pilot's flying school, the school shall give the student a minimum of 200 hours total flying time, of which not less than 35 hours nor more than 50 hours shall be dual and check time and, as such, be counted toward the solo-flying experience required for transport pilot's license.

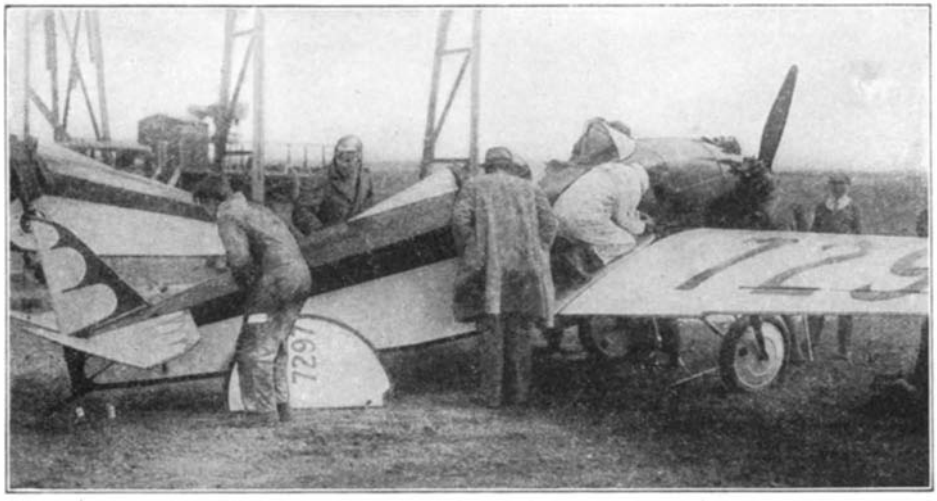
EACH graduate of a transport pilot's flying school shall have a minimum of 10 hours solo experience in flying each of two distinct types other than those used for primary dual instruction. He shall also have 10 hours solo on at least one type of cabin plane which shall be not less than a four-place type and which shall be loaded to normal capacity during these prescribed flights. He shall also have 10 hours solo experience in night flying.

The minimum required subjects and division of time in a private pilot's ground school are: Air Commerce Regulations, five hours; aviation engines (including principles of internal combustion, carburetion, cooling, lubrication, and ignition), 10 hours; airplanes (including history of aviation



HOW THE PLANE IS BUILT

Future pilots may be seen here studying the parts and framing of an airplane. In foreground: welding a joint



PRACTICE

Part of the work of the ground school course in aviation consists in obtaining practical experience in the construction of a plane. Students are here shown assembling a monoplane

theory of flight, nomenclature, construction, rigging, maintenance, and repair), 10 hours.

Minimum required subjects and division of time in a limited commercial pilot's ground school are: Air Commerce Regulations, five hours; aviation engines (including principles of internal combustion, lubrication and cooling, carburetion, ignition, construction, various types, inspection, maintenance, and repair), 15 hours; airplanes (including history of aviation, theory of flight, nomenclature, aerodynamics, construction, rigging, various types, inspection, maintenance, and repair), 15 hours; aerial navigation and meteorology, 15 hours; five hours of each of the above required 15 hours on airplanes and on engines may be shop practice on the basis of three hours shop practice equivalent to one hour of classroom instruction. Shop practice shall be under the direct supervision of the ground instructor.

THE minimum required subjects and division of time in a transport pilot's ground school are:

Air Commerce Regulations, five hours; engines (including principles of internal combustion, carburetion, ignition, lubrication, cooling, aviation types, construction, inspection, maintenance, and repair) 25 hours; airplanes (including history of aviation, theory of flight, nomenclature, aerodynamics, construction, rigging, various types, inspection, maintenance, and repair), 30 hours; meteorology, 15 hours; aircraft instruments, radio and its use in aeronautics, the parachute, its care and use, 10 hours; and aerial navigation, 15 hours. Ten hours of the above required 25 hours on engines and 10 hours on the above required 30 hours on airplanes may be shop practice, on the basis of three hours shop practice equivalent to one hour of classroom instruction. Shop practice shall be under the direct supervision of a properly licensed ground instructor.

Any individual, partnership, or corporation engaged in giving instruction in flying either as a ground school or as a flying school or a combination of both, may apply for an Approved School Certificate upon a regular form provided by the Aeronautics Branch. This form, when properly filled out, enables us to determine whether or not the applicant has facilities sufficient to meet the standard of minimum requirements. If he has not, he is so informed.

THE inspector who rendered a favorable report on the application for an approved school by no means has finished his work with respect to that particular school. From time to time he will drop in unannounced on that and other institutions previously approved and make an inspection of the entire school to see that there have been no changes in the equipment, facilities, and conduct of the courses that will affect the standard of minimum requirements. Should he find a direct violation of the School Supplement of the Air Commerce Regulations, the evidence he produces would be grounds for suspension or revocation of the certificate.

Schools holding the Approved School Certificate are permitted to advertise their designations and ratings and thereby they obtain a decided advantage over competitors who have not applied for the Department's approval. The approved schools likewise are regarded by the general public as institutions worthy of patronage. For the first time since the Aeronautics Branch was established, we are in a position to answer inquiries as to adequate flying schools by forwarding the latest list of approved schools which speaks for itself and needs no interpretation or elaboration.

INADEQUATE instruction has resulted in a large number of accidents which otherwise would have been avoided had there been a definite and thorough standard of instruction followed. Our accident statistics show the human element in flying is credited with the majority of the causes of aircraft accidents, and one of the prime factors in the personnel question is proper and thorough instruction, as "errors of judgment" and "poor technique" lead in percentages of causes.

The approved schools are being looked to by the people of the country to graduate competent airmen and imbue them with sufficient knowledge of the subject to the end that they may always be able to protect themselves and others for whose lives they may be responsible, from accidents and mishaps that have resulted in the past from improper instruction and guidance. The Aeronautics Branch of the Department of Commerce, fully aware of its important obligation, is making every effort to see that the standard of minimum requirements in the approved schools is being followed constantly and consistently.

THEORY

No person who does not know something of aerodynamics, the theory of the airplane motor, and the various intricate parts of the plane would ever be given a license by the Department

OUR POINT OF VIEW

Air Rights

THERE have been many complaints against the flight of airplanes over private property and, in some sections, there has been agitation for state control of air routes to keep planes away from congested areas where a crash might endanger persons or their property or where their noise excites nervous people.

Even the most casual glance at flight regulations will bring the realization that here is a fertile legislative field that has scarcely been touched. Most cities have ordinances denying planes the right to fly below certain minimum altitudes and the Department of Commerce has made other stringent flight regulations but as yet there are altogether too few laws to exert a restraining influence on inconsiderate or foolhardy fliers. If laws are inadequate, however, it should be remembered that the industry is young and must feel its way carefully; regulatory measures will be taken as they become necessary.

The government recognizes air transportation and, by non-interference, implies that the flight of a plane over "posted land" does not constitute trespass. But the necessarily low altitude of take-off and landing may force, sooner or later, regulations as to the size of the airport or may authorize the acquisition of rights of way by the power of eminent domain. Complainants against the possible danger or annoyance of planes flying over privately owned land have at present only the weapon of city low-altitude ordinances, for the old theory that the property owner's rights extend to the skies has no basis in fact. When this theory was acceptable, no one had use for the air above building height. The rapidly growing air commerce of today, however, gives the question a different aspect.

Calendar Reform

THE Council and Executive Committee of the American Association for the Advancement of Science, speaking officially for the 18,000 members of that great association which includes the entire personnel of American science, has again gone on record as favoring calendar reform. At the last annual meeting the following action was taken:

"*Resolved*, that the American Association for the Advancement of Science approves of any alteration in the calendar that would adjust it to modern conditions for scientific work and that the Association would welcome in this connection co-operation with other bodies such as the committees of the League of Nations that are concerned with this subject, and,

WHEREAS, The Council is convinced that calendar simplification should be internationally adopted for the benefit not only of scientific work, but also of commerce and of the peoples of the earth in their daily lives, and likewise for the promotion of international and national understanding; therefore, be it

Resolved, That the Council advocates calendar simplification for international adoption as soon as may be practicable, and the calling of an international conference to report upon the best method, agreeable to all nations concerned, that will remove the serious defects of the present calendar; and favors a revision of the calendar such that the year will consist of 13 months of 28 days each and and extra day of non-week-day name, with an additional midyear leap day in leap years."

An editorial expression of opinion on the part of the SCIENTIFIC AMERICAN, regarding calendar reform, will be short: we favor it, though not necessarily in the above manner.

Under the Mediterranean

AN undersea railway tunnel, the conception of which, at first thought, seems to savor of the imagination of a Jules Verne, has been proposed by Spanish engineers and already preliminary steps have been taken looking to its ultimate construction. It would pass from Spain under the sea to the land of Spain's traditional enemies, the Moors. It would be 20 miles long—the world's longest—and 1500 feet below sea level at its deepest point.

Offhand, the economic value of this tremendous undertaking may be questioned. It may seem like more or less of a local affair, a connecting link between Spain and her north African interests. To realize its full significance, one must consider the vast commerce that is carried on between the African west coast and all of Europe. The products of the Belgian Congo, Liberia, Sierra Leone, the Gold Coast, the Ivory Coast, to say nothing of immense French and British possessions farther south, to the east, and closer to Europe on the Mediterranean—all with vast natural resources in minerals and products of tropical jungles and plantations—are rapidly assuming a very important place in the world's commodity markets. With a rail link directly through to Europe, it is certain that the future growth of western Africa would be phenomenal. And although the tunnel under the strait is as yet only in the projected stage, it is possible that within a decade or so a cargo of freight may be loaded on a train at Capetown and be discharged in Madrid, Paris, Brussels, or Berlin.

France and the Naval Conference

THE Conference has encountered only the expected obstacles but they offer more difficulty than at first appeared. In addition, the overthrow of Tardieu's cabinet provided an unexpected delay of three weeks and pointedly reminds the Conference of Mr. Macdonald's tenuous hold on the British Premiership. The domestic affairs of Great Britian, France, and even Japan are having a powerful, and may later have a decisive, influence on the outcome of the parley.

It is commonly reported in England that the Conservatives and Liberals will allow Mr. MacDonald to remain in office only long enough to convince independent British voters that the Labor Party's program will not solve the problem of British unemployment. In the last test vote in the House of Commons on one feature of this program, the Government was supported by a bare majority of eight. The necessary votes were furnished by Liberals who, anxious to prevent the premature fall of the Cabinet and the failure of MacDonald's naval disarmament program, supported domestic legislation they scarcely approved.

Tardieu's overthrow and rapid return have probably stiffened his attitude towards the Conference and it is now believed he will not reduce France's claims for more tonnage unless he is given some guarantee regarding the French position in the Mediterranean. Majority British opinion is against such guarantees and informed commentators point out that a similar agreement with France in 1907 guaranteeing French colonies and Atlantic Coasts from the German fleet, in exchange for protection of British interests in the Mediterranean by the French fleet, was the first of a series of steps that eventually involved Britain in the costly World War. This section of British opinion is firmly determined to entangle itself no further with Continental Europe. If this determination involves the failure of the Conference, they are prepared to accept the consequences and to resume their

(*Please turn to page* 402)

Revising Our Air and Our Water

A Piece of Research in Pure Science Provides an Unexpected By-product, Giving Atmospheric Oxygen an Isotope

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

THE radiations which the human eye can see have of course been thoroughly studied. The shorter ultra-violet waves have been photographed to the limit which the opacity of the earth's atmosphere sets inexorably. But the long waves of the infra-red until very recently have been detected only by the heating effects which they produce, (see upper illustration, opposite page) and this is a relatively insensitive method which no one would think of using for radiations which could be seen or photographed.

For years, therefore, astronomers have dreamed of plates which would be sensitive not only to red light but to the slower vibrations which the eye can not see. It has long been known that plates bathed in solutions of certain dyes become sensitive to the yellow and red, and these can now be bought anywhere. But to find dyes which would extend the sensitiveness still farther is a difficult thing to do and, moreover, a very expensive one requiring the work of many trained investigators. A few years ago the search seemed at a standstill, for all the money which was available to follow up a problem of purely abstract scientific interest had been exhausted. Relief came from an unexpected quarter.

ORDINARY blue sky reflects a great deal of the shorter waves of sunlight but very little of the long waves. So if a landscape photograph is taken through a screen which transmits only deep red and infra-red light the sky looks black on it. With the plates then available this demanded an exposure of minutes which, for a scientific curiosity, was all very well. Meanwhile, however, the moving picture producers had struggled with the problems presented by night scenes in their plays and succeeded by the use of powerful floodlights, which were naturally expensive. The infra-red landscapes showed just the combination of dark sky and brightly lighted foreground which they wanted but the exposures were far too long. An emulsion highly sensitive to the infra-red thus changed from the dream of the pure scientist to a requisite of a great industry. This justified the cost of further investigation and a new dye, "neocyanine," was discovered by the chemists of the Eastman Kodak Company, which makes it possible for the producers to photograph their "night scenes" in broad daylight.

The light which is most potent in producing these pictures is not really "invisible" but lies close to the limit of the visible spectrum at which the human eye, having already sunk to something like a thousandth part of its sensitiveness for the more familiar yellow and green rays, gives up the struggle to see further. The new plates are at their best here, and their range extends far out toward the longer waves, though with gradually decreasing sensitiveness. With the aid of these new neocyanine plates Dr. Harold D. Babcock at Mount Wilson Observatory photographed the solar spectrum to about 11,500 Angstrom units, some 2000 Angstrom units farther than the limit of previous knowledge, and has measured many hundreds of lines in the new region (see cut).

A REMARKABLE PHOTOGRAPH

Taken in total darkness by Babcock, by means of infra-red (heat) radiation from three common 600-watt electric heaters under-excited so that they were invisible even to the dark-adapted eye. Exposure 48 hours with F/2 lens. The "secret" is the new neocyanine sensitized plate

It was by no means easy work. The chief trouble came from scattered light. Even in the best spectroscope a small amount of light is reflected from the surfaces of the lenses and the prisms (or the grating) and, after various vicissitudes, is distributed broadcast in the field of view. In ordinary work this produces a faintly luminous background which does no harm at all. But in the present case the plates were hundreds of times as sensitive to the ordinary red rays and even to those just beyond the limit of the eye as they were to the long waves which were to be studied, and if indeed even a very small part of the former rays were scattered the plates became fogged. It was necessary to find some screen to place in the path of the rays just outside the spectroscope which would cut out entirely the red and near infra-red while transmitting the longer waves. After many tribulations this problem was solved and step by step a new region half as long as the visible spectrum was added to the field of precise astrophysical knowledge.

After the hundreds of lines have been accurately measured, new problems arise. Some of them are produced in the absorption of light by the hot gases of the sun's atmosphere, others by the cold gases of the earth's. To distinguish between these an old but very pretty device may be employed. Photograph on the same plate in parallel strips the spectrum of the eastern and western limbs of the sun. The first is coming toward us, the second receding, and in consequence all the solar lines are slightly shifted toward the violet and the red, respectively. The lines produced in the earth's atmosphere are of course unaffected and may thus be distinguished with certainty.

THE next task is to find what substances produce the lines and this will take some time, for the spectra of even the more familiar elements have not yet been photographed in this new region. A few strong lines which had been detected in the laboratory by means of heat measuring devices already have been identified.

Nearer the visible spectrum where laboratory comparisons were available many interesting things have already been found. For example, a group of lines belonging to carbon (see spectrogram) and two fainter lines of sulfur have been identified beyond the limit of the visible red. The first of these familiar elements previously had been detected in the sun only by means of its compounds (though some very faint lines of the element itself have since been recognized in the green). As for sulfur, the new plates provide the only proof we have of its presence in the sun.

But discoveries have not been confined to the sun. The most remarkable one has been made on our earth, or rather in its atmosphere. It is of interest primarily to the chemist and yet it has been made by the very methods which the astronomer employs in analyzing the sun. In the

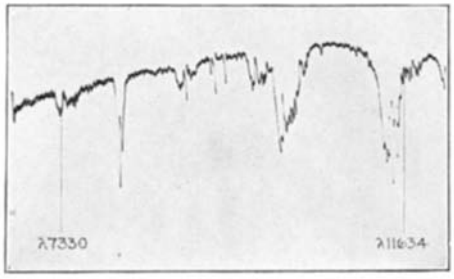
red end of the solar spectrum there are two strong bands composed of closely grouped pairs of lines which were recognized in the very dawn of spectroscopy by Fraunhofer, who gave them the letters A and B. These are due to oxygen—not to hot atoms of the element in the sun's atmosphere but to cold molecules in the earth's. This has long been known but it is only within the last few years that the theory of such banded spectra has gone far enough to let us understand what the molecules were doing.

A molecule composed of two atoms can act in a much more complicated way than a single atom—not only can an electron "jump" from one state to another but the two atoms may vibrate, changing their distance from one another, and the molecule as a whole may rotate. Both the vibration and rotation are quantized and may change from one state to another by jumps, and each set of jumps gives a different line in the spectrum. Different changes in the vibratory motion of the oxygen atoms, for example, give rise to the A band in the deep red, the weaker B band in the red, and the fainter bands in the orange and green, while different changes in the rotation of the molecules give the separate lines in each of the bands. This sounds complicated, but so are the spectra! The complications, however, open the way to find things that would otherwise be quite out of reach.

IT is a familiar enough fact nowaday that many—indeed most—of the chemical elements are really mixtures of different kinds of atoms called isotopes. The isotopes of any given element are exactly alike in their chemical properties but different in weight. Thus, for example, there are two kinds of chlorine of atomic weights 35 and 37, the observed value 35.46 being an average for the two which are present in unequal proportions.

Aston, with his ingenious "mass-spectrograph," has with great skill identified the isotopes of a great number of elements and determined their atomic wights. Is there any perceptible difference between the spectra of two isotopic atoms—for example, the two kinds of chlorine? When we have to deal with the spectra of free atoms the differences are of extraordinary minuteness—just perceptible in one or two cases with the most powerful apparatus, but practically negligible. This means that the energy involved in jumps of the electrons within an atom depends almost wholly on their own arrangement and hardly at all on the mass of the heavy nucleus at the atom's center.

But when two atoms are united in a



OLD TYPE OF RECORD

Not a spectrogram but a bologram of a portion of the infra-red solar spectrum, made with a bolometer, by Dr. C. G. Abbot. The varying heat as different parts of the spectrum were passed changed the resistance of platinum wires, actuated a galvanometer, and cast a beam of light on a laterally moving photographic plate. The limit of Rowland's former photographic study of the spectrum, also the new limit with neocyanine, are indicated at wavelengths 7330 and 11634 A. U.

molecule things are different. The energy of vibration of the two about their average distance, or the energy of the rotation of the molecule, does depend to a considerable degree upon the actual weights of the vibrating or rotating particles, and there are corresponding differences in the spectrum. For example, there are two kinds of atoms of boron, of atomic weights 10 and 11. When combined with oxygen (to form the incomplete molecule BO) each of these isotopes gives a complete band spectrum. The two sets of bands are just alike in structure but shifted in position sometimes by a good many Angstrom units, so that they may easily be separated on the photographs. In this way the existence of a number of Aston's isotopes has been confirmed independently.

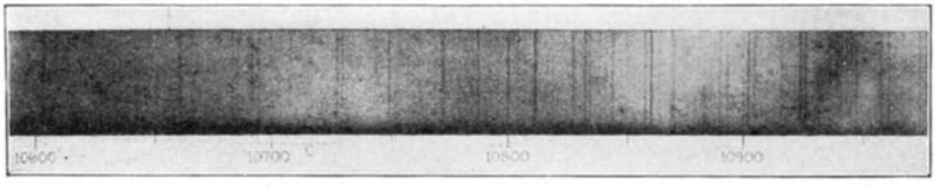
Now in the vicinity of the strong lines of the A band of oxygen there are some much fainter lines also produced in the earth's atmosphere. Two young investigators at the University of California, Giauque and Johnston, using Babcock's measures, have found that these lines are exactly where the bands due to an isotope of oxygen ought to be. The ordinary atom of oxygen has a weight of 16 standard units, and the common oxygen molecule O_2 is composed of two of these. Molecules composed of one oxygen atom of weight 16 and one of weight 17 account for the new bands.

A new kind of atom in the air which we breathe has therefore been discovered by spectroscopic observation of the sun. Moreover, the spectra showed how much of the new kind of oxygen was there. By comparing the strength of the lines of the new molecule produced when light traverses the whole thickness of the atmosphere, with those of the familiar kind produced by layers of air a few meters thick, Babcock found that only 1/1200 as great a thickness of air was required to match the lines. Hence only one oxygen atom in 1200 is of the heavier sort. This explains the otherwise disconcerting fact that Aston's very careful work did not detect the new isotopes, for according to his own estimate his apparatus could not have shown it up if it had been less than 1/1000 as abundant as the principal isotope.

It is probable that the spectroscopic method may detect other isotopic atoms present in too small amounts to be found otherwise. If there are two kinds of oxygen there must also be two kinds of water, ordinary H_2O with an atom of O_{16} and a rarer kind with O_{17}. Is there hope of detecting the latter among the numerous water-vapor lines which are produced in the earth's atmosphere? Some day perhaps, but a deal of work remains.

WATER is an amazingly complicated thing, even in its simplest form of vapor. Its molecule contains three atoms and such a system still defies the best efforts of theory. All three atoms attract one another and they may all change their mutual distances when they vibrate, so that a great many different modes of vibration are possible. And when such a molecule rotates it will not in general rotate smoothly and uniformly but will wobble in accordance with definite mathematical laws and in a very complex fashion. We should therefore expect the spectrum of water vapor to be complicated and it is exceedingly intricate—full of bands extending from the visible spectrum up to wavelengths more than 100 times as great. The recent photographs show that the infra-red bands are composed of a multitude of lines too closely packed to be separable except by the photographic method.

To work out the complicated changes in the molecule which produce these lines will try the mettle of the best investigators, and it may be a long time before all the problems which the new photographs of the spectrum offer have been solved.—*S. S. Leopolis, Gulf of Corinth, Dec. 9, 1929.*



INFRA-RED SPECTROGRAM MADE PHOTOGRAPHICALLY

The range of radiation included here—half as long as the visible spectrum—would be totally invisible to the eye and would not affect an ordinary plate. Other spectrograms have been measured as far into the infra-red as 11634 A. U. Line in margin near 10700 is almost certainly due to atomic carbon in the solar atmosphere. Spectogram kindly furnished by Babcock of Mount Wilson, the astronomer to whom Dr. Russell refers in the text

When You Buy Your Plane

What Details of Construction, Features of Operation, and Factors of Safety to Consider

By LIEUTENANT (j.g.) H. B. MILLER, U. S. N.

THE uninformed non-flyer who is in the market for the purchase of an airplane is immediately astounded with the number of models and types from which he may choose. As in the automobile industry, each particular type has its adherents.

The prospective purchaser finds that every professional aviator is a potential salesman for some airplane company. His arguments are generally shaded by a possible commission. True, however, if he does not believe in the type of plane he himself flies and sells, no one else could be expected to have any confidence in the ship.

As a matter of fact, each particular type of plane probably has one or more good features. All the best points can not be incorporated in any one ship. Every plane is a compromise. For instance, if a high top speed is desired, a high landing speed necessarily results. But, it happens that a low landing speed is also desirable. Both cannot be had in the same plane. The designer gets to work. He adopts a safe landing speed and must accept the maximum speed which is then attainable.

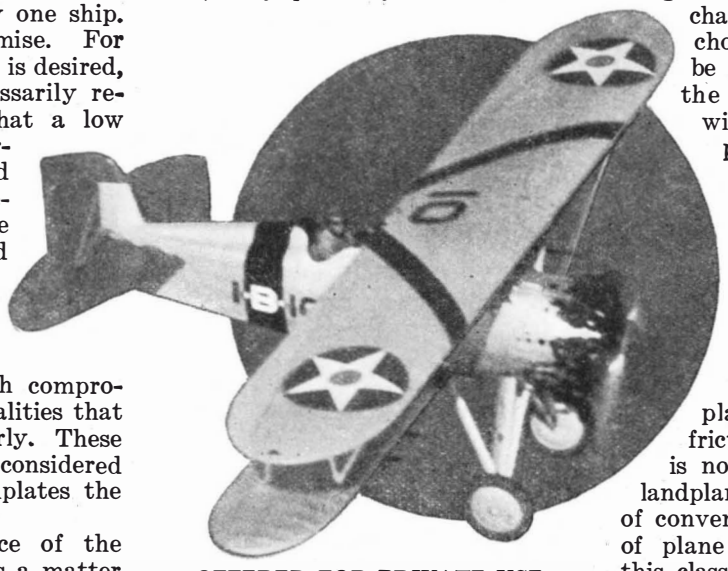
Each type of plane is the result of a number of such compromises. Certain definite qualities that are desirable stand out clearly. These points should be thoroughly considered by the person who contemplates the purchase of an airplane.

The order of importance of the various desirable features is a matter of circumstances and requirements. Take for example, the man who has hired a capable pilot to fly his plane. A high top speed with a reliable pilot will more than offset the combination of a slow landing ship and a less capable pilot.

EACH designer of the 170 licensed types of planes on the market has tried to make his ship the best of its class. He has endeavored to incorporate in it maximum performance, highest efficiency, and the greatest possible safety. Some of the resulting planes are better than others. A discussion of the various features which should be observed and considered may prove of interest to the man who has begun to read airplane advertisements with a personal interest.

The very first consideration is naturally one of money. The sale of any article usually depends upon the cost price. The American custom of time payments has reduced in importance somewhat the economic value of this factor. To a transport and passenger company the initial cost must be subjected to the other items such as safety and payload.

Time payments have been applied to practically all industrial products. Now even aeronautical corporations are taking advantage of this system of financing to increase their sales. The future of aviation is closely related to the youth of the country. It is unlikely that young men will have the capital necessary for the outright purchase of a plane. On the other hand, they probably will be able to make the first payment on a new ship. Final payments will be made with money earned in carrying passengers or in their usual occupations.



OFFERED FOR PRIVATE USE

This Navy fighter, offered as a sport model, is fast and easily maneuverable

Wide price ranges are now available to the buyer. The cost price of a plane is generally a fair index of the power, speed, and finish supplied by the manufacturer. It parallels the automobile to an amazing extent in this respect. Quantity production will naturally lower the sale price, but that day still lies in the future. Planes are available for a sum as low as 900 dollars. If you will recall the discussion concerning compromises, however, you will realize that you get very little but a low initial cost. The plane will lack power, safety, comfort, speed, and payload. You will obtain, however, a low landing speed and economy of operation.

Sales prices run up to six figures. The cost price is influenced most by the power plant with which the plane is equipped. A fairly accurate thumb-rule is available for the uninitiated. Everyone knows the relation existing between the market values of automobiles and their performances. An airplane proportionately equal in comfort, speed, and operation to an automobile can be purchased for approximately three times the cost of that particular car.

THE kind of territory in which a plane is to be used decides the general type which must be purchased. In some localities a choice of land or seaplanes must be made. Here convenience is the criterion. Safety, of course, will influence a transport company to use seaplanes. On the other hand, seaplane terminals are often difficult of access—both for the passengers and for the planes. Corrosion resulting from salt water is difficult to combat. Power being equal, the payload of a landplane is greater than that of a seaplane because of less take-off friction. If the over-water flight is not too long, multiple-engined landplanes can be used for the sake of convenience. The amphibion type of plane is particularly adapted to this class of work. The safety factor of a seaplane is enjoyed while the advantages of a ground terminal are retained.

A young flyer is more likely to desire an open cockpit type of plane. The wind rushing around his ears creates a happy illusion of immense speed and power. This type of ship is best built as a two-seater, though it often comes as a three-place job. Few provisions are made for the carrying of luggage. It is the roadster of the air.

Any number of planes are available for sport purposes. One can be found to suit the experience of any pilot. The latest navy fighter is offered by one company as a commercial sport model.

The cabin ship can be had with any number of seats. Plenty of room is always available for suitcases and

picnic lunches. Flying clothes are unnecessary, for ordinary clothing will not become soiled. Conversation is possible and a cigarette can be enjoyed while at the controls. Maps can be studied at leisure without fear that they will blow away. The children will not fall out upon unsuspecting pedestrians.

If a plane is to be used for training, certain definite qualities are required. The best all-around type is the open-cockpit two-seater. A low stalling speed is desirable. High top speed is not necessary for the student. The ship must be sturdy to withstand the terrific shocks to which it will be subjected. In order to permit a thorough course of training, the plane should be designed for stunting. A medium sized power plant is sufficient. Since a student is likely to have minor crack-ups, the training plane must be easy of upkeep. The engine should be accessible from all angles. Ease of maintenance and upkeep are paramount.

The terrain over which your plane is to operate must be considered. If a ship is to operate only at sea-level, its ceiling is of little importance. However, if mountains are likely to be encountered in any of your trips, reserve climbing power must be available.

The Rocky Mountain range was nicknamed "Jenny Divide" in the days when the wartime JN-4 was in its prime. Only a good Jenny could get sufficient altitude to fly over these mountains. Even those that did succeed in making the grade had to dodge around the higher peaks.

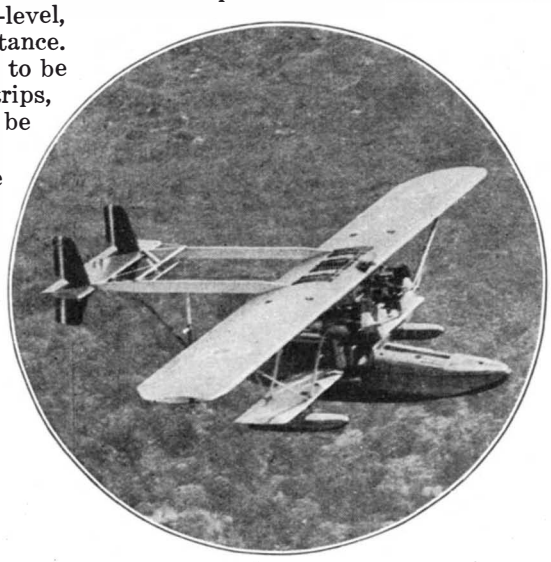
As a plane climbs higher, its stalling speed increases. In practical terms this means that a ship must land at a faster speed than normal on a field situated at high altitudes. A long roll necessarily follows a fast landing. Unless a long field is provided, brakes should be installed. Conversely, a long run is also required for the takeoff. Requirements for a high-altitude plane are maximum power, maximum wing area, and minimum weight.

The argument concerning the relative merits of the biplane and the monoplane will long continue. Generally speaking, the biplane has more strength than the monoplane. For straight commercial work, however, where no undue stresses are placed on the ship, the monoplane is sufficiently strong. The advantage of all around visibility appears to belong to the biplane in spite of the extra wing.

The monoplane has less parasite resistance because of the absence of brace wires and the extra wing. Accordingly, it is generally faster. On the other hand, where maximum wing area is necessary, as in carrying heavy loads at high altitudes, the span of the single-winged ship becomes enormous and unwieldy. The Boeing Company, which operates over the Sierras, continues to use large biplanes for passenger work. The enormous amount of wing area permits greater loads to be carried and allows a slower landing speed.

Most people are very apt to think of safety as a quality which can be built into a plane at will. The airplane designer can contribute a great deal to safety. In the end, however, it is the pilot who builds or destroys the reputation of a plane. A poor and untrained pilot may crash a plane which has always been considered very safe.

As long as gravity continues its work, crashes will result. The best pilots have cracked up a plane or two sometime in their career. The desirable plane, then, is one which will best withstand a crash. It is one that will insure the greatest protection to the pilot and his passengers.



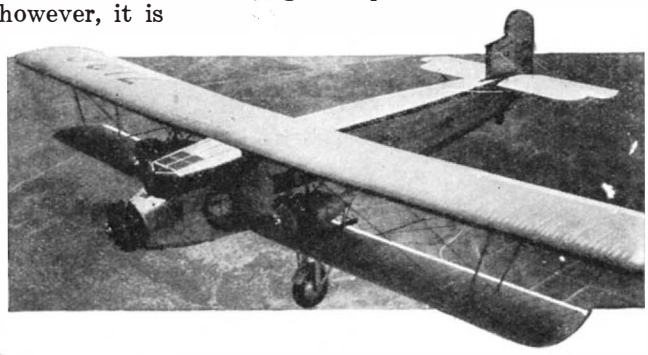
VERSATILE

The amphibion type of plane, used for flights over either land or water is, in some respects, the ideal

Modern steel and alloy construction has replaced wooden strength members. No longer are cockpits likely to fold up on the pilot to pin him in. Fittings and wing bracings should be sufficiently strong to withstand necessary shocks. Component parts of the landing gear such as wheels, axles, and struts should be especially strong. A split-axle type of landing gear is particularly helpful in forced landings. It will straddle bushes and stumps instead of causing the plane to nose up.

Planes can be and have been built that will not spin unless deliberately forced into this condition. Peculiarly, planes that are difficult to spin are also generally very hard to bring under control once they have been worked into one. Unfortunately, a ship of this design invariably sacrifices its maneuvering qualities. Maneuverability is necessary along with a fair amount of stability.

It is assumed that parachutes will be standard equipment for a single-engined plane. Preparations for abandoning a plane in mid-air are best made when selecting the plane. If an open cockpit job, is the cockpit under the wing? A plane that is hard to climb into is even more difficult from which to jump in an emergency. The Department of Commerce now requires one door in a cabin plane for every six passengers.



GREATER WING AREA

Relatively larger loads and slower landing speeds are possible with this transport

A plane to be worth consideration must have good visibility for the pilot. Otherwise potential collisions on the ground and in the air will exist. Certain blind spots are unavoidable, but careful design will reduce these spots to a minimum. A ship that maneuvers well permits the pilot to uncover the necessary blind spots quickly.

THE fire menace has decreased due to proper plane and engine design. Battery ignition has been eliminated. Fire walls between the engine and the fuel tanks are protective. Electrical insulation must be such that it can be easily maintained. Gasoline and oil lines should be short and free from vibration, otherwise they will crack and increase the fire hazard. The addition of metal control surfaces in the future will insure control of a plane in the air even though it should catch fire. A pressure fire extinguisher is essential. A liquid (CCl_4) under high pressure in a small cylinder can be released by the pilot in the cockpit. This is discharged through small jets at critical locations about the engine, such as the carbureter.

A minimum upkeep and operating expense is essential to commercial aviation. To the person who operates a plane for pleasure, expenses are a necessary evil to be reduced as low as possible. The lighter the plane and smaller

EASE OF MAINTENANCE AND INSPECTION ARE PARAMOUNT

Since the student flyer will inevitably have minor crack-ups, the training plane must be of a type easily maintained and yet sturdy. It must be capable of "taking much punishment"

the engine, the smaller the expenses. A light plane compares favorably with a medium sized car in gasoline consumption. Fuel consumption increases with power and load. A thorough understanding of engines by the pilot results in increased economy in the operation of the plane.

Hangar fees are nearly constant for the standard size small plane. This increases rapidly, however, with wing span. Folding wings offer some solution to this problem, especially if a person erects his own hangar and has but limited space.

Service stations are now springing up all over the country. It is no longer necessary for each pilot to be able to serve as a mechanic on his plane. True, he must know a few fundamentals and rules in order to obtain proper operation of his engine. Both top and major overhauls can be done by qualified aviation service experts at a reasonable cost. Rigging and fabric jobs can be done equally well by these staffs of experienced men. In fact it is now possible to have practically any kind of repairs made by experts in any section of the country without serious loss of time in waiting.

EASE of maintenance and inspection is essential. Control wires should be run so that there is no danger of their jamming in unguarded pulleys. No trick gadgets which hide working parts should be tolerated. The engine cowling must be such that it can be easily removed and other parts should be easily accessible.

Above all, the plane must be essentially rugged. The best pilots occasionally make poor landings. Poor pilots invariably make poor landings. In either case, the landing gear takes a beating. Some form of oleo shock absorbers will often save a broken landing gear. Another aid is the adoption of oversized wheels and tires. They will cushion a hard landing. In a soft field they will keep the plane from sinking into the soil. A plane so equipped will be able to get in and out of fields the condition of which would otherwise cause a crackup.

Most engine mounts of planes are convertible and the manufacturer allows the customer a choice in the selection of the power plant which is to be mounted in his ship. The amount of power needed depends directly upon the weight of the plane and the performance the buyer desires.

The engine that is chosen, whether for a single or multiple-engined plane, should be one that has proved its reliability in actual service. Past performance will indicate what you might expect from it. As with all machinery the results are proportional to the care and upkeep given them. Flying with wide open throttle may bring you to your destination quicker, but it will bring very little return for your investment. Top speed operation will necessitate more frequent overhauls.

An engine easy of maintenance is especially desirable. It indicates first of all a simple and orderly type of construction. This can be interpreted to mean that the designing engineer knew what he was about. A mechanic can check over and service a "clean" engine installation quickly and in a satisfactory manner.

Comfort while in the air makes flying a pleasure and decreases weariness. It is a short cut to safety, because it permits the pilot to devote his entire time to piloting. All manually operated controls must work easily. A long cross-country flight will develop all points of discomfort to a very marked degree.

The frequency of well-equipped airports in this country makes the endurance of a plane of minor importance. Fuel capacity of from three to four hours is desired, however, in order to reduce the servicing of the plane. The endurance of large transport planes is seldom over five hours, although they could fly much longer. However, it would be necessary to leave many pounds of payload behind in order to carry additional fuel which pays no dividends. It is thus more economical to have the planes land and refuel more often while they carry a larger pay load.

THERE are planes for every one—for every purpose. Prices fit all pocketbooks. Different makes and models satisfy different needs of the buyer. All desirable requirements can not be had in any one plane. Some points must be sacrificed during the design compromise. The prospective buyer, however, will discover a plane in the market of today which will cover the majority of his demands.

After the plane is purchased its performance depends almost entirely upon the pilot. A good flier will fly the ship in a way that will bring satisfaction to the owner. A poor or inexperienced pilot will obtain poor results from any plane. So, in addition to careful consideration in the buying of your plane, handpick your pilot!

Courtesy Bellanca Aircraft Corporation

FOR GENERAL PURPOSES

A typical small cabin plane. Comfort and cleanliness, which make flying a pleasure and decrease weariness, are exemplified in this plane. Many good features are noticeable

Florida's Lusty Infant Industry

Tree Producing Invaluable Tung Oil Now Naturalized American

A CENTURIES-OLD Chinese industry may soon be forced to yield its hold on the American market to an infant competitor in Florida, according to Professor M. Ogden Phillips in an article in *Economic Geography*. Each year American manufacturers pay from 10,000,000 dollars to 15,000,000 dollars to Chinese producers for this oil which is superior to linseed oil for the production of high grade paints and varnishes, and is used in the making of linoleum, insulating materials, soaps, water-proof cloth and paper, and many other products.

The first tung oil tree in Florida was planted in 1906 and in 1913 the first tung oil to be produced on the American continent — 2.2 gallons — was extracted from a bushel of the seeds. In the fall of 1928, over 160,000 trees had entered commercial production. Florida tung oil trees three and a half years old have produced over 300 nuts per tree in contrast to 130 nuts from a 10-year-old tree in one of the best groves of China. Certain individual trees in Florida have produced as much as four gallons (32 pounds) of tung oil in a year.

The peculiar qualities of tung oil make it superior to linseed oil and give it a higher market value. Flax, from which linseed oil is obtained, must be planted each year while tung oil trees are planted only once for a production of 25 to 30 years. Flax is susceptible to disease when planted continuously on the same land and is hard on the soil, requires plow cultivation and thus invites erosion, and must be harvested promptly when mature. Tung oil nuts can be left on the ground for weeks and gathered at the convenience of the grower, and the trees retard erosion of the soil.

The crop of nuts is gathered, husked mechanically, and then allowed to dry thoroughly. The seeds are then cracked and pressed whole without removing the seed coats. Before pressing, they are heated sufficiently to make the oil flow readily.

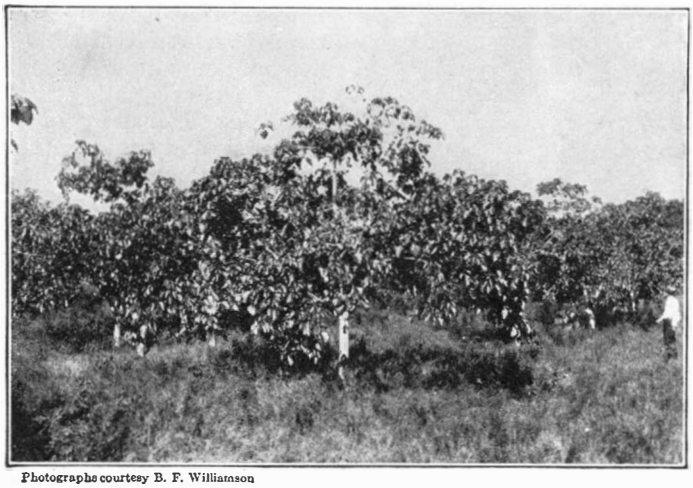
The maximum yield of oil from flax seed is 255 pounds per acre while the yield from an acre of nine-year-old tung oil trees is 1800 pounds.

A YOUNG PRODUCER

The tung oil tree does not differ much in appearance from common fruit trees

A HEALTHY START IN LIFE

Tung oil trees are grown in outdoor nurseries, then planted 116 trees to the acre



Photographs courtesy B. F. Williamson

A TYPICAL TUNG OIL TREE GROVE

Trees begin to bear within three or four years. After the seventh year, when crowding begins, they are thinned to 60 trees per acre

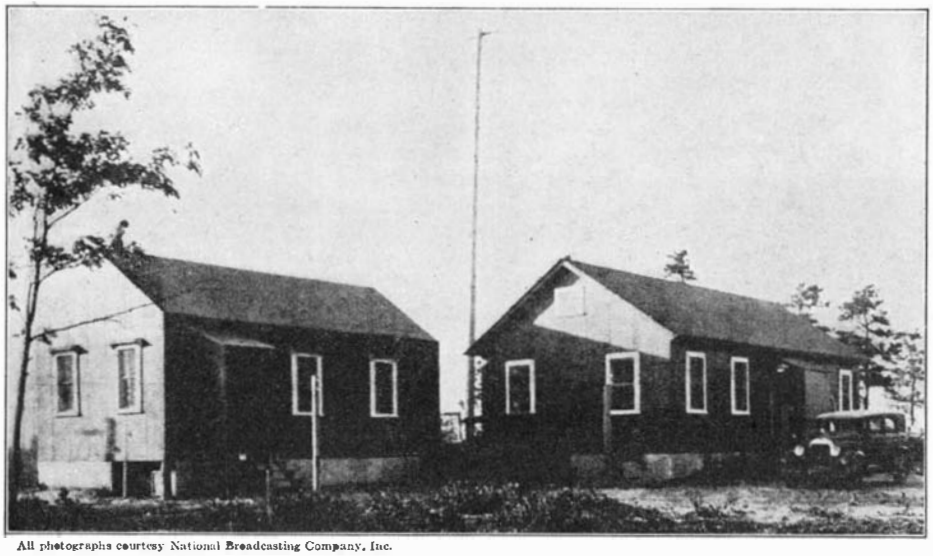
DRYING PREPARATORY TO PRESSING

Part of a recent crop of tung oil nuts. They are stored until dry. It will be noted that they are about the size of small apples

Voices Across the Sea

The Successful Exchange of International Programs Places Another Milestone on the Path of Radio Progress

IT will probably surprise some people to learn that the groundwork for the recent international exchange of radio programs was laid about the time crystal radio receiving sets were the rule rather than museum curios. Ten years ago, when engineers and business men first realized that the baby radio showed promise of becoming a giant in a decade, engineers of the General Electric Company, the Westinghouse Electric and Manufacturing Company, and the Radio Corporation of America began to experiment in long distance transmission. These engineers declare that engineers abroad should share equally in the glory of the achievement.



All photographs courtesy National Broadcasting Company, Inc.

THE RECEIVING END ON LONG ISLAND

In these two buildings the radio signals from England, Holland, Germany, and Sweden are monitored daily. All foreign programs to be rebroadcast are picked up at this point

First experiments were conducted with the so-called long waves, many of them of the same frequency as those used for regular broadcasting in the United States today and others even longer. Then the short waves, more or less overlooked, were picked up by the experimenters and it was discovered that they had tremendous possibilities for covering great distances. To date, short-wave transmission is considered the best available method of sending radio signals from continent to continent.

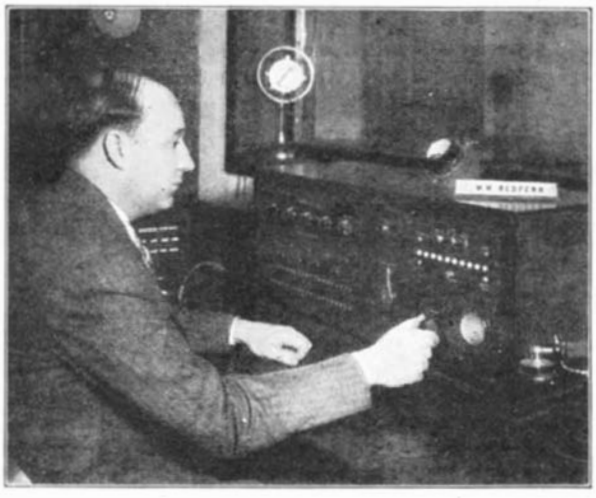
THE early work of the engineers who dreamed of a world united by radio signals was more or less haphazard. Haphazard for engineers, that is. The first objective was to exchange speech with Europe by means of radio. This, after a number of experiments, was accomplished in 1924, when the British Broadcasting Company relayed a program from KDKA for the first time.

While these experiments in long-range work were going on, regular broadcasting was developing at a tremendous speed in the United States. Distortion of sound was being eliminated and in a short space of time the presentation of a symphony orchestra on the air was as much a matter of routine as the reading of weather reports.

The ether path across the Atlantic proved to be a rough one at best, the engineers discovered, and they quickly found out that music was too fragile a thing to send long distances without serious things happening to it. And the rebroadcasting of the music from one continent for listeners in another continent was the immediate goal of the advocates of international exchange of radio programs. Equipment was improved, huge sums were appropriated for experimental work, and various types of transmitters, receivers, and antennas were tested under all conceivable conditions.

WITH the organization of the National Broadcasting Company several years ago, the work of the three aforementioned electrical groups was co-ordinated and, as a result of this co-ordination, progress was speeded. Engineers began to pick up programs from England and Germany and at times the reception was comparable to that from regular commercially operated transmitters in the United States. Little of this was revealed to the public. Then on February 1, 1929, with only a few hours' notice, a program of symphonic music, originating in London, was successfully picked up and rebroadcast through a network of NBC stations. The dream of the engineers was realized. From time to time other programs from England were heard through the American network and later came programs from Germany and Holland. Rarely were these programs planned as much as a week ahead—the engineers still were not certain of what they could do.

Christmas Day, 1929, marked the beginning of a new epoch in international exchange of radio programs. More than a week before Christmas the NBC announced that it would attempt to rebroadcast, within a few hours time, special programs originating in England, Holland, and Germany and that American programs would be sent on short waves to those countries. Though fairly confident that the programs would be received successfully, the word "attempt" was not eliminated from the announcement.



CONTROL BOOTH

All programs are monitored by studio engineers before being transmitted by the wire lines to the network

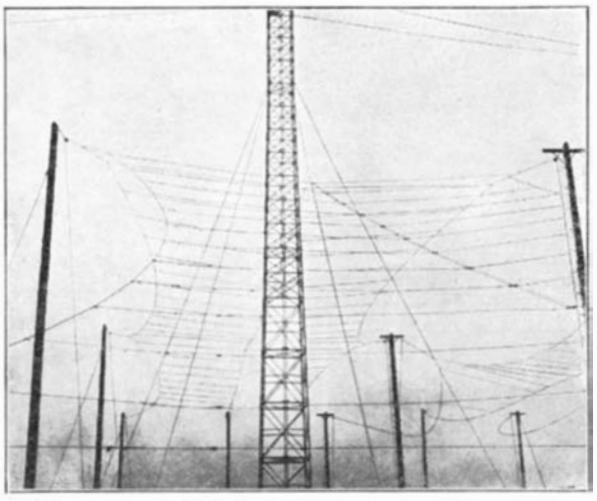
Christmas Day came and with it came three programs from abroad. The reception was better than even the most opti-

mistic had expected. Throughout the quality was comparable to the reception from domestic broadcasting stations and the American listeners' approbation was expressed in no uncertain terms.

There were several reasons for selecting Christmas Day for the great experiment. One was in order to send and receive messages of international goodwill. Another was that the atmospheric conditions were favorable. At this time the most exhaustive survey of north Atlantic radio transmission problems ever attempted had just been completed and the engineers had data never before available. Two years previously a complete record of atmospheric conditions and other matters relative to trans-oceanic broadcasting had been started by engineers. The next year a similar record was kept and the records of the first year checked against the second year's survey. The data thus obtained enabled engineers to figure on what conditions to expect at a given time, current conditions being taken into consideration.

SOME confusion seems to exist in the minds of listeners as to the exact path followed by a radio program in its journey from a foreign studio to an American home. It is well at this point to trace the route of the program. The presentation from London, received in the United States the afternoon of Christmas Day, may be taken as an example.

The artists gathered before a microphone in the London studios of the British Broadcasting Company. The program was picked up for transmission and was heard by British listeners through the regular BBC transmitters. American listeners, however, did not hear the program from the same transmitter used to send it to English listeners. Instead, the program went on land wires to station G5SW, experimental short-wave transmitter of the BBC located at Chelmsford on the coast of England. From this point it went on the air on short waves. The wavelength selected was one that long and careful experiments had shown was best picked up by the experimental short-wave receiving plant of the Radio Corporation of America at Riverhead, Long Island. These signals from abroad, when received at Riverhead, had not sufficient strength to be passed on directly to American listeners by re-transmission. At Riverhead they were carefully monitored, rectified, and then amplified and sent to the main control room of the NBC at 711 Fifth Avenue, in New York City. Here they were subjected to further attention and again amplified before being sent out on the thousands of miles of network wires that carry programs to the scattered transmitters. Amplified again at the transmitters, the program started on its last lap through the ether, to be picked up and reproduced by the receiving sets in American homes. Despite the circuitous route, the continuous amplification, and the necessary monitoring, the quality of the program heard in America differed little, if at all, from that heard by British listeners.



ANTENNAS

This forest of wires intercepts the short-wave signals from abroad, for rebroadcasting in the United States

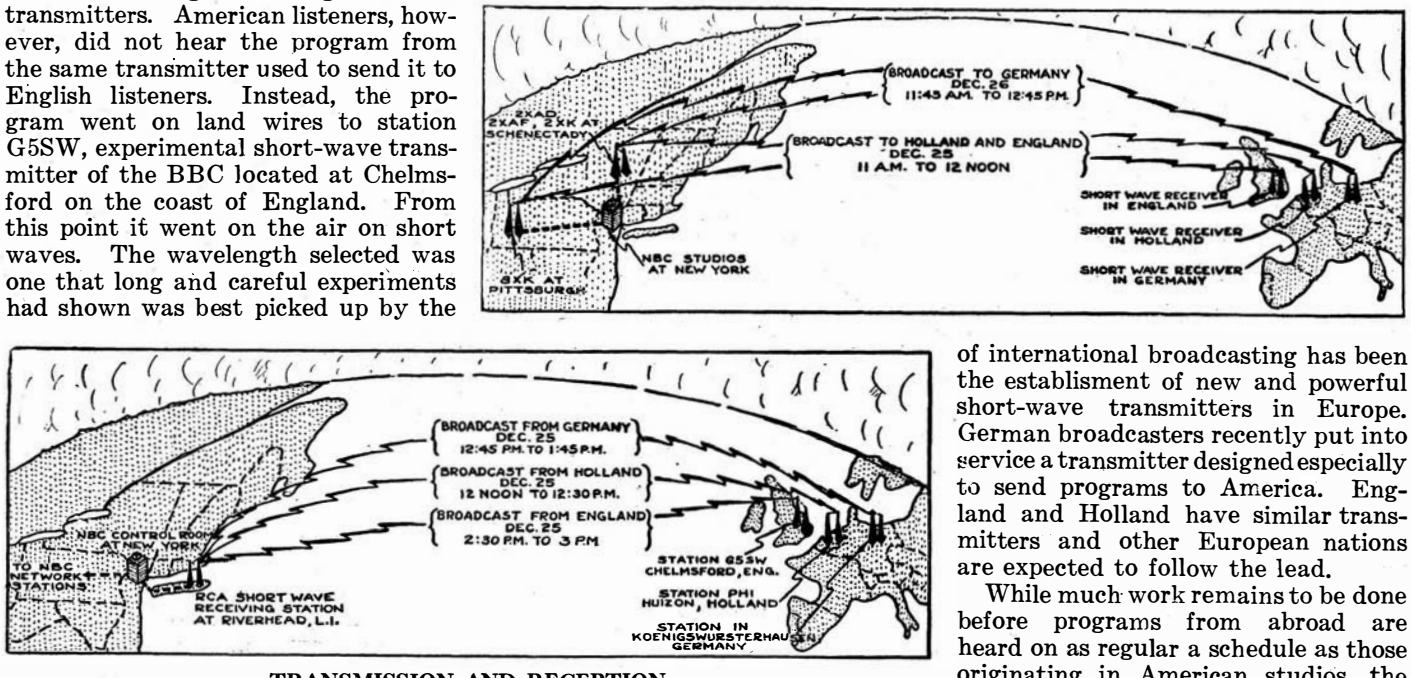
THOUGH started on their transatlantic journeys from different short-wave transmitters located in the respective countries, the programs from Holland and Germany followed the same general route.

Of the special equipment used in this international exchange of programs little can be written. Much of it still is being improved and construction details are jealously guarded secrets. Though engineers have known for a long time that static can no more be eliminated than snow or rain, they have learned much about shielding the delicate signals from atmospheric disturbances.

Standard antennas do not give the best results in the reception of short-wave signals, engineers discovered, and the result has been the development of a new type of antenna, covering acres of ground and resembling a huge spider web. Similar problems in every technical phase of the program interchange brought radical changes and developments in equipment. There is as much difference in the equipment used for regular broadcasting and for short-wave transmission and reception as between a stock model automobile and a machine built exclusively for racing.

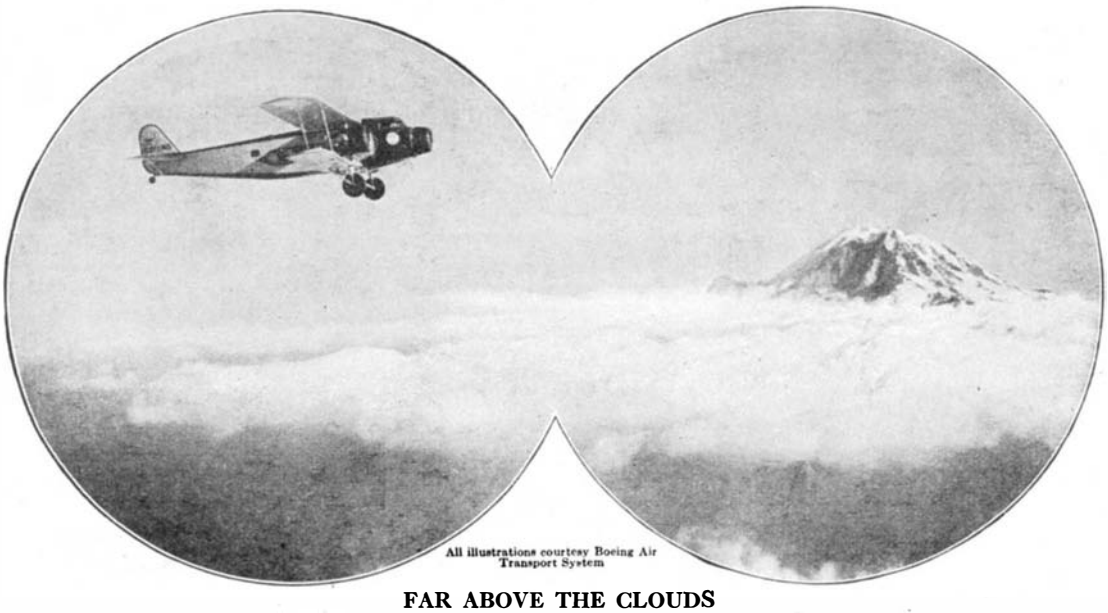
Of great assistance to the progress of international broadcasting has been the establisment of new and powerful short-wave transmitters in Europe. German broadcasters recently put into service a transmitter designed especially to send programs to America. England and Holland have similar transmitters and other European nations are expected to follow the lead.

While much work remains to be done before programs from abroad are heard on as regular a schedule as those originating in American studios, the actual pioneering is history and the public has had proof that it is possible.



TRANSMISSION AND RECEPTION

The upper illustration shows diagrammatically the Christmas broadcast from this country to Europe. The lower drawing indicates the reception and rebroadcasting in this country



FAR ABOVE THE CLOUDS

To the right is Mount Rainier-Tacoma, 14,408 feet above sea level. The three motors of the transport plane at the left enable it to rise above the crest of this famous mountain

An Air-Transport Operator Speaks

"It Is the Operator's Obligation to Employ Every Known Device to Make Air Transport Safe and Speedy"

By P. G. JOHNSON*
President Boeing Air Transport System

WHEN at the end of 1929, pilots of the Boeing system, operators of the two longest airmail routes of the country, completed 8,000,000 miles of flight, the first time any company in the United States has achieved that honor, it prompted reflection on the lessons learned in flying these 8,000,000 miles.

The Boeing Airplane Company, which started 13 years ago with a one-room factory employing 30 people and grew into the largest plant in the United States devoted exclusively to the production of airplanes, had done no commercial flying prior to 1927. We had been making airplanes, most of them for the government, but when the government decided to retire from the operation of airmail planes and called for bids on the Chicago-San Francisco leg of the transcontinental route, we decided to become operators.

We knew in a general way that this route (which is the longest regularly operated mail-passenger line with daily service in the world), would call for a heavy investment, the best type of plane which could be built or bought, and eternal vigilance and care in the operation of these planes. We put in a bid and won the award.

We then found that, to operate this route successfully and build up patronage, the types of plane then available would not be adaptable for our use. In 150 days we designed and built 25 mail-two-passenger planes, distributed them along the line with preliminary test flights over the route, organized operation and traffic departments, and at midnight of June 30, 1927, started flying the airmail. Now we have more than 8,000,000 miles behind us. The lessons we have learned and the methods employed have a bearing on air transport operations in general.

The theory of our system is that the mail must be put through on schedule if possible within the margin of safety. That we have been quite successful is evidenced by the fact that in the flying of 8,000,000 miles there have been only three fatalities. Our plan of servicing planes really begins at the factory, because the designers have the benefit of suggestions from men who are flying our planes 10,000 miles a day. Consequently, our high-speed, large-capacity cargo planes, the mail-two-passenger, mail-four-passenger, and large tri-motored transports, represent not only the designers' opinions of what a plane should be but incorporate suggestions received in actual operations.

IT requires a fleet of 53 planes and 64 pilots to operate these two lines, and we are as careful in the choice of pilots as in the equipment. It is our policy not to employ a pilot who has had less than 2000 hours' experience. Most of our pilots have had from four to eight thousand hours in the air, and they are men who know how to act quickly and correctly when emergencies present themselves.

Another feature of our operations, which is quite different from that of the ordinary air transport line, is our extensive night flying. Each night our planes fly 4600 miles between dusk and dawn, and of our total mileage of 8,000,000, approximately 3,600,000 were flown at night.

Recently we completed eight month's successful operation of the first night tri-motored passenger transport service on a regular schedule over an established airway. We determined that this type of dark-to-dawn flying was not only feasible, but that the public will patronize these night planes when flown by an experienced company with proper equipment and personnel.

It is logical to expect that the percentage of night flying done by the transcontinental line will increase, because air transport reaches its maximum efficiency when it extends over the entire 24 hours.

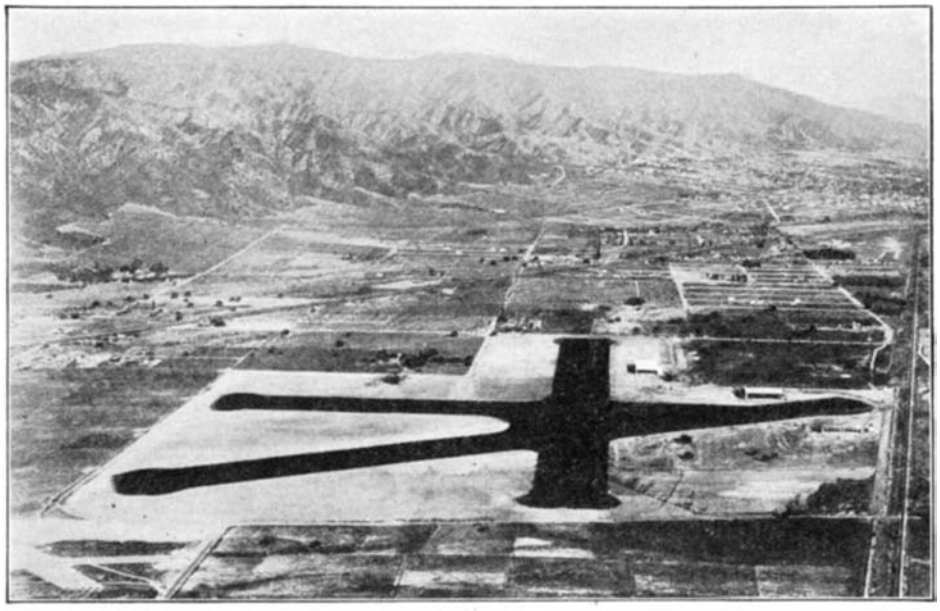
By flying at night we are able to deliver mail and passengers between points as distant as 1200 miles, without the loss of any business hours. Night flying, however, calls for supplementary equipment and also the training of pilots for this type of flying.

Another important thing that we have learned from flying 8,000,000 miles is that we can now get more

*See "Among Our Contributors," page 341.

service out of airplanes than formerly. Until recently we used five planes, one for each division, in transporting a load of mail and two passengers from Chicago to San Francisco. Because of improved equipment and engines, and more experienced personnel, we are now using two planes to do the work of these five. This means that we have made a step towards reducing the unit cost of transportation, a factor in promoting the use of the airplane.

Our experience has also taught us that most of the delays to air transport occur on the ground, and are entirely apart from structural or engine troubles, which account for only 4 percent of delayed schedules. The chief reason for delay has been the uncertainty as to flying conditions due to weather.



UNITED AIRPORT, BURBANK, CALIFORNIA

Modern terminals such as the one shown above are essential to the safe and consistent operation of a transport line. The dust-proof runways 300 feet wide are prominent features

FOR months we experimented with a radiophone system, so that the pilot could have voice communication with the ground. We wanted a set which would be workable under all conditions. During the months of tests, we ran into many exasperating situations. We found that reception varied at different altitudes; that there were areas of radio shadows, skip distances, and blind spots; spark plugs and motors set up disturbances which had to be eliminated.

Our communication department, however, whipped those problems. We are now completing the most extensive radiophone installation in both ground stations and plane equipment used by any air transport line in the world, and by the time this article is published we expect to be operating 22 ground stations in nine states, and pilots on our Chicago-San Francisco and Los Angeles-Seattle planes will be able to have continuous voice communication with the ground, and between planes in flight. Radiophone is a profitable investment because of its great safety factor and the extent to which it expedites the service.

RADIO PLAYS ITS PART

Radiophone systems are important links in airlines. The pilot can talk to ground stations 200 miles distant

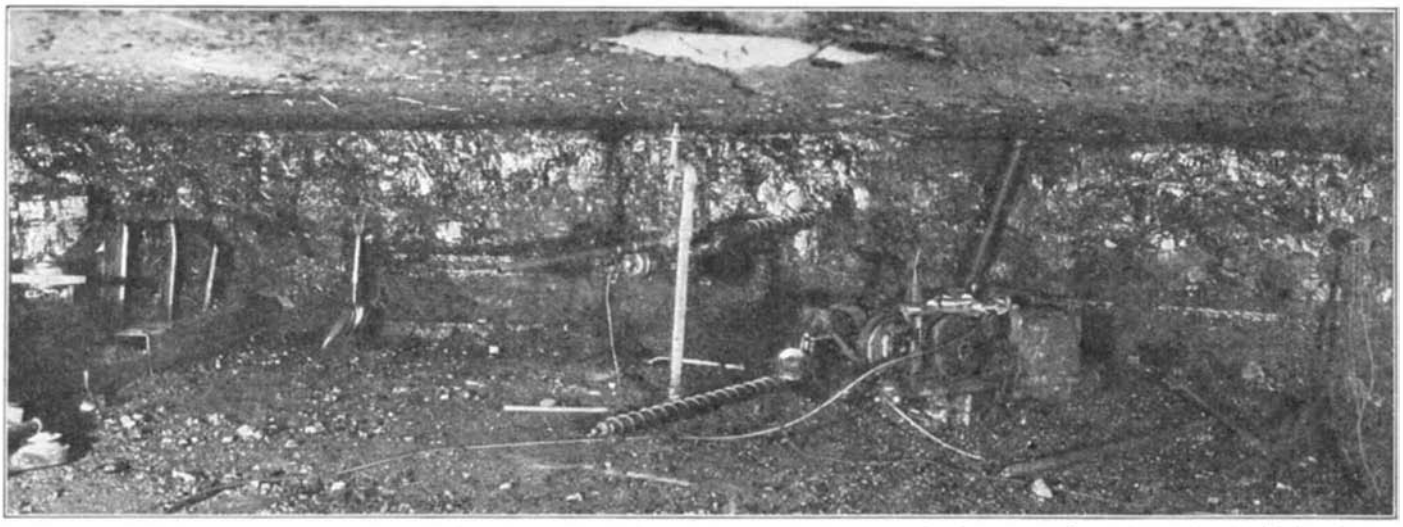
Our pilots are talking from an altitude as great as 12,000 feet to ground stations 200 miles distant. This voice communication between the pilot and the ground, and between pilots of planes in flight, has these advantages; it adds much to the safety of flying; reduces the number of emergency landings due to uncertainty as to weather ahead; enables pilots on regular routes to complete a larger number of scheduled trips on time; and increases the pay load by reducing the amount of excess gasoline now carried to give pilot ample cruising radius when he is uncertain as to weather. Radiophone is also of considerable value in dispatching planes and giving orders to pilots in the air.

Our pilots on the Chicago-Oakland-San Francisco route not only have the above described voice communication between plane and ground, but can take advantage of directive radio beacon and weather report service maintained on the transcontinental route by the Department of Commerce. In this system, a radio beam is broadcast by transmitters known as equi-signal beacons. Transmitters employ two cross loops, radiating a characteristic "dot and dash" signal. When dots and dashes blend into a continuous series of "dashes" the pilot knows he is on the course fixed by the beacon. If he hears "dot-dash" he knows he is to the left of his true course, and when he hears "dash-dot" he learns he is to the right.

We have also put into the field to supplement the present Federal weather reports several mobile weather broadcasting radio trucks. They are placed north and south of our east and west transcontinental line, at points where they can detect storms which will sweep down on our line, and by advising us in advance we can know when to keep our planes on the ground, or when to leave our regular route and fly around the storms.

WE have made these preparations in advance of starting, this spring, a 20-hour night and day passenger service between San Francisco and Chicago, using 18-passenger (or 12-passenger and mail) planes. It is the operator's obligation to employ every known device to make air transport safe and speedy, as it is logical to expect that the airplane will be developed to the point where it will be commonly used not only for the transportation of mail and express, but of passengers as well.

We have not defeated every problem in our path, but the progress we have made in the last few years would indicate that the words "it cannot be done" have been stricken from the lexicon of the air-transport operator.



ON A LONG FACE IN INDIANA

With the new carbon dioxide shell, the coal may be shot as soon as it is undercut, the machines following each other closely, as shown here. On the left is the loading machine; next comes the shot drill; then the mining machine; and at right, the new shell

Blasting Coal Without Explosives

Inert—Flameless and Non-inflammable—Carbon Dioxide in New Shell Blasts Coal With a "Slow" Heave

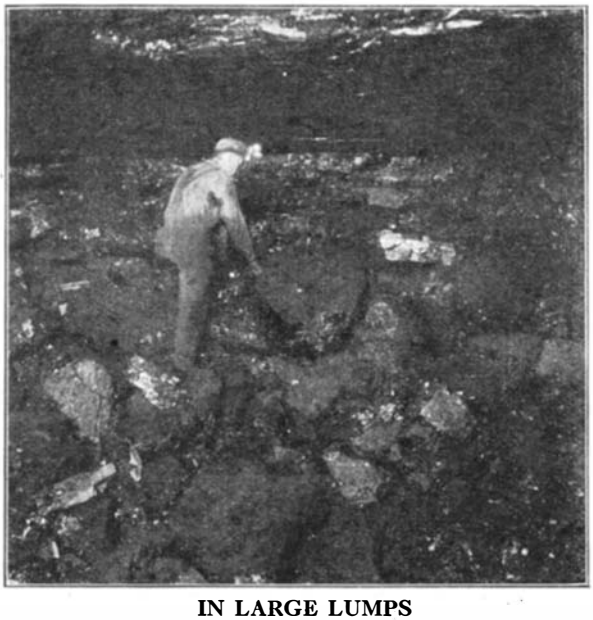
By FRANK H. KNEELAND

IN some kinds of industrial blasting, shock of detonation is of distinct advantage; in others it has a decidedly adverse effect and should be avoided by all possible means. Shock produces a shattering effect on the material blasted. Consequently, dynamite or some other "quick" explosive is usually employed in quarrying rock or other mineral where it is desired to break it into small fragments. If large pieces are wanted, a "slow" explosive gives far better results.

In coal mining where the lump sizes usually bring a higher price than the slack or fine material, a comparatively slow, heaving action gives much better results than the quick, shattering, disruptive effort of high explosive. For this reason black gunpowder has been almost universally preferred in the past by miners and mine operators.

A NEW device on the American market, particularly applicable to coal production, is not an explosive and is not so classed by the United States Bureau of Mines, although it possesses some of the general characteristics of explosives. This device, known as Cardox, utilizes the expansive force of an inert and harmless gas for breaking down the coal at the working face. No smoke, flame, or noxious odors are produced, and the results obtained are unquestionably superior to those afforded by even the slowest of explosives.

The means employed to render an inert gas effective for this purpose are extremely simple. If we could make a miniature steam boiler—small enough so that it could be loaded into a bore hole like a charge of explosive—provide it with one weak plate that would rupture under a predetermined pressure without injury to the rest of the boiler shell; if we could fill this boiler with water; and if, after it had been placed within the coal to be shot down, we could quickly apply enough heat to evaporate the water, the pressure within the boiler shell would rise until the weak plate would give way. In other words, the "boiler" would "explode," and the surrounding coal would be broken and heaved down by the expansive force of the steam. This action on the coal would be far less disruptive than that of any explosive, just as the ordinary industrial boiler explosion is less destructive than that of a powder magazine.



IN LARGE LUMPS

The comparatively slow shot of the Cardox shell does not shatter the coal into cheapened small grades

Roughly speaking, the Cardox shell or cartridge is nothing more nor less than a small boiler provided with a weak plate and an instantaneous furnace. The "boiler" is a hollow, one-piece forging of high-grade alloy steel.

IT is roughly bottle-shaped and provided with a filling valve at one end. The opposite end, or mouth, is closed by means of a soft steel disk—the weak plate in the boiler shell—which rests against a hardened steel shear ring. The joint gasket of fiber, disk, and shear ring are held securely in place by means of a steel cap that is screwed onto the shell neck.

The "instantaneous furnace" previously mentioned consists of a paper tube containing chemicals—sodium chlorate, charcoal, and powdered aluminum—capable of reacting with each other and producing intense heat. This

heater also contains an ordinary electric match-head or squib, the wires from which terminate at either end. When in place within the shell, one end of this heater rests within and makes electrical contact with a support that is insulated from the body of the shell, while the other end makes similar contact with the sealing disk, which is in electrical contact with the shell body.

Because of its low disintegration energy—latent heat of vaporization—as well as its inert nature and harmlessness while in the gaseous state, carbon dioxide is the material employed for charging the Cardox shell.

Today carbon dioxide is a fairly common article of commerce. Its use in soda fountains is familiar to everyone. It may be readily liquefied under pressure, provided its temperature is kept below the critical temperature, approximately 88.7 degrees, Fahrenheit. Above this critical temperature, it cannot be liquefied regardless of the pressure placed upon it. This is only a little above normal coal mine temperature, and, consequently, only a small amount of the heat evolved by the heater is taken up in raising the temperature of the liquid contents of the shell while the rest goes to superheat the gas formed when the critical temperature has been reached.

DEPENDING upon its model, the shell is capable of holding from 3 to 4½ pounds of liquid carbon dioxide. The heater normally contains from 125 to 175 grams of heating compound, the exact weight varying with the thickness of the disk employed and the charge of carbon dioxide. These three elements — weight of charge, weight of heater, and thickness of disk—may be varied to suit the nature and texture of the coal to be brought down, and best results are secured when a proper balance between the three has been established.

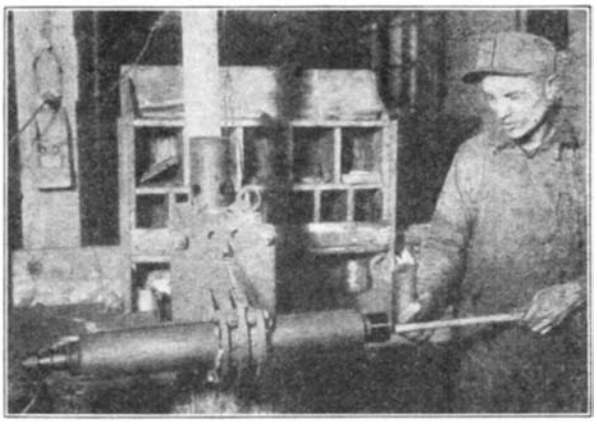
In practice a shell is brought to the charging station where the heater and disk are renewed. The shell is then placed in a rack and liquid carbon dioxide pumped into it at a temperature of about 0 degree, Fahrenheit, and a pressure of approximately 900 pounds per square inch. When the desired charge has been loaded into the shell (as determined by weighing) the filling valve is closed, the shell removed from the rack, and the cap covering the valve end screwed lightly into place.

The shell may now be taken to the working face. An electric post drill readily drills a hole in the coal sufficiently large to receive the shell. As the shell is slipped, discharge end foremost, into this hole, a terminal plug, with firing cable attached, is inserted in its outer end. Thenceforward the shell is treated exactly as if it were a charge of explosive. It is shoved to the back of the hole and tamped in place. The lead cables are connected to the firing cable; the operative retires to the nearest break-through, connects the firing cable to the terminals of a blasting machine, shouts a warning such as "fire!" or "fire in the hole!" to other workmen who may be in the vicinity, and, after a slight pause, gives the machine handle a vigorous twist.

The current from the blasting machine ignites the match-head which in turn starts the reaction between the chemicals of the heater. By this means in approximately 1/85 of a second as nearly as it can be measured, the liquid carbon dioxide within the shell is vaporized and the pressure jumps from the loading pressure of 900 pounds per square inch, to several thousand pounds per square inch, the exact pressure depending on the thickness and shearing strength of the disk. In any case this pressure exceeds the resistance of the disk and its central section first bulges and then shears against the hardened steel shear ring that supports it. This central portion or slug is caught and retained within the discharge cap while the gas that is liberated by the disk's failure escapes through the vent holes against the coal, which is broken and heaved down by the expansive force of the liberated gas.

Inasmuch as carbon dioxide is a colorless, odorless, tasteless, and inert gas, its presence in the atmosphere at a coal face is not perceptible to the senses except through its temperature. Thus the air in a place that has just been brought down by this means frequently is perceptibly cooler than before the "shots" were fired.

Since carbon dioxide is inert chemically, it can be breathed in small quantity without injury. The only ill effect of its presence in the air is its dilution of the normal oxygen content. Analyses of samples of the air at the working face taken as quickly as possible after a Cardox shot or series of shots had been fired have never shown more than 2.6 percent of carbon dioxide. The amount of dilution ordinarily encountered seldom exceeds .5 percent. Either of these percentages is negligible so far as respiration and ill effects on the human body are concerned.



PREPARING THE SHELL

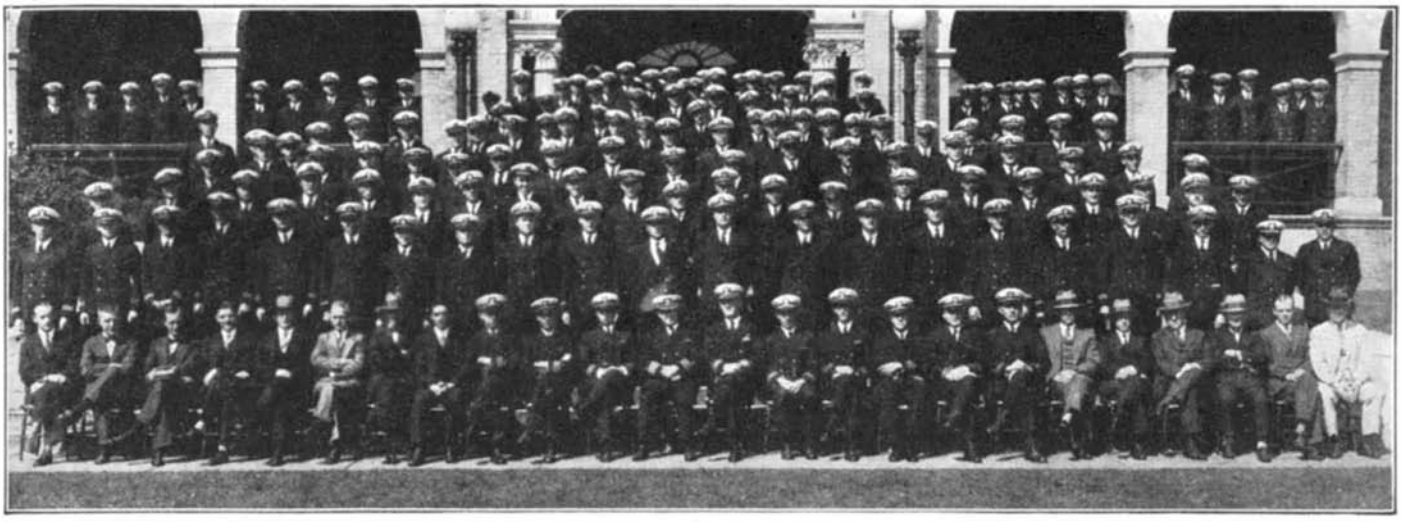
An operative is here shown inserting into the shell the paper tube—the "furnace"—containing chemicals

INSERTING CABLE TERMINAL

The cable is large so that shell may be pulled out of the fallen coal by its aid

AS has been stated, the release pressure of this gas varies with the thickness of the disk, ranging from 10,000 to 20,000 pounds as against the 50,000 to 55,000-pound explosion pressure of black powder and the 100,000 to 150,000-pound pressure for permissible explosive. The initial shock that is dealt the coal is thus far less with Cardox than with even the slowest of explosives and the shattering effect and amount of fine coal produced is proportionately less, so that more lump and less slack is produced. Not only this, but the shock and jar imposed on the roof strata is less violent and less timbering is needed.

Another and, in some cases the most important advantage possessed by this means for bringing down coal, is its safety in the presence of explosive mixtures of air and fire damp, or methane. After test by the United States Bureau of Mines, Approval Number 1 was issued covering this cartridge as a permissible blasting device. It is thus not even classed as an explosive. Important as this safety feature may be, however, there are many coal mines in the United States and elsewhere in which methane is seldom, if ever, found. To these, the improvement in quality of the product that its employment effects will be the important factor governing its adoption. To many mines this quality improvement is sufficient to spell all of the difference between an operating profit and a loss.



THE POST-GRADUATE SCHOOL, CLASS OF 1930

The Cultured Naval Officer

Few People Realize the Broadness and Completeness, Technically and Culturally, of Our Naval Education System

By CAPTAIN W. D. PULESTON, U. S. N.*

IN our naval service tradition has played a larger part in forming the character of the personnel, commissioned and non-commissioned, than is generally realized. Paul Jones' defiant "I have just commenced to fight"; Decatur's toast "My country, may she ever be right, but right or wrong, my country"; Craven's debonair bow to death, trapped in the conning tower, with his "After you, pilot"; and Farragut's inspiring "Damn the torpedoes, go ahead"; built up and continue to sustain the morale of the Navy, without which professional skill would avail little.

Accounts of these incidents, and of numerous others less known to the public but familiar to the naval service, originally were passed along by word of mouth from one naval generation to the next until they have gradually become enshrined in the mind of the service and serve to incite a laudable ambition among their younger hearers. But commissioned naval officers must also have thorough technical knowledge of their ships and weapons else their pride and daring will only bring them more quickly to defeat and expose their country to ruin; and unfortunately, inspiring tales of the exploits of previous leaders will not bestow their abilities upon their professional descendants.

The commissioned officers of our Navy in the Revolution came mainly from the masters and mates of the colonial merchant marine and during the almost continuous maritime wars of our colonial days many of them became more or less acquainted with the customs and discipline of the British Navy. They knew enough of gunnery to fight with the guns that were a part of the equipment of almost all merchant vessels of that day and they were bold and skillful seamen and navigators. Most officers of this type were inclined to underestimate the need of systematic education and training, although Paul Jones, from the beginning, asserted that a naval officer, in addition to being a "capable mariner," should be "a gentleman of liberal education, refined manner, and punctilious courtesy, with the nicest sense of duty."

A FEW other of our earlier officers appreciated the necessity of proper education for naval officers, and commencing with the Honorable William Jones in 1814, nearly all our Secretaries of the Navy advocated the establishment of a naval school ashore where systematic instruction could be given midshipmen. Although most of the senior officers were opposed to the education of midshipmen ashore, they nearly all took pains to instruct their midshipmen in such professional subjects as seamanship and navigation, and instilled in them at an early age the strict code of the sea.

In the decade prior to 1845 there was much agitation in the public press about conditions in the Navy. Various groups of midshipmen from time to time memorialized Congress about their grievances, and the mutiny planned on the *Somers* and the subsequent hanging of Midshipman Spenser attracted the attention of the country to the unsatisfactory conditions surrounding the midshipmen afloat. The Navy in 1839 received its first appropriation for building steam vessels and even the crustiest old sea-dog was obliged to admit that a knowledge of steam could not be acquired at sea on a sailing ship. Forward-looking officers immediately realized that the advent of steam gave an additional reason for the establishment of a naval school ashore. But even these developments would not have established a naval school except for the support of Secretary Bancroft, who overcame the opposition in the Navy, borrowed a fort from the Army at Annapolis for its first home, ran it for a term under the general authority of the Secretary of the Navy, and in 1846 persuaded Congress to confirm his action and make the first annual appropriation for the Naval Academy. George Bancroft, scholar, historian, and statesman, gave to the Navy the Naval Academy, and to his country since its formation, a continuous supply of carefully trained junior naval officers.

The first course at the Naval School included English grammar and composition, arithmetic, geography, history, navigation and the use of steam, the Spanish and French languages; provision was made for its future improvement by the clause "and such other branches desirable to the accomplishment of a naval officer as circumstances may render practicable." Between 1845 and the Civil War the Naval Academy gradually enlarged and improved its curriculum. Throughout this period the Naval Academy

* See "Among Our Contributors," page 341

was considered sufficient to satisfy the educational needs of the Navy.

During our Civil War the capture of Charleston was greatly desired by Lincoln for military and political reasons, but the Navy alone was unable to reduce it. Among the young naval officers who witnessed the Navy's futile efforts to capture Charleston was Lieutenant Commander Stephen B. Luce, who, later, in command of a small gunboat, covered the passage of Sherman's Army across the Savannah River.

After the Civil War, Luce, while on duty as Commandant of Midshipmen at the Naval Academy, was one of the founder members of the United States Naval Institute, the object of which is "the advancement of professional, literary, and scientific knowledge in the Navy." In a broad sense the Naval Institute was the first post-graduate educational institution in the Navy. It met a real want and it continues to flourish to the present day.

THE success of the Naval Institute inspired Luce to additional efforts, and in 1877 he wrote the Secretary of the Navy advocating the establishment of a post-graduate school where officers could be given instruction in the art of war. In 1884, Secretary Chandler established the Naval War College and appointed Luce as president.

About 1873 the automobile torpedo was invented and shortly afterwards the Navy Department established a torpedo class at Goat Island, Newport, Rhode Island, to study and develop the new weapon. The War College and the Torpedo School were the first strictly post-graduate schools of the Navy. The Naval War College was also the first institution primarily devoted to the study of naval warfare in the world although Germany and other European countries had their Army War Colleges.

Thus the Naval War College, which is the apex of the present naval educational system, was the second educational institution in point of time to be established. Later other post-graduate schools began to appear, for the period of naval reconnaissance was at hand; and although there continued to be some opposition in the service to additional schools, it was gradually overcome.

After the World War, the Department detailed a Junior Class to the War College to be trained for duty on the staffs of high commanders and for command of small units. This new course provides junior officers trained in staff duties, and directs the attention of a large body of junior officers to the study of war at a comparatively early age when their minds are fresher and they can readily comprehend new subjects.

The Corps of Naval Constructors were next to realize the need of special post-graduate work, and in 1881 Rear Admiral Capps, then a junior officer, was sent to Greenwich, England, to study naval architecture and kindred subjects. Later prospective naval constructors were sent to Glasgow, Scotland, and this custom persisted until 1901, when candidates for the Construction Corps were sent to the Massachusetts Institute of Technology. This procedure still obtains, and yearly a quota of prospective naval constructors enters Massachusetts Institute of Technology. Some years later the Corps of Civil Engineers selected Rensselaer Polytechnic Institute for the post-graduate education of candidates for its corps, and today both these institutions can be regarded as an integral part of the naval post-graduate system.

AS early as 1893, the Bureau of Medicine and Surgery began a post-graduate course for medical officers at the United States Naval Laboratory, Brooklyn, New York. This subsequently developed into the Naval Medical School affiliated with the Naval Hospital at Washington. In addition, this Bureau has, since 1920, sent officers to civilian institutions, medical centers, and hospitals for special post-graduate courses.

About 1900, interest in post-graduate education began to quicken throughout the Navy because the great improvements in ship design, marine engineering, electricity, ordnance material, and naval accessories, and the increase in educational standards throughout the United States made it plainly evident that four years at the Naval Academy was not sufficient to give officers the technical knowledge necessary to carry on the various duties to which they might be assigned. The Department responded to this service reaction by establishing in 1909 a "School of Marine Engineering" at Annapolis, with a technical curriculum and a staff of instructors about half of whom were civilians, eminent in their own specialties. In 1912 the curriculum was extended to include courses in ordnance and gunnery, electrical engineering, wireless telegraphy, naval construction, and civil engineering.

The World War caused a temporary suspension of this school, which reopened in 1919, with a more comprehensive curriculum based upon:

(a) A one-year basic course taken by all students at the Post-graduate School in Annapolis during which they refresh their knowledge of mathematics, physics, thermo-dynamics, and perhaps languages.

(b) Specialized courses of one or two years given at the following universities, where students concentate their energies on their particular subjects: Columbia University gives three of these courses—mechanical engineering, electrical engineering, ordnance optics. Massachusetts Institute of Technology furnishes to naval students courses in aeronautical engineering, ordnance design, ordnance torpedoes, and aerology, of one year each, and naval construction of two years. Both Harvard and Yale provide courses in communication engineering which include instruction in telegraphy and wireless telegraphy. Rensselaer Polytechnic Institute gives a two-year course in civil engineering to the Ensigns who desire to join the Civil Engineer Corps.

UNITED STATES NAVAL ACADEMY

An air view of the Naval Academy showing the United States Naval Post-graduate School in center background, under the arrow

ORDNANCE, in addition to the course in torpedoes and ordnance design given at Massachusette Institute of Technology and ordnance optics at Columbia, requires a course of ordnance ballistics at the University of Chicago, ordnance explosives at the University of Michigan, and ordnance metallurgy at Carnegie Institute of Technology.

By this comprehensive system of post-graduate instruction, the Navy can be sure that its commissioned personnel will contain a sufficient proportion of technical experts who are acquainted with the latest developments in all material of a modern fleet. But the Navy Department gains a great deal more by this program of post-graduate education than a group

of officers highly skilled in certain technical activities; it is brought at once in contact with the numerous educational institutions of our country; it must acquaint itself with their many activities in order to insure that the Navy is fully utilizing their services. This contact broadens the whole outlook of the Navy, for, in attending these various universities, naval students learn more than the content of their particular course—they learn the latest methods of instruction and the newest systems of research; and they return to the service bringing this new mental contribution with them which they gradually diffuse to the whole body of naval officers throughout the service.

ENSIGNS STUDY PARACHUTES

A class of Ensigns receiving post-graduate instruction in the use of parachutes

These technical specialists should insure us that our ships and their armor, guns, powder, shell, machinery, and boilers are the best that American science and industry can produce, and that the Navy will receive the care necessary to its efficient maintenance. This is an essential factor but it is not enough; the junior officers of the Navy will in due time succeed to higher command and they must early prepare themselves for this duty. To assist them in their preparation for their executive and operating duties, a "School of the Line," which was recommended in 1919, was established in 1927, as soon as the number of officers available permitted. This course embraces navigation, tactics (elementary), ordnance, mechanical engineering, electricity, logic, economics, diplomatic history and foreign relations of the United States, communications, radio, and aviation theory —a truly formidable list of subjects.

BUT it must be remembered that the young officers taking this course come from the fleet and have some knowledge of all these subjects and are likely to be thoroughly familiar with at least one of them. This course enables young officers to even up their progress in the various branches of naval science, while it requires them all to take such subjects as logic, economics, and diplomatic history, that will enlarge their mental horizon.

This School of the Line is an intermediate course between the Junior War College Course and the Naval Academy; and when practicable, graduates of this school, which lasts one year, proceed to the War College and, after taking the Junior Course there, are returned to the Fleet. This school, which the Navy established in 1927, completes the last link in the chain between the Naval Academy and the Naval War College. Junior officers fortunate enough to be assigned there, begin the study of the art of command which they will continue many years later—after much practical experience in active service at sea—by taking the Senior War College Course.

Aviation has become an integral and essential part of the Navy, and the Naval Academy curriculum has been widened to include many of its phases in the undergraduate work of the midshipmen. The Departments of Engineering and of Seamanship carry out most of the undergraduate work; and so important has it become that the junior class at Annapolis does not take the summer practice cruise but remains at the Naval Academy where it takes a three-months' course in naval aviation which includes aeronautical engineering, indoctrinal flights, and ground school work. Midshipmen usually average an hour's flight every second working day during this course.

In addition, the department maintains elementary aviation schools at Hampton Roads and San Diego for post-graduate work, where graduates may review their work of the Naval Academy, or if they graduated before the course was established, can get an indoctrinal flight course and some ground school work.

The real Post-graduate Aviation School is at Pensacola, where naval aviators who are going to devote their major time to aviation receive either a primary or advanced course that requires two years.

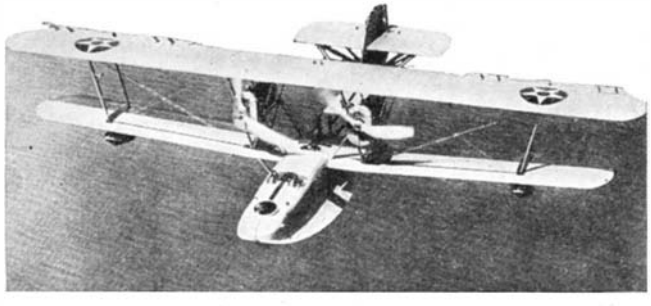
No less important than the Aviation School is the Submarine School at New London, Connecticut, where officers and men destined for the submarine service are given a six-months' course in the operation and care of submarines.

The Department also sends officers to the Chemical Warfare School of the Army at Edgewood, New Jersey, provides special courses in naval communications and torpedoes and gives refresher courses in languages to officers about to go to foreign shore duty.

The office of the Judge Advocate General in 1911 commenced sending officers detailed to duty there to the Georgetown School of Law after their regular office hours, and this practice continues.

THE predominating characteristic of the whole scheme of naval education is the preparation of officers for particular tasks, beginning at the Naval Academy where all available time and the energies of the officers and instructors are concentrated on preparing the midshipmen for their duties as junior officers of the Navy. The next step in the school system prepares line and staff officers for duty as heads of departments or command of small units, and in the third step, the Senior Class at the Naval War College, officers are prepared for high command after much practical experience.

The Naval Academy has a definite task to perform within a limited period of time, and although it gets splendid young material to develop, it must limit its effort and its course to the practicable, and must first make a midshipman a "capable mariner" and then add the "liberal education." The graduate of the Academy, no matter whether he goes into the Line or Staff, has only commenced his education. During his career he will probably learn more from the counsel, admonition, and criticism of his seniors, and from his own experience, than from text-books and formal courses. In training enlisted men, the young officer will begin really to educate himself, and as he matures he will find already in operation available for his use the comprehensive school system herein described. And what is more important, he will find in the service an appreciation of the necessity of post-graduate education that did not always exist. But the Navy properly and justly retains a healthy distrust of impractical theorists, and the final test of all officers will be their ability to carry on their work in the Fleet.

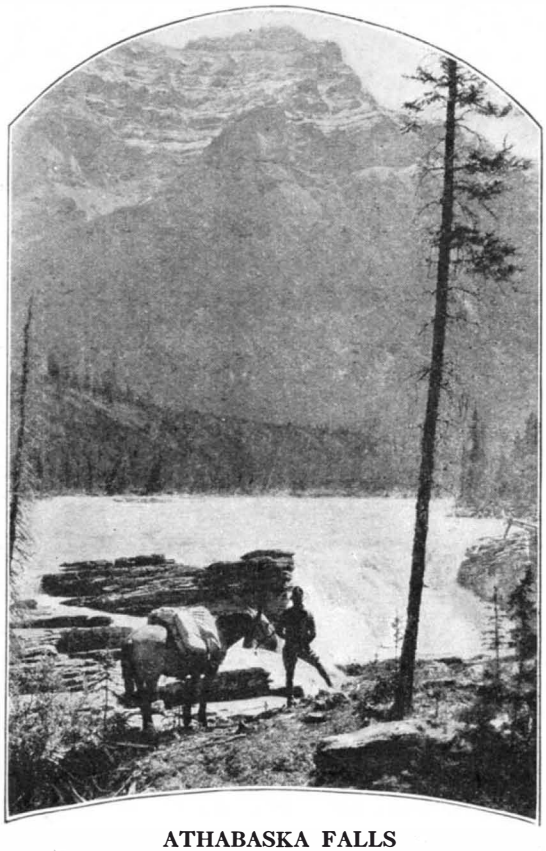


MIDSHIPMEN ALOFT

The Naval Academy keeps step with the development of naval aviation material

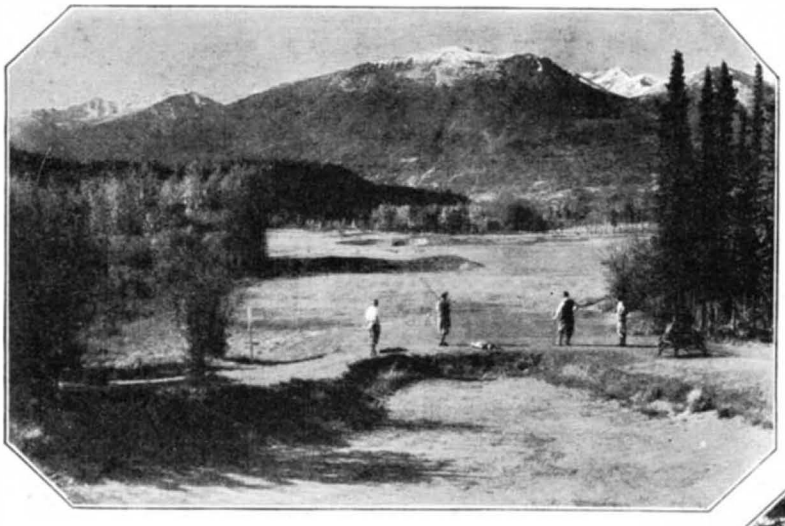
Canada's Peerless Playground

OUR own national parks are exploited to such an extent that we are apt to forget that our neighbor over the border also has the beauty of nature. Therefore we shall both illustrate and briefly describe the finest of Canada's natural possessions—Jasper Park. The avowed purpose of national parks is to make "the wild places of the land sacred." Civilization spells death to beauty; the primeval forest falls never to rise again. Waterfalls are denuded of their water so that wheels may turn and we can have cheap light and power. All these things are desirable, but the price is frightful. With the building of the transcontinental railways across the Yellowhead Pass a new door was opened to the Canadian Rockies; a new and wonderful alpine district was visioned to all lovers of the beauties of nature. Jasper National Park comprises 5380 square miles—a region larger than some European kingdoms, and more than half the total area set aside in Canada's national reserves. One of the chief characteristics of the park is the variety and beauty of its mountain lakes. Outstanding, too, are the number and depth of the canyons, each with its turbulent stream and often a fine waterfall thrown in for good measure.



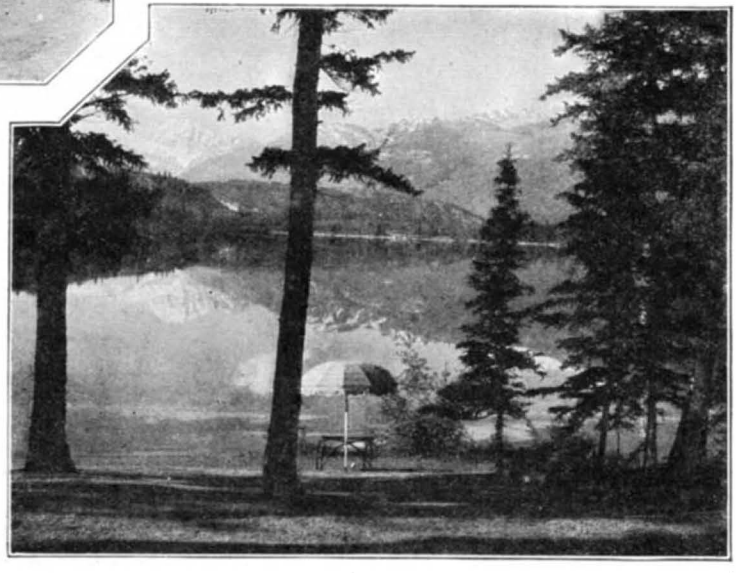
ATHABASKA FALLS

The mountain in the distance is Mount Kerkeslin, 9900 feet in height. The water is milky with silt from many of the glaciers. Delicate touches of vegetation here and there save the rugged scene from apparent harshness



JASPER PARK GOLF COURSE

This golf course is interesting owing to the rocky character of the site. Hundreds of cars of earth were brought in from the prairies to provide the soil for the fairways and greens



LAC BEAUVERT

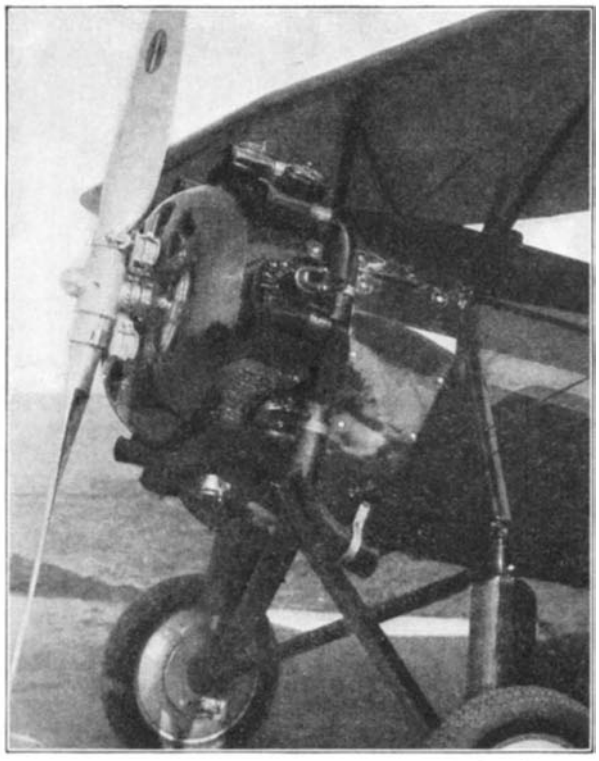
Mount Edith Cavell is in the distance. A fine hotel has been built on the pine-girt shores of Lac Beauvert, one of the most beautiful lakes in Jasper National Park. The lake and the mountains form a surpassingly beautiful picture never to be forgotten by the tourist

GLACIER LAKE

From this vast ice sea issue streams which take their way finally to three oceans and carry life and fertility to thousands of miles of valley and plain. The attractions of Jasper National Park are so very diversified that it may be visited at any or all seasons of the year

The Successful Airplane Diesel

First Detailed Description to be Published of the Design of This Revolutionary Engine



THE PACKARD DIESEL ENGINE

In one of the test planes. In appearance, it does not differ radically from the conventional gasoline engine

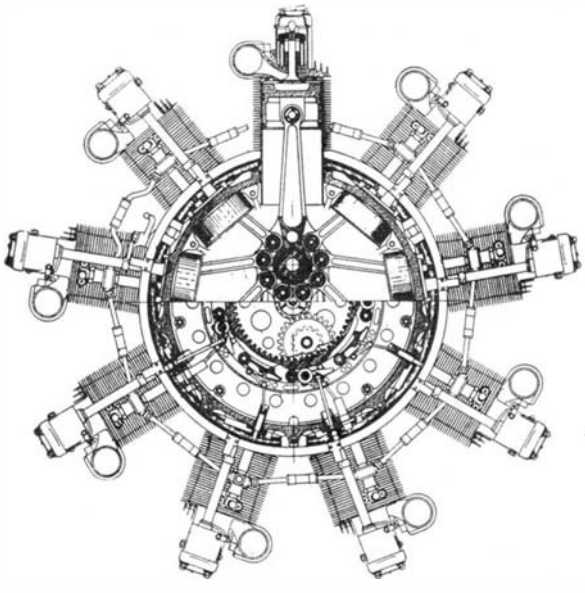
FOR several years much experiment and research has been carried out in the effort to adapt the Diesel engine to airplane use. About a year ago the Packard Automobile Company, of Detroit, announced that it had been successful in designing and building such an engine but the construction details of this engine have been a carefully guarded secret. In the meantime a very extensive testing program has been carried out, a close estimate showing that the total of experimental ground and flight testing of this engine has amounted to an equivalent of approximately 330,000 horsepower-hours which represents a sufficient output for an average plane to fly a distance of a quarter of a million miles. It has passed an Army 50-hour acceptance test, and for it the United States Department of Commerce has issued an approved type certificate. Its advantages have been covered in some detail in past issues of SCIENTIFIC AMERICAN*. In this discussion, therefore, we shall limit ourselves to a description of the most important constructional details, condensed from a description by the designer, Captain L. M. Woolson.

THE Packard Diesel aircraft engine is of the radial air-cooled type having nine cylinders with a bore of 4 13/16 inches and a stroke of 6 inches, giving a displacement of approximately 980 cubic inches. It is rated at 225 horsepower at 1900 revolutions per minute and weighs 510 pounds, or 2.26 pounds per rated horsepower. The engine's outside diameter is slightly over 45 inches and it is attached to the mounting ring with eight 3/8-inch bolts. So far as its general characteristics are concerned, with relation to size, weight, and general arrangement, the engine does not differ radically from conventional gasoline aircraft engines of a similar type. However, the engine incorporates many constructional features never before employed in aircraft engines.

A casual inspection reveals a radical departure from current practice in that each cylinder is supplied with only one valve which serves as both inlet and exhaust; and the single rocker-arm box which is slanted in the direction of the spiral of the slipstream contributes much to the clean external appearance of the engine and, what is more important, to its low parasitic drag.

The real point of departure between the system used by the gasoline aircraft engine and the Diesel engine are the ignition systems involved. The gasoline engine requires a complicated electrical ignition system in order to fire the combustible mixture whereas the Diesel engine generates its own heat to start combustion by means of highly compressed air. The temperature of the air in the cylinder at the end of the compression stroke of a Diesel engine operating with a compression ratio of about 16 to 1 is approximately 1000 degrees, Fahrenheit, which is far above the spontaneous ignition temperature of the fuel used.

One important advance, in the Packard Diesel, over previous Diesel practice, is the ability to extend the range of engine speeds possible with the Diesel cycle. Stationary and marine Diesels have heretofore been rated at 100 to 300 revolutions per minute and even so-called high-speed Diesels have been limited to about 1200 revolutions per minute. The speed of the Packard Diesel, however, has been increased to over 2000 revolutions per minute. This has been accomplished by an engine design that produces exceptional fuel turbulence. This and the highly efficient, quick-acting fuel pumps are the means that produce the accelerated mingling of the fuel and air which bring about the greatly increased speed. The engine structure has been designed to withstand the resulting maximum cylinder pressures which are considerably in excess of 1200 pounds per square inch.



IN PARTIAL CROSS-SECTION

Valves, cams, fuel system, and other parts described in the text are clearly shown

HERETOFORE Diesel engines, even of the lightweight type, have weighed about 25 pounds per horsepower; the Packard engine weighs but one tenth as much. A review of the design will show that important weight economies have been secured by the elimination of carbureters and magnetos and by an intense simplification of design. Evidences of the latter are found in the one-piece crankcase construction of extremely light weight and the single valve arrangement which automatically halves the number of parts ordinarily required for valve operation.

*See page 73, January, 1929; page 356, April, 1929; page 222, October, 1929; page 36, January, 1930; and page 310, April, 1930.

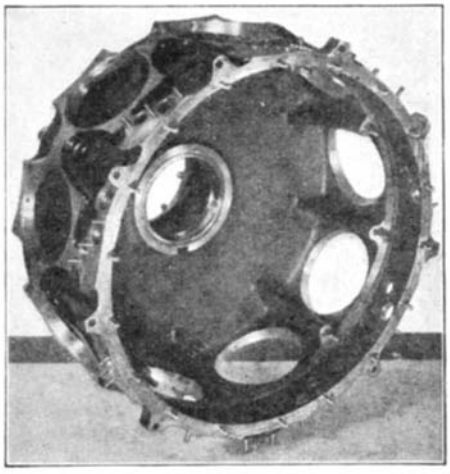
The crankcase, which weighs only 34 pounds, is unique not only because it is of one piece and thus dispenses with heavy flanges and bolts, but also in respect to the novel fashion in which the cylinders are fastened to the crankcase. Two circular hoops of alloy steel encircle the cylinder flanges in contact with the crankcase at the front and rear of the engine and these hoops are contracted by means of sturdy turnbuckles. Thus an initial stress which exceeds by a wide margin the operating stress resulting from the cylinder explosions, is set up in these hoops. Under this system the crankcase is subjected to an initial compression which it is well adapted to resist. When the engine is running, however, these stresses are materially reduced and at no time is it possible to transfer any tension loads from the cylinder to the crankcase.

OF no less importance are the arrangements whereby the crankshaft and propeller are protected from excessively high stresses. In the Packard Diesel the maximum cylinder pressures are over 10 times as great as the average cylinder pressures during the working stroke. This would necessitate the pistons, connecting rods, crankshaft and propeller being approximately 10 times as strong as they would have to be to resist the average pressure, were it not for the fact that effective measures have been taken to cushion these major parts of the engine from the shock loading. Advantage is taken of the fact that the peak explosion pressures exist for a very short time in each cycle. The crankshaft counterweights and the propeller are both flexibly mounted on the crankshaft so that the stresses in the crankshaft are greatly reduced.

The counterweights, instead of being rigidly bolted to the cheeks, are pivoted on them and are located between powerful compression springs. When the crankshaft is suddenly accelerated, the counterweights lag behind slightly so that the peak cylinder pressure is expended before the counterweights are again solidly driven by the crankshaft. In a similar fashion the propeller hub is allowed to float on an extension of the crankshaft driving end, and specially designed propeller-blade clamp rings, provided with integral driving lugs, receive the driving effort from a two-arm driving member splined to the crankshaft. On the extremity of each of these two arms a pair of rubber blocks are compressed, between which the propeller clamp ring driving lug is secured. The inherent damping or hysteresis of the rubber blocks, supplemented by the surface friction in the counterweight mounting, quickly and entirely smooths out the shaft rotation.

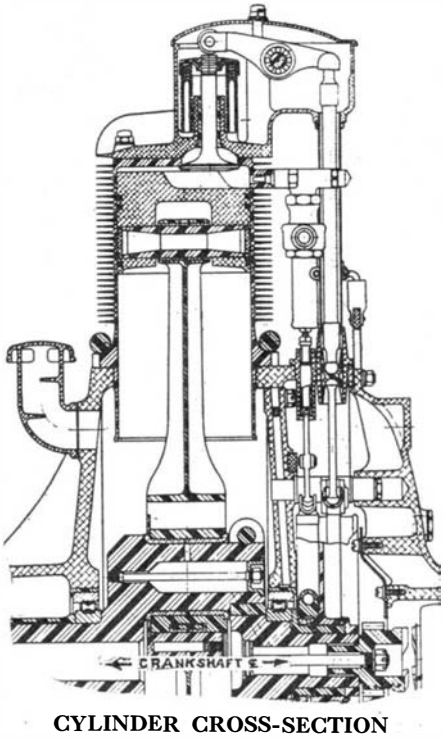
Each cylinder weighs only 11¾ pounds. It was recognized that the cooling problem of a Diesel cylinder was considerably simpler than that of a corresponding gasoline engine cylinder since the increased thermal efficiency of the Diesel is reflected in far lower heat losses to the cylinder walls. This fact justified a simple form of closed-end cylinder design in which the cylinder head proper is formed integral with the cylinder barrel, a construction which is not considered satisfactory for gasoline engines.

The fact that only pure air is drawn into the cylinder on the intake stroke of the Diesel permits the use of a single valve for both inlet and exhaust purposes. This arrangement makes for simplicity, weight saving, and reliability; and, furthermore, the available time for opening and closing the valve is lengthened appreciably so that lower rates of acceleration thereof can be utilized, thus saving wear and tear on the whole mechanism.



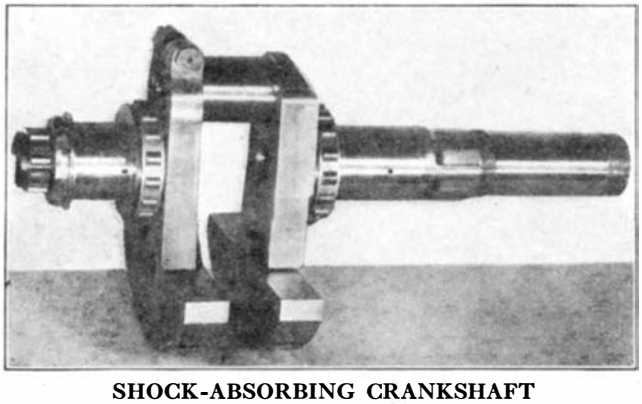
THE 34-POUND CRANKCASE

This is unique because of its construction and method of attaching cylinders



CYLINDER CROSS-SECTION

Side view, showing mechanism of one cylinder, left side, and the two cams



SHOCK-ABSORBING CRANKSHAFT

Here will be seen the method of mounting the counterweights on pivots between springs to cushion the shock of explosion

In this Diesel the turbulence necessary to insure a homogeneous mixture of fuel and air is accomplished by giving the incoming air an extremely rapid whirling motion. This high velocity spiral motion of the air is brought about by shaping the inlet port as a flattened Venturi arranged tangentially to the cylinder bore. By this method of air injection and the finely atomized injection of the fuel, accurately controlled and timed, complete combustion is assured.

THE feature which probably contributes most to this phase of operation is the combination fuel pump and nozzle unit. Heretofore the majority of solid fuel injection Diesels of the high-speed type have been characterized by a multiple pump unit mounted somewhere on the engine remote from the cylinder heads in which the nozzles are located, and connected to them by comparatively long capillary tubing. The many difficulties arising from this kind of system have been overcome in the Packard Diesel since the pump and nozzle are practically one unit with extremely short connecting passages between them.

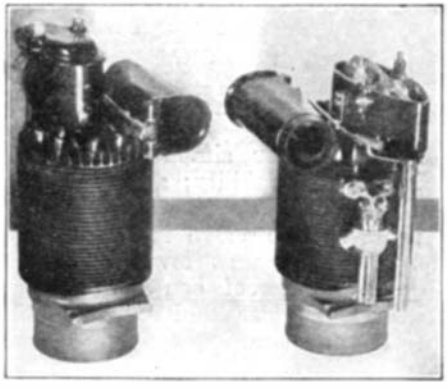
The crankcase is a one piece magnesium alloy casting of rather large diameter, this casting supporting through the medium of a forged steel container a deep-groove ball bearing at the front end adapted to take both propeller thrusts and radial load at this point. A roller bearing is mounted immediately ahead of the front crankshaft cheek, this bearing arrangement being quite orthodox.

The crankshaft is of the commonly used split type, the rear half being attached to the front half by means of a

clamp bolt and key engaging the crankpin. The rear crankshaft bearing is also of the roller bearing type and is supported in a removable wall in the crankcase, termed the diaphragm. The diaphragm also carries the major working parts concerned with the operation of the valves and fuel pumps.

The connecting rod assembly follows standard practice in practically every respect, a master connecting rod being used in conjunction with eight link connecting rods.

The valve and fuel-pump push rods, of which there are nine each, are



LIGHT-WEIGHT CYLINDER

At left: front of cylinder with air intake. *At right:* rear, air valve and fuel pump

radially arranged at the rear of the engine and are, in turn, operated by two cams which are formed integrally and each of which is provided with four lobes. These cams are driven at one-eighth engine speed in the direction opposite to the crankshaft rotation, a large internal gear being formed integrally with the cams and a compound idler gear meshing with the cam and crankshaft gears respectively. Both the single valve and fuel pump of each cylinder are operated through the medium of rocker arms which contact with the respective cams and are supported on a common shaft which is anchored in the diaphragm and which also obtains a steady bearing in suitable bosses formed in the cover casting.

WHEREAS the inner end of the air-valve push rod seats in a spherical receptacle formed in the rocker arm referred to, the inner end of the fuel-pump operating push rod fits in a specially formed groove or channel provided in the fuel rocker arm. Furthermore, these fuel-pump push rods are connected by linkage near their inner ends to a circular control ring mounted in a groove on the diaphragm, the movement of which ring is controlled by an externally mounted lever connected to the pilot's control and *offering the sole means of regulating the speed of the engine.* The linkage referred to moves the inner end of the pump push rods, this movement altering the effective stroke of the fuel-pump plunger and thus varying the amount of fuel injected into the cylinders in accordance with requirements.

The cylinder-head caps (see drawings) are light aluminum alloy castings which serve merely to support the overhead valve mechanism and valve stem guide and incorporate the inlet and exhaust ports. This casting is secured to the top of the cylinder by means of ten studs which insure good thermal contact for heat transfer from the upper surface of the cylinder to the radiating fins on the caps.

The aluminum alloy piston used is characterized by a peculiarly shaped head provided with an eccentrically located pocket which is designed to promote, in conjunction with the inlet port and valve arrangement, the high degree of turbulence which is so largely responsible for the efficient operation of this engine at high speed.

The fuel pump and nozzle assembly constitutes a radial detachable and interchangeable unit which is bolted to a flange on the rear of each cylinder. Among the advantages favoring this construction are the elimination of all high-pressure tubing between pump and nozzle and the avoidance of the resultant troubles, such as air pockets, after dripping, and variations in timing due to the compressibility of the liquid in the piping and the elasticity of the pipe itself under pressures as high as 6000 pounds per square inch.

ONE of the major problems in connection with the development of this Diesel airplane engine has been the matter of starting. The special requirements in aircraft service are that the engine must start promptly in all conceivable operating temperatures, and also that the starting mechanism must be light in weight and simple to operate. A great deal of experimentation was carried on with various types of starters, such as the cartridge type using 12-gage shotgun shells, the compressed air type, and various forms of field starters not carried in the plane. It was finally concluded that the conventional type of inertia starter, used so extensively with gasoline aircraft engines, offered the best solution. It was also found necessary to develop an incandescent heating element, or glow plug, to give the required heat for starting at below-zero temperatures. These glow plugs offer no handicap to the ordinary operation of the Diesel. With them instantaneous starts are possible at any temperature at which it is possible to turn the engine over at all.

The starter incorporates a small flywheel which is rotated through a system of gearing at very high speed by means of either a hand crank or an electric motor. When sufficient energy has been imparted to the flywheel, a dog-type clutch is manually engaged with the crankshaft, resulting in the rapid cranking of the engine during the few seconds necessary to dissipate the energy stored up in the flywheel. The engine starts immediately on its regular supply of fuel oil, no special fuel or preparatory heating being necessary. At very low temperatures, however, it is essential to use the glow plugs.

In stopping the engine it is merely necessary to close the throttle completely against a spring stop, this extra motion of the throttle mechanism serving to restrict the stroke of the fuel pumps so that no fuel is forced into the nozzle. The engine can be stopped instantly no matter how hot it may be, without danger of kicking backwards.

SUMMING up: the engine is started with the throttle wide open, and then is easily stopped by closing the throttle completely. There are no other controls used except those of the inertia starter. The engine automatically adjusts itself to burn efficiently whatever fuel is being injected.

A very intensive testing program was carried out in the development of the Packard Diesel. This testing has comprised dynamometer, torque stand, and flight testing in two different types of planes: a Stinson Detroiter, six-place cabin plane, and a Waco three-place open cockpit plane. Ground testing on individual engines has been carried up to 500 hours on the dynamometer. This program has covered a period of two and a half years of test work.

As a result of this development,

ALUMINUM ALLOY PISTON

With two compression rings and one oil ring. The pocket helps promote turbulence

simplification and further economies in the operation of transport planes may be prophesied. Large transport, mail, and freight planes may be driven either by a single Diesel engine of large power or possibly by two smaller engines mounted on the wings so as to remove the source of noise from the passenger compartment. In this fashion it is believed that a high degree of safety and low cost of operation will be arrived at, thus greatly stimulating the growth of commercial aviation.

Advice to Students of Aviation*

By DR. H. J. COOPER
Medical Section, Aeronautics Branch, Department of Commerce

ALL persons desiring to become licensed pilots should bear in mind that while they may pass the physical requirements for student and private pilot licenses, that is no guarantee they will not have difficulty with the physical examinations for limited commercial or transport licenses.

Many former students have been physically disqualified when they applied for limited commercial or transport licenses, and, as a result, considerable misunderstanding and disappointment have arisen. Therefore, the medical section of the Aeronautics Branch desires at this time to disseminate as much information on the subject as possible.

THE medical section approves or disapproves a medical examination upon the basis of the grade of license applied for. If a student examination shows that the applicant just barely meets the physical requirements for that grade, he will be qualified for it. However, the medical section can not write the applicant that while he has been approved as a student pilot, and will be approved later for the grade of private pilot, his examination is unsatisfactory for either limited commercial or transport pilot and therefore he will not be able to reach either of these grades of license as long as his present defects exist.

The reason the medical section can not do this is because it has no way of knowing, out of the total number of student applications received, what students plan to become limited commercial or transport pilots.

There are two fundamental principles that a student should keep in mind when he starts in training.

1. If his sole desire is to become a private pilot for the purpose of flying his own plane when and where he pleases, and if he has no desire to operate commercially, he should take the student physical examination. If satisfactory, this examination will also qualify him for the grade of private pilot when he becomes eligible for the flight test and the written examination for that grade.

2. If a student's sole purpose in applying for a student permit is to become later a limited commercial or transport pilot, he should take the transport physical examination at the start. In this way he will know before he starts his training whether he has any defects which will bar him from qualifying for that grade of license he ultimately desires.

The student who desires to become a limited commercial or transport pilot will not be put to any more expense for medical examinations by following this advice, because, although he pays $15 for the transport examination, this examination includes tests that will not have to be made again no matter how long the interval may be between the date of the examination and the time at which he becomes eligible for the limited commercial or transport license. If he takes the student examination for $10, he will later pay $5 for that portion of the examination not made originally.

The attention of student applicants also is directed to the following:

1. The Department of Commerce maintains two types of physical examination, one for student and private pilot and one for limited commercial and transport pilot. The requirements for student and private pilot are, of course, very much more lenient than those for limited commercial or transport pilot.

2. Any applicant who has been physically qualified for student pilot on the basis of a satisfactory student examination will be physically acceptable for private pilot at a later date, provided, of course, that his physical condition has not changed adversely in the meantime.

3. Any applicant who has been physically qualified for student pilot on the basis of his having taken and passed a transport physical examination, will be physically acceptable for any grade of license applied for at a later date, again provided that his physical condition has not fallen below standard in the meantime.

4. When a student applicant takes the transport physical examination and finds that while he qualifies for student and private pilot, he does not qualify for limited commercial and transport pilot, he should write the Medical Section, Aeronautics Branch, Department of Commerce, Washington, for an official opinion on his defects. The Medical Section will inform him what the possibilities are of his receiving medical approval for the higher grades of license by a waiver.

5. If any applicant is physically disqualified for student pilot, he is at liberty to inquire of the Department the nature of his defects, and if the medical section believes there is anything in the way of treatment that will reasonably improve the defect, the applicant will be so advised.

6. When a student applicant has been physically disqualified by a medical examiner, he should await action on his examination by the Department. He should not visit other examiners in an effort to qualify, for even if an examination made by another medical examiner is satisfactory, it will not be accepted. Under such circumstances the Medical Section will require that the applicant return to the original medical examiner in order to demonstrate to that examiner that the disqualifying features are no longer present.

7. Prospective applicants who know they have certain physical defects are invited to communicate with the Medical Section and state the nature of the defects. The Medical Section will inform the prospective applicant whether or not the defects are disqualifying.

8. The student permit of any student will be suspended in case of an accident in which he sustains personal injuries such as to interfere materially with bodily functions. The suspension of the student permit will be maintained until the student is able to submit to a physical examination, made by an authorized medical examiner, showing that the student has recovered from his injury. In case of partial recovery, the medical section will determine whether or not the recovery is sufficient to warrant removal of the suspension.

9. In order to make the visual requirements clear, special attention is directed to this paragraph. The lowest vision acceptable for student pilot is 20/50 in either or both eyes, without correcting lenses. Judgment of distance must be within the normal specified limits, without correcting lenses. If the student just meets the foregoing minimum requirements, he is required to wear correcting lenses in his goggles, bringing his vision approximately to normal. His judgment of distance must be within qualifying limits while wearing this correction. Failure to meet any of the foregoing requirements will result in disqualification.

10. When it is necessary for the student to wear corrective lenses in his goggles, the correction should be ground into the goggle lenses. Small corrective lenses fastened on the inside of the ordinary goggle should not be purchased. Students should be very particular in these matters, for incorrect lenses often result in harm to the vision.

11. Student applicants who do not meet at least the minimum physical requirements will not be recommended for license. Waivers will not be recommended for students.

*Reprinted by courtesy of *The United States Daily.*

IN A SWEEPING DIVE

A Boeing Navy fighter in a dive. It is imperative that all military aviators have much stunt flying training

Stunting for Safety

Training in Plane Acrobatics Instills Confidence and May Help the Pilot Out of Tight Places

By LIEUTENANT (j.g.) H. B. MILLER, U. S. N.

STUNT flying has been the direct cause of perhaps more peace-time air crashes than any other one thing. As a result of this fact and the consequent adverse publicity freely dispensed by many periodicals and newspapers, the prejudice of the public against stunting has been so encouraged that it is now almost insurmountable. The ability to stunt, however, is at times an invaluable aid to safety; it may even mean the difference between life and death for the pilot and his passengers. Lieutenant Miller explains in no uncertain terms why and when this is so.

—The Editor.

THE reaction of the public against stunt flying has definitely begun. Denunciations of stunting and acrobatic flying are becoming more and more frequent. No doubt there has been sufficient flagrant display of this type of flying to warrant public censure, but on the other hand, it is more likely that the whole truth of these cases has not been known.

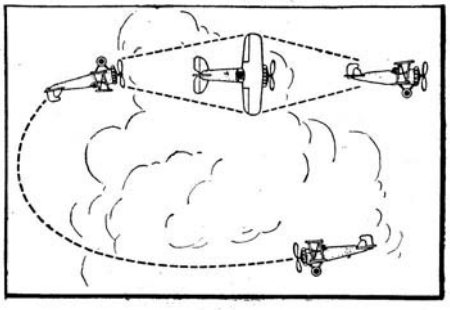
Only recently a pilot lost control of his plane while performing a loop. Both the pilot and passengers were killed. Moreover, people on the ground were endangered, because the plane fell into the heart of the residential section of the city. On the face of the matter, stunt flying would automatically be condemned.

UNFORTUNATE as is this case, it is positive proof of the definite need of thorough acrobatic training for all flyers. This particular pilot had just obtained his private license, after the necessary 15 hours of solo flying and 10 hours of dual instruction, which permitted no time to devote to advanced flying. The pilot's stunt training was obtained on the ground at a round-table discussion. In addition, the flyer violated all air traffic rules when he stunted over an inhabited district. It is amazing to think that two people could be found who had sufficient confidence in such a novice pilot as to take a joy hop with him.

Had the pilot qualified after a thorough training course, he would not have lost control of his ship. Also had he been thoroughly indoctrinated, he would have observed the Air Commerce Regulations and private property would not have been endangered.

For safety's sake, then, why not prohibit all forms of stunting by all pilots? The answer is a paradox. For safety's sake, regulated acrobatic flying should be encouraged.

The expression "stunt flying" is used generally to cover the abnormal maneuvers which can be done with an airplane. In addition, this expression should include such things as diving at hangars, flying low over cities, and other forms of "dizzy flying." Moreover, all unnecessarily hazardous flying such as the Dole Flight are covered by the term "stunt flying."



IMMELMAN TURN

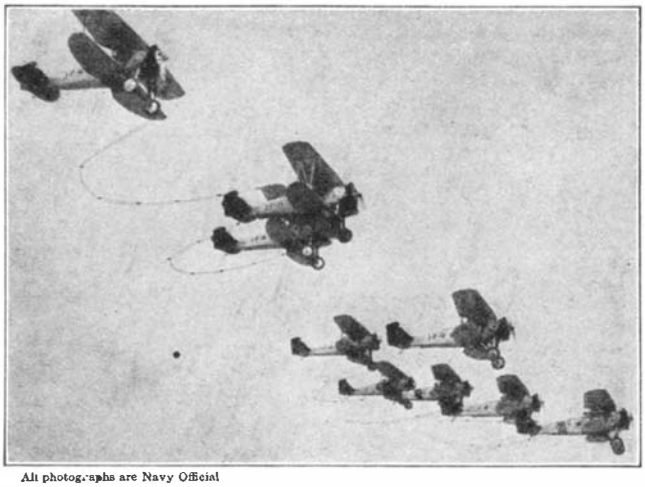
From a half-completed loop, a roll over and flight in the opposite direction

Such stunt flying as changing from one plane to another while in flight, and long over-water flights in land-planes after insufficient preparation, add nothing to the progress of aviation. Failures resulting from such attempts discourage the enthusiasm of the public for aviation.

Our military services will not assist in the dedication of an airport, when the program tolerates such flying as wing-walking. This type of stunting is discouraged officially.

The expression "acrobatic flying" is accurately applied to those intentional maneuvers of a plane flying in any positions other than a straight line. When done at a dangerously low altitude, acrobatic flying becomes stunt flying.

Acrobatics can be indulged in safely only with suitable equipment. Training ships and sport planes capable of being stunted are now available. Strength sufficient for violent flying is built into these ships and the manufacturer of a plane will state the maneuvers for which his ship is designed. The pilot who stunts a plane which is not designed for that purpose will sooner or later come to grief. Too often have the wings deserted an old broken-down plane during some violent maneuver. The flyer who recognizes the limitations of his ship will probably enjoy a long career in aviation.

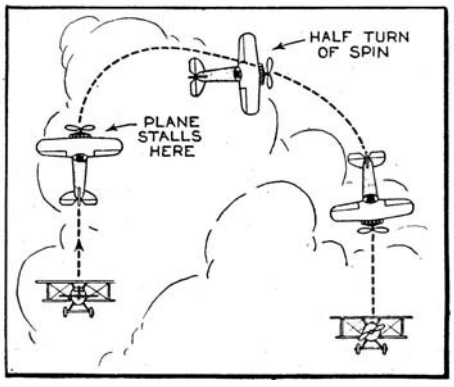


All photographs are Navy Official

THE HIGH-HAT SQUADRON

Executing difficult maneuvers and formation flying with planes lashed together with ropes, at the National Air Races

Acrobatics can be performed with various degrees of gentleness. Some pilots can bring a plane down after a stunt hop with the ship in perfect condition. Others will perform exactly the same maneuvers and land the plane with slack in the brace-wires. Few ships have ever been built that cannot be broken up in the air if the pilot so desires. Even military fighting planes, which possess a safety factor of 12, can be flown to pieces. Just because a commercial plane will withstand active evolutions, that feature should not be abused. Material failures are especially apt to result when pulling out of prolonged and fast dives.



SPLIT "S"

Useful for turning in a limited space. The pilot climbs steeply, stalls, and turns

Confidence can be instilled in a student flyer in no better way than by giving him acrobatic training. This should come after the student has had 15 or 20 hours of solo flying. A person learning to swim progresses slowly until he is thoroughly at home in the water. Moreover, he lacks faith in himself at first. The same is true of the student aviator.

Handling a plane under unusual conditions and attitudes gives the young flyer complete confidence in his flying ability. If he should ever find himself thrown into some unusual maneuver, it will not be strange to him. He will instinctively manipulate his controls as in acrobatic flying in order to return the plane to its normal attitude.

One case on record shows that a flyer became lost in a low-hanging fog. In endeavoring to continue his flight to a landing field, he followed a blind canyon. Suddenly the pilot found himself hemmed in by the canyon walls. In front was a spur of the mountain which was too high for him to climb by flying straight ahead. Nosing the plane down momentarily to gain speed, the pilot pulled back sharply on his control stick. At the top of the loop, he half-rolled his ship into an Immelman turn. Saved; one life!

Instructions in acrobatics are quite simple. The various stunts are discussed in detail on the ground. The instructor then takes the student up and goes through each maneuver a number of times. With the instructor still in the plane, the student goes through the evolutions until he has learned to perform them with a fair degree of skill. The novice then must put in many long hours of solo acrobatic flying for mastery of stunts is had only by long and arduous practice. Finesse and perfection are a result of hard work.

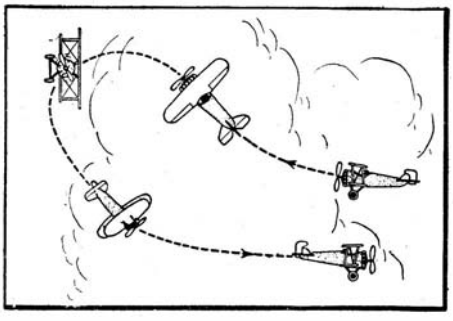
LOOPING IN FORMATION

An experienced pilot can follow another through any maneuver. Here three Navy planes are on top of a loop

EXCLUDING the various forms of inverted flight, which is extremely advanced, there are only a comparatively few acrobatics. By ingenious combinations, a skilled pilot can appear to do a multitude of distinct maneuvers, but the bases of practically all of them are the loop and the spin. Nearly all other maneuvers are merely variations of the spin. Among these are the barrel-roll, which is a horizontal spin; the falling leaf, which is a series of partial spins, alternating to right and left; and a split "S" which is a half-spin reversing the direction of flight.

A combination of loop and spin produces a roll on top of a loop. The Immelman turn is merely a half-roll executed at the top of the loop. This reverses the direction of flight and at the same time gains altitude. The roll can be extended into a double-roll and even a triple-roll. A recently devised maneuver has proven popular. This is called the "slow roll." In this the pilot rolls his ship horizontally by use of the ailerons alone. An appreciable length of time is required for this maneuver, as compared to the snap-roll which is merely a stall.

The flipper turn and the wing-over are not classified as stunts. The former is merely a steep turn of a greater bank than 45 degrees. Here the action of the elevators and rudders reverse in their relation to the horizon. Picture the tail surfaces inclined over 45 degrees from their normal position.



WING-OVER

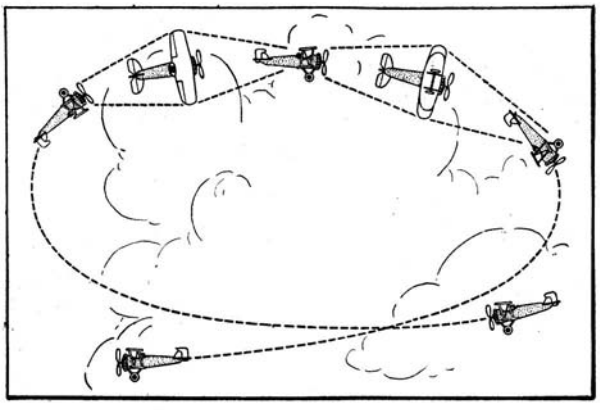
A climb, a steep banking turn, and the plane has reversed, but has lost altitude

The rudder then becomes the elevator, and vice versa. The wing-over is merely a 180-degree turn with a sharp climb at the moment of greatest bank.

This maneuver begins with what is practically a stall and, when it is completed, the plane is flying in the opposite direction with less altitude.

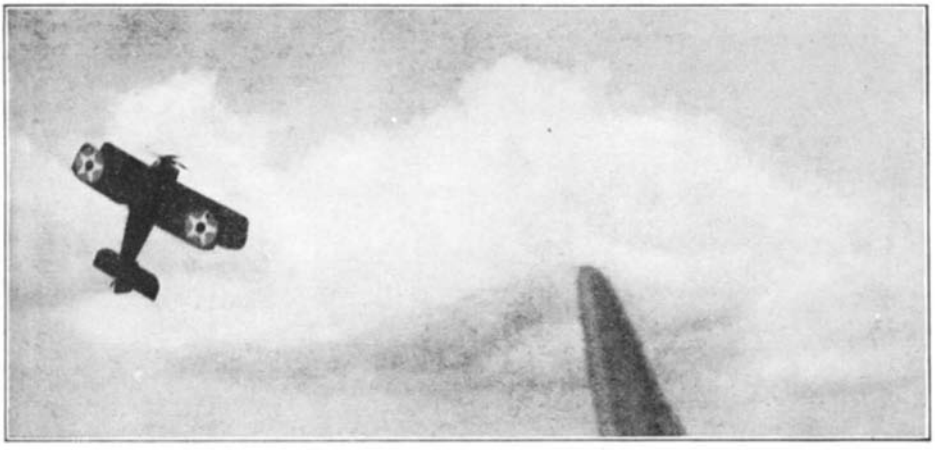
Acrobatic flying is used by the military services almost exclusively for training purposes. A good stunt pilot is generally a smooth flyer. Always, is he master of his plane, but he rarely, if ever, indulges in acrobatic flying without good reason.

Contrary to popular belief, stunts are



A DIFFICULT LOOP

The pilot begins the loop, makes a full roll at the top of it, completes the loop, then continues original flight



DOING A BARREL ROLL

A Navy fighting plane doing a barrel roll, photographed past the rudder of another plane. This maneuver is the same as the ordinary spin, except that the plane's movement is horizontal

seldom indulged in during aerial combat. This is because most of them are based on a spin which is a result of a stall, and a stall means, of course, loss of speed and altitude—two factors which cannot be sacrificed during combat. It is an acknowledged fact in pursuit work that the simplest maneuvers will lead to a conservation of altitude and consequently to the most advantageous positions. An experienced pilot will follow his enemy through a loop or Immelman turn with no difficulty whatsoever. And if the enemy goes through maneuvers

"THREE SEA HAWKS"

From left to right, Lieutenants Davis, Tomlinson, and Storrs, three Navy fliers

that result in loss of altitude, the following plane holds a distinct advantage.

The commercial flyer has no need for stunts in his everyday work. If he has mastered acrobatics, however, he will be a better flyer in every way. Safety in the air is augmented by the experience and skill of the pilot. The passengers he carries will be safer because of his ability to handle a plane in any emergency or abnormal attitude.

Except in a very few special cases, acrobatic flying should be indulged in only under the air-traffic rules of the Department of Commerce. The basis of these regulations is safety—for the performing plane, for other planes in the air, and for people on the ground. These rules provide that no acrobatic flying shall be done over a congested area, over an open-air assembly of people, or within 1000 feet horizontally from an airport or airway. These are very necessary rules.

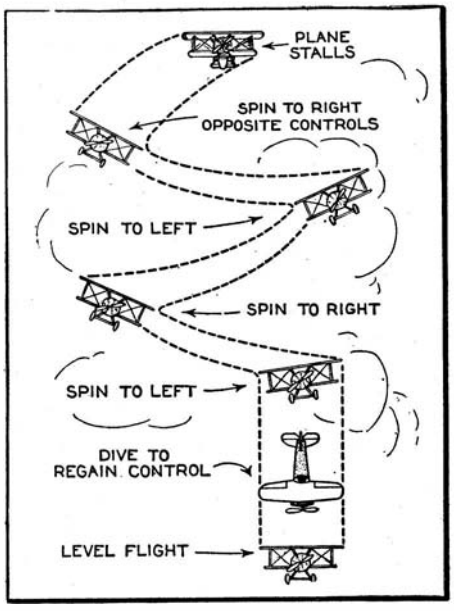
Further, all such maneuvers shall be completed at an altitude of not less than 1500 feet. This is a wise provision. The student, especially, needs plenty of altitude in order to recover from possible spins. High aloft, mistakes can be corrected, and in case of engine failure a bountiful supply of altitude is most comforting.

Exceptions to the Air Commerce Regulations are granted in special cases. For instance, at the National Air Races, acknowledged masters of acrobatics are permitted to perform at lower altitudes. As a crowd producer, there is no equal to such spectacular performances.

Who, having seen them, can forget the "Three Sea Hawks," and the "Three Musketeers" at the races held in Los Angeles in 1928? The tremendous crowds saw probably the most perfect flying of all time.

AS the Sea Hawks rolled over and flew across the field on their backs in perfect formation, one man who was watching the performance was overheard to say, "I don't believe it. There is a trick in it somewhere." The trick was in the many hours of hard work these men had devoted to the attainment of perfection. They knew every trick of the air and of the planes they were piloting.

No one who saw Lieut. Al Williams' inverted stunt flying at the Air Races in Cleveland last October could fail to realize that here was a master of the



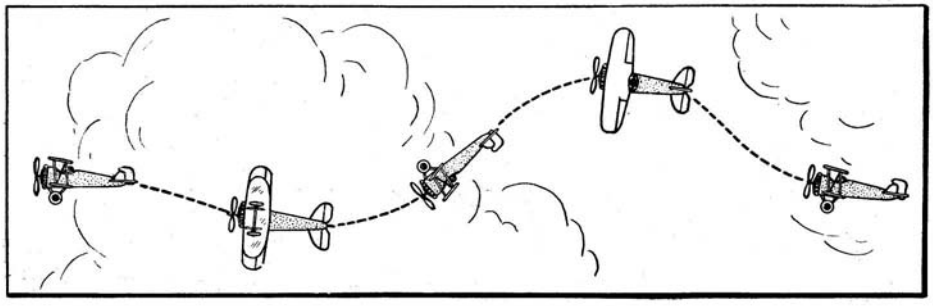
FALLING LEAF

After a stall, the plane settles like a leaf until the pilot dives to regain control

airplane. His uncanny skill is a direct result of the many arduous hours spent in practicing acrobatic flying.

Fortunately, the Department of Commerce prohibits stunting with pay passengers. But there are thrill-seeking people who would tempt a pilot with money to attempt maneuvers unsafe with his type of plane. Accidents would multiply overnight if this restriction were removed. Few pilots can afford to fly a person on a stunt hop just for friendship's sake. It is an expensive gesture and, in addition, there is always the possibility of a resulting liability lawsuit if the passenger should be injured, friendship or no friendship.

Acrobatic flying is merely hard work which prepares a pilot to fill a position of responsibility and trust. It is therefore of the greatest importance that the syllabus of every aviation school should include thorough training in acrobatic flying.



BARREL ROLL

This maneuver might just as well be called "the corkscrew" for the plane, in executing it, moves forward in a horizontal spiral, slightly changing its altitude in the manner shown

Midget Marine Motors

The Rise of the Outboards Has Been Rapid, But Even Greater Developments May Be in Store

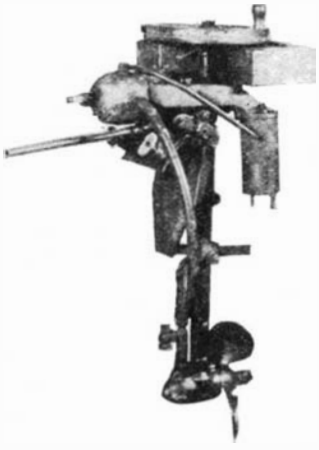
By THOMAS W. FARNSWORTH

THE desire to transform the row boat into a motor boat was no doubt the *raison d'etre* of the outboard motor. The first attempts were simply small editions of larger inboard motors, with clutches, shafting, foundations, stuffing boxes, and struts. It was, of course, difficult to shift these from one boat to another, and even when this was done, the chances were that the new boat had to be made over before it would take the motor. The solution of this problem was a portable, detachable motor which could be clamped to the stern of the small boat. Thus we have the so-called "outboard motor."

ONE man's meat, as has been said, is another man's caviar. And how well we see this demonstrated in the world of outboard motors! The little motor which saves hours of labor for the fisherman or hunter who "putt-putts" to his day's sport in the early dawn, is the same motor which gives hours of joy to the children at the seashore or on the lake, while the more powerful motors provide the last word in thrills for those who get their fun in racing or stunting on the water.

Formerly automobiles put a damper on pleasure boating, but now it would seem that they are helping to revive it. As automobiles increased in numbers and popularity, the demand decreased for power boats for recreational purposes. Boats, the usefulness of which was limited in most American climates, to approximately six months of the year, could not compete with the year-round automobiles, offered in about the same price range. But now that the highway congestion is becoming so tremendous, people in greater numbers each year are seeking recreation on the water. In many instances the automobiles are used simply to get to the boats, or perhaps to carry the boats to the water.

Once the boating public made up its mind that it must have a portable motor—and hence one that was light and free from a multiplicity of parts—it was logical that the fundamental working principle should be that of the two-cycle system.



AN OLD TIMER

One of the first Evinrude motors ever produced. Compare with the new models

Briefly, a two-cycle motor consists of crankcase, crank, connecting rod, piston, and cylinder. It gets its name from the fact that in one revolution of the crank the two strokes of the piston complete the cycle. There is an explosion every time the piston reaches the top of the stroke, as against every other time in the four cycle.

THE AUTHOR AFLOAT

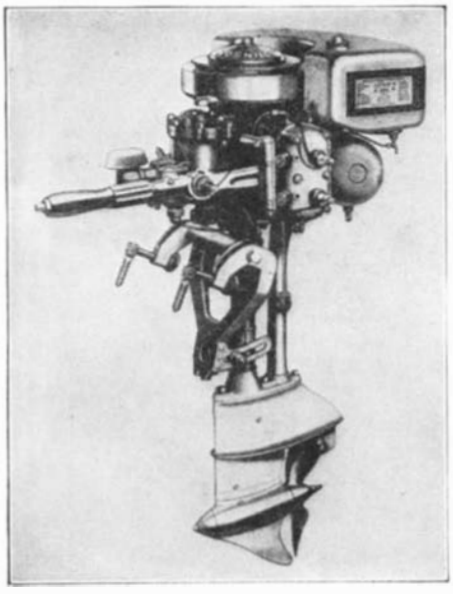
The first outboard motor in the United States (which country now leads the world in outboard motor production) was built by C. D. Waterman in Detroit, Michigan, in 1904. There is record of the Waterman Marine Motor Company's advertising outboard motors as long ago as 1908. The Waterman motors were produced by the Caille Motor Company. The first motor had a single cylinder, held vertical. The crank, which was horizontal, drove a vertical shaft through a set of bevel gears. This shaft followed down to below the water line where it drove the propeller through another set of bevel gears. Most of the working parts of this motor were exposed. The whole unit pivoted for steering. A long tiller handle extended into the boat and on this was attached a fuel tank.

ABOUT 1910, Ole Evinrude came into the field with an engine similar in form to the one which is in present use. This engine had its cylinder placed horizontally and the crank drove the shaft direct, thus eliminating a set of bevel gears. An attempt to eliminate the lower set of bevel gears was made by driving a shaft direct with a propeller on the end of it and supporting the whole unit at an angle on the transom of the boat. By 1914 there were no less than ten manufacturers in the outboard field.

Before 1920 outboard motors were composed largely of cast iron, malleable iron, and bronze. With the introduction of the Elto light twin in 1921, aluminum made its appearance, while shortly thereafter an aluminum alloy called Lynite, having approximately twice the strength of aluminum, was used extensively in the construction of outboard motors. Thus, today we have at one extreme a twin-cylinder motor weighing but 29 pounds and developing 2¾ horsepower, while at the other extreme is a 4-cylinder motor

AN OUTBOARD MOTORED CABIN CRUISER

Motors can now be obtained that are adaptable to almost all kinds of craft, from tiny rowboats to such luxurious cruisers as the Sea Sled illustrated in the above photograph



"SEA HORSE 32"

A Johnson four-cylinder outboard, typical of design advances that have been made

weighing 120 pounds and developing 35 horsepower. This low weight per horsepower is due directly to the extensive use of alloys.

Before 1921 no attempt was made to streamline under-water parts. In 1921 and up to the present date, streamlining of the lower unit and gear housing has been a most important factor in the construction of the outboard motor. The airplane industry has contributed some valuable data in this connection.

IN 1921 Ole Evinrude, now president of the Outboard Motors Corporation, and the Johnson Motor Company brought out motors with twin cylinders opposed. In 1924, outboard motor boats were raced. An Elto twin averaged nine miles per hour. The next meet produced an Evinrude motor which made 12 miles per hour. From that time progress has been made by leaps and bounds until at the present time outboards on specially designed boats are approximating 50 miles an hour.

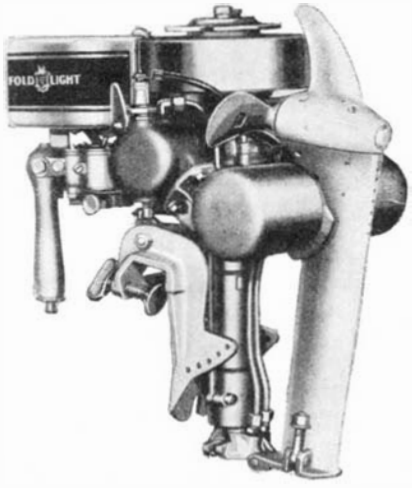
In 1928 the Elto Outboard Motor Company brought out the first four-cylinder outboard motor, and the Johnson Motor Company put an additional valve on their motor called a "release charger." This valve releases the compression in the inactive cylinder and diverts the entire charge of fresh gas to the active cylinder, making the motor much easier to start.

Here then we have motors which have not increased in weight in anything like the proportion of their increase in power. The refinements which have gone into the improvement of these motors are very interesting. The power curve, which began to drop off at 2600 r.p.m. had to keep going up to 5000 r.p.m. This necessitated handling the gas mixture faster, cutting down the resistance and balancing and lightening the moving parts. The new features, designs, and mechanical refinements which have been added to outboard motors have had to do largely with increased revolutions per minute. As most of us know, horsepower is in direct proportion to revolutions per minute. So if the 2000 r.p.m. motor of yesterday was four horsepower, the same motor at 3000 r.p.m. would be about six horsepower and at 4500 r.p.m. would be about nine horsepower—as we find it today.

THE friction and retardation of the gas being sucked into the crankcase, compressed, expanded into the cylinder, compressed, exploded, expended, and ejected by the fresh charge, had to be overcome. One way in which it was found that this could be done was to increase the number of ports, and last season saw two-port, three-port, and four-port motors. One motor came out with a combination of two and four ports, using a mechanically operated rotary valve to admit the gas mixture to the crankcase. This rotary valve not only permitted a large opening to the crankcase, but because of its mechanical operation kept this opening effective for the full length of the suction stroke. The same result is accomplished with a valve acting against a spring installed in the intake manifold leading to the crankcase. In this way, instead of the gas mixture being shot into the crankcase during the brief opening of the ports, it is sucked in continuously during the outward travel of the pistons. Larger openings, admitting gas for a longer time, mean a greater volume, higher compression, more revolutions per minute, and hence more power.

Compression has been increased by reducing the crankcase dimensions and when the limit was reached, the crank itself was increased in size to take up more room. Cylinder compression was increased in proportion by reducing the compression chamber. In the early racing days, motors were "pepped up" by filling in under the pistons with cork or Plastic Wood and brazing metal to the piston head.

Having satisfied in part the public's demand for speed, the manufacturers of outboard motors have been turning their attention to improvements and refinements. These include ease of starting, under-water exhaust, balanced reciprocating parts, ball- and roller-bearings, streamlined under-water parts, lighter and stronger materials, oiling and cooling systems, and so on.

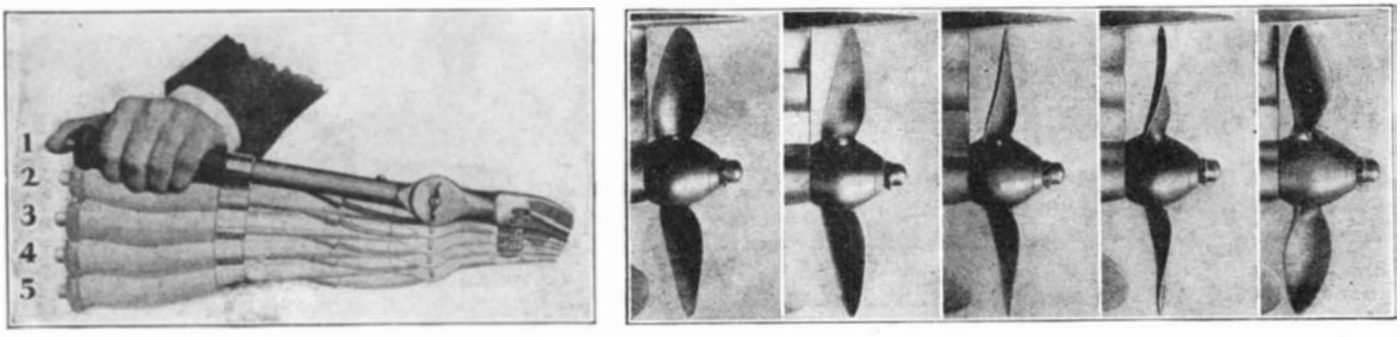


Courtesy Outboard Motors Corporation

THE "FOLD-LIGHT" TWIN

An Elto motor especially designed for carrying in a motor car or otherwise where extreme light weight and compactness is desirable. Note two mufflers

A recent addition to the outboard motor field is a product of the Indian Motor Cycle Company. This firm has had 27 years' experience in the building of small motors. Their



THE CAILLE "MULTI-FLEXIBLE" CONTROL

By moving the tiller arm up and down as at the left, the pitch of the propeller and consequently the speed of the boat may be varied. Also, as at the extreme right, the propeller blades are in "reverse" when handle is in position 5. Neutral position is obtained at 4

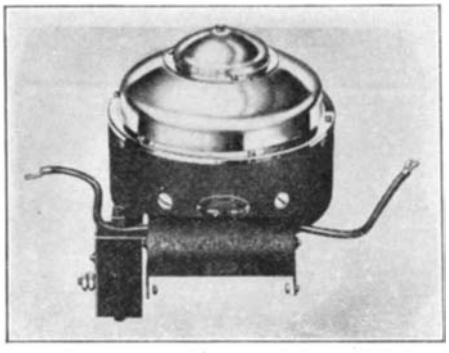
heavily finned one-piece muffler and under-water exhaust, one-piece crankcase, and new cylinder construction of hot-head type are outstanding features.

Because the two-cycle motor has simplicity, cheapness, compactness, inherent light weight, ability to run at any angle, ease of lubrication to a degree, lack of moving parts, and steady running, the disadvantages have been overlooked, even though these are rather numerous. We might list, for instance: hard starting, lack of low-speed control, temperamental control and operation, lack of thorough lubrication, concentration of heat about the exhaust ports, enormous fuel and oil consumption, uneven piston heat temperatures, spark plug difficulties, poor carburation because of low depression in the Venturi and bad fuel caused by oil being mixed with the gas.

When we consider this rather formidable-looking list there would seem to be little wonder that a four-cycle outboard motor is being attempted which does away with most of these disadvantages and contributes many additional advantages. The Cross radial five-cylinder motor, built by the Cross Gear and Engine Company of Detroit, is the outstanding example of efforts along this line. This motor is said to develop 50 horsepower at 4000 r.p.m.

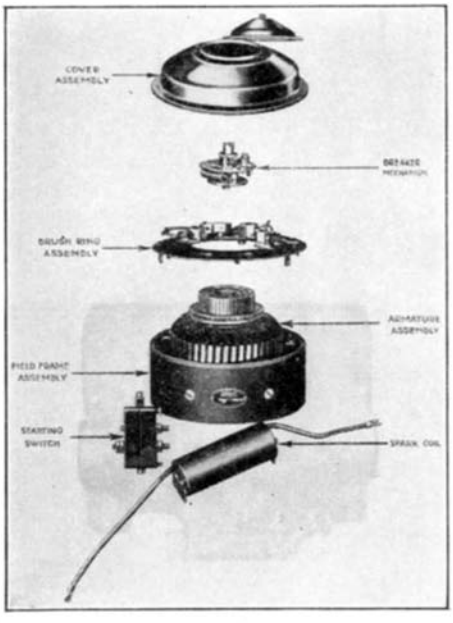
Probably the greatest development, and one which may be due to revolutionize the outboard motor industry, is the new electric self-starter and generator for outboard installation. The Type KB starter-generator, built by the Owen-Dyneto Corporation, is a six-pole, compound-wound, single-unit machine equipped with battery-charge regulator. It is made in two designs, one for use in a six-volt circuit, the other for use in a 12-volt circuit, and is composed of four main sub-assemblies, field frame assembly: armature assembly, brush ring assembly and cover assembly.

The field frame assembly is mounted on top of the engine crankcase and consists of a field frame made from a single steel stamping, six removable laminated pole pieces, and two field windings—a series and a shunt—both containing six coils connected in series.



ELECTRIC STARTER

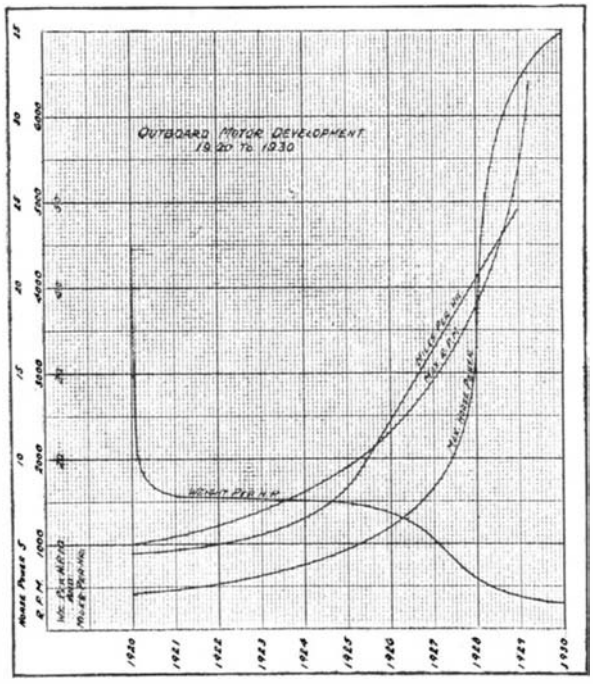
Above: The starter-generator assembled.
Below: The unit taken apart to show the components. See description in text



THE armature assembly is of conventional mechanical construction, and is of large diameter with thin stack to accomplish flywheel effect, for it is keyed direct to the engine crankshaft, and serves as the flywheel for the outboard motor. It is of the two-circuit series type, and weighs approximately 16 pounds.

The brush ring assembly is a steel stamping formed for rigidity and is centered in the field frame by six small tongues. The ring mounts the Dyneto battery-charge regulator and three brush holders: two for the main brushes and one for the control brush. The main brush holders are securely riveted to the ring, but the control brush holder is movable, to allow setting of the charging rate by movement of the control brush. The battery-charge regulator automatically regulates the charging rate as the voltage condition of the battery warrants.

When the starting switch is turned to the "on" position, the starter-generator first operates as a motor and spins the engine at from 400 to 450 r.p.m. After the engine begins to run under its own power, at speeds above approximately 1000 r.p.m. with the six-volt unit, and above approximately 1500 r.p.m. with the 12-volt unit, the machine automatically operates as a generator and charges the battery; at lower speeds it operates as a motor. The power available from the starter motor increases as the speed is diminished and absolutely prevents the motor from stalling.



The curves on the accompaning chart indicate what have been the influencing factors in the outboard motor industry in the last ten years, and may serve as a basis for prediction.

It would appear that weight-per-horsepower reduction could not continue to drop off at its present rate. Revolutions will probably continue to mount higher and higher and this, of course, will mean more horsepower, and consequently greater speed.

The obvious advantages of the four-cycle engine will help in the development of this type of outboard but the question may be raised as to whether the more delicate mechanism, with its multiplicity of parts, will stand the abuse the public is now giving the two-cycle outboard motor. The question also arises as to whether the boating public will be willing to pay for the much more expensive four-cycle type of motor, even with the great saving in operating cost.

IT seems reasonable to predict that outboard motors will be developed with an increased number of cylinders. It is possible that something will be done along the line of the German Junkers opposed-piston two-cycle Diesel engine.

Just what is in the future it is hard to say. But one thing is certain: the outboard motor is here to stay. It is filling an increasingly large place in the outdoor life of America and, like the "flivver" or the motorcycle, may develop from a hobby to a necessity.

The outboard motor will soon be made so fool-proof that anyone will be able to drive it. And, just as the automobile is today, it will be operated by many a man, woman, and youth who knows little or nothing about what makes the wheels go round.

Michelson

An Appreciation of America's Foremost Optical Physicist *

By PROFESSOR WILLIAM H. CREW†
Physicist, United States Naval Research Laboratory

IT is my purpose to sketch briefly the scientific achievements of the man whose first researches were carried out at the United States Naval Academy over 50 years ago and who now, at the age of 76, has set for himself three tasks which to others, even in his own field, seem almost Herculean. And furthermore, it will be interesting to note the far-reaching significance and influence on contemporary thought in physics that may be attributed to these major researches of Professor Michelson.

More than three quarters of a century have passed since Albert Abraham Michelson was born in a small village, Strelno, just 40 miles from the birthplace of Copernicus and then, in 1852, a part of Germany, but now within the borders of Poland. But during practically all of that time he has lived in America as a citizen of the United States.

AT the age of 16 he was appointed by President Grant as a midshipman at the United States Naval Academy and was graduated four years later in the class of 1873, or as then designated, "Date of '69." One reads with interest Admiral Fiske's account[1] of his boxing tilt with Michelson when they were schoolmates at the Naval Academy, a fight from which Fiske emerged in rather the worse condition. However, upon the admiral's own admission, his admiration of Michelson the "pugilist" is surpassed by his admiration of Michelson the physicist. We also learn from Admiral Fiske that an innate interest in physical experiment and evidence of unusual ingenuity were observed in Michelson during his years as midshipman; although Admiral Worden,[2] so it is alleged, was a bit concerned for the future of one who devoted so much of his time to extra-curricular experiments. Humanity may be thankful for the influence that then permitted the individual to follow his true bent undeviated by the rigid restraints of a military régime.

Not very long after graduating, Michelson was detailed to the Naval Academy (1875-1879) as an instructor in mathematics and physics, and at that time he outlined in a simple, characteristic half page in *Nature*[3] an improved method of determining the velocity of light.

Before the Navy had established a post-graduate school, certain officers were selected and sent abroad for graduate study, and in this line of duty Michelson spent the years 1880 to 1882 in Berlin, Heidelberg, and Paris; and in the following year he resigned from the Navy to enter upon an academic career. It is interesting to note that 36 years later (1918) he was again on the Navy Register, enrolled in the United States Naval Reserve Force as a specialist. I recall with pleasure making a visit during the War to the roof of his laboratory at the University of Chicago where he was developing an optical range finder for use by Navy vessels.

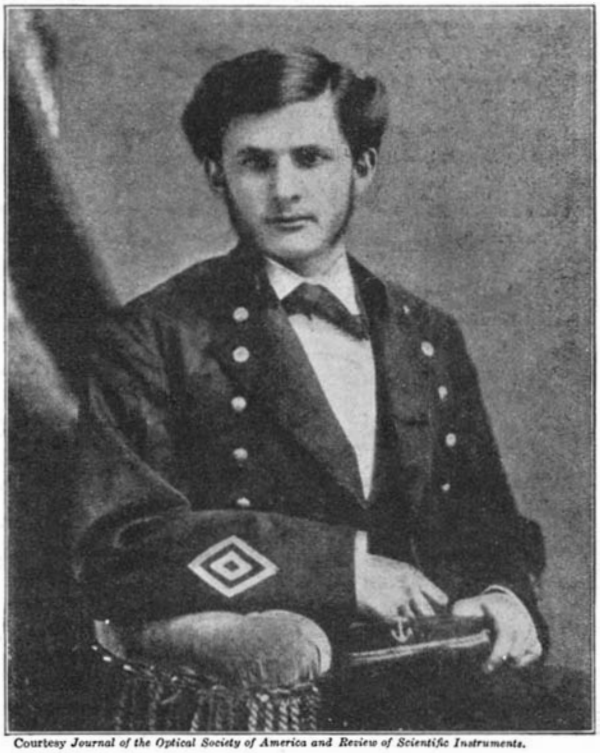
FOLLOWING his early Navy career, Michelson became a professor of physics first at the Case School of Applied Science at Cleveland and later at Clark University at Worcester and finally, since 1892, at the University of Chicago, to which he was called as head of the Department of Physics.

The recognition of Professor Michelson as a scholar and an investigator of the highest order is borne out by the many honors, both foreign and domestic, of which he has been the recipient. His awards, such as the Rumford Medal, the Copley Medal, and so on, are too numerous to mention here, but one cannot resist pointing particularly to the fact that Professor Michelson was the first American physicist to receive the Nobel Prize Award.

Although for nearly 40 years Professor Michelson has made his home in Chicago, much of his time has been recently spent in California where, even during the past summers, he has been repeating the ether-drift and velocity-of-light experiments, always with new and improved technique, increased precision, and with convincing results. It is thus that we learn of Michelson, at 77, outlining three new tasks which are in brief: the re-determination of the velocity of light; a refinement of the measurement of the diameters of stars; and another search for a possible ether-drift.

It may be of interest to review very briefly the principle researches of Professor Michelson; and then to consider their bearing and influence on current physical thought.

PROBABLY the first serious effort to find out whether or not the velocity of light is finite was made by Galileo; but the crudeness of his experiments left him with no evidence that the passage of light from one point to another was not instantaneous. In 1676 the Danish astronomer, Römer, pointed out that inequalities of the time intervals between eclipses of Jupiter by one of its satellites may be accounted for by the varying distance of the earth from that planet due to the periodic motion of the earth about the sun and at the same time assuming a finite velocity of light of about 192,000 miles per second. Subsequently, short-range determinations of this velocity were made, and noteworthy were the toothed-wheel experiments of Fizeau (1849) and Cornu (1874), and at the same time the revolving-mirror experiment of Foucault.



Courtesy Journal of the Optical Society of America and Review of Scientific Instruments.

MICHELSON AS A MIDSHIPMAN

His first determination of the velocity of light (*Scientific American Supplement*, Sept. 13, 1879) was made about five years later when he was a young teacher

* Reprinted by courtesy of *United States Naval Institute Proceedings*.

† See "Among Our Contributors," page 341.

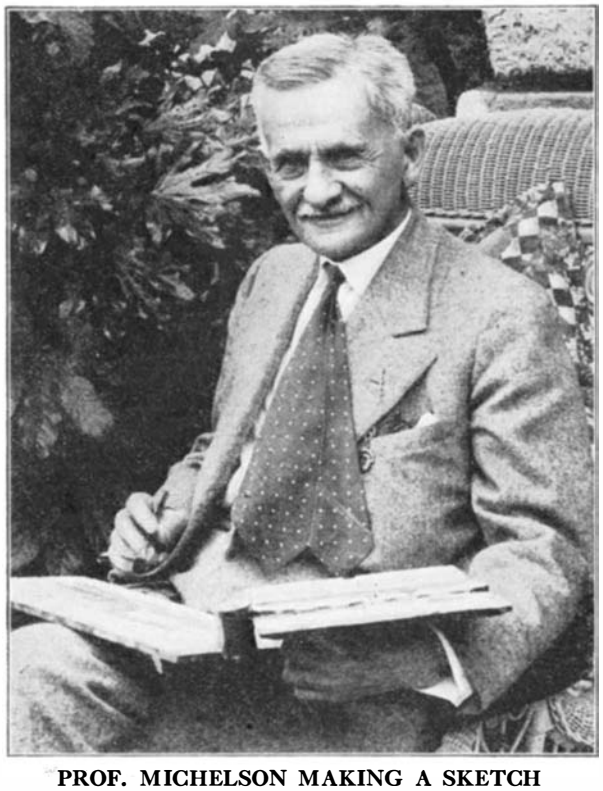
[1] Fiske, "*From Midshipman to Rear Admiral*," page 15.

[2] Admiral Worden was then superintendent of the United States Naval Academy, and formerly was commanding officer of the ironclad *Monitor*.

[3] *Nature*, **18**, 195 (1878).

The method of determination of the velocity of light as proposed by Michelson in 1878 was that of the revolving mirror, driven by an air blast and calibrated against a tuning fork of accurately known frequency. The apparatus for this experiment was set up along the sea wall of the Naval Academy at Annapolis, a position which is now occupied by the tennis courts. Here an unobstructed path of 500 feet between mirrors was obtainable. The results of this experiment were published in the *Proceedings of the American Association for Advancement of Science*[4] in 1878, and the best value obtained, 186,508 miles per second, was a mean of ten independent observations "made under difficulties, and with apparatus adapted from material found in the laboratory of the Naval School."

In the years subsequent to 1878, improvements in the measurements of the two fundamental factors in this experiment, the *distance* interval and the *time* interval of the passage of the light beam, have been made under the direction of Professor Michelson. The distance between mirrors in the 1924 determination[5] was about 22 miles, accurately measured for the purpose by the United States Coast and Geodetic Survey, between Mount Wilson and Mount San Antonio in California. The rotating mirror in this case was in the form of an octagonal prism, each face being an optical flat, and it functioned also as a timer by virtue of its calibration with a standardized tuning fork. This experiment has given what is by all odds the most trustworthy value of the velocity of light, namely, 186,359 miles per second in air.



PROF. MICHELSON MAKING A SKETCH

Water color sketching is his recreation. So also is the refinement of accuracy in the determination of "*v*"

In the early eighties, when in Germany, Professor Michelson's interests were first directed to the "Aberration Question," which in short was this: "Does the medium, usually called 'ether,' in which light waves are propagated through empty space, remain fixed with respect to the stellar universe while the earth moves freely through it; or does the earth drag the ether with it, as a rapidly moving vehicle carries a quantity of air with it into its motion?"

A study of this question, both experimental and theoretical, has led the way to a vastly greater comprehension of the universe in which we live than has, perhaps, ever been realized before. In particular, the results of the now famous "Michelson and Morley Ether-Drift Experiment," carried out at Cleveland in 1887, gave the initial impetus to the theory of relativity. Let us consider this far-reaching experiment.

AS early as 1880, Professor Michelson conceived the idea of making a direct test for ether-drift by sending simultaneously two beams of light waves out from a point in two mutually perpendicular directions, and by means of mirrors reflecting each back along its own path to the starting point. If during such an experiment there is no drift of the ether, the two beams of light waves will arrive together in step; but, on the other hand, if there is a drift of the ether along the path of one of the light beams, then the two sets of waves will arrive somewhat out of step. To measure such a possible "out-of-stepness" Michelson invented (1882) a simple but tremendously ingenious interferometer, an instrument which has since found application in many and various types of optical measurements.

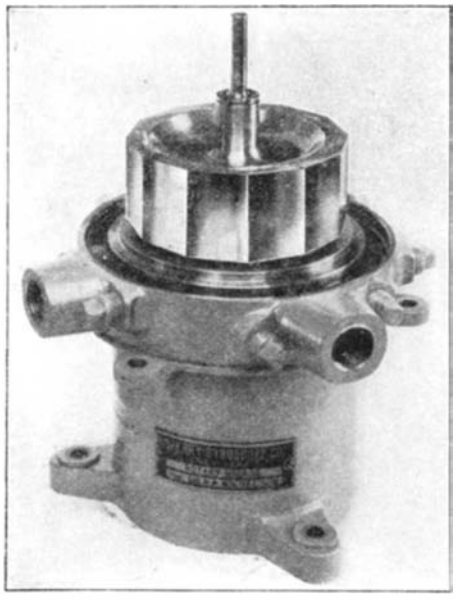
His first effort to detect ether-drift with an interferometer was in Helmholtz' laboratory in Berlin; but here the vibrations due to city traffic made the use of this instrument impossible, and accordingly the apparatus was moved to Potsdam. The results obtained there, however, were considered inaccurate and therefore of no significance, and were disregarded.

Upon returning to America, Professor Michelson, assisted by Professor Morley, built an interferometer on a large scale at the Case School of Applied Science; and there they made the surprising observation that the light waves reflected back along the two perpendicular paths of the interferometer met one another "in step." The immediate interpretation of this was that there was *no relative motion*, that is, no drift, between the earth and the ether. This experimental observation was repeated later, and with increased precision, by Morley and Miller at Cleveland, and by Michelson at the University of Chicago and in each instance the original Michelson-Morley experiment was substantiated.

THIS experimental result which indicated no ether-drift was in contradiction to the supposed facts deduced from observations of aberration; and as late as 1900 Lord Kelvin, at the International Congress of Physics held in Paris, averred that the "only cloud in the clear sky of the theory of the ether was the null result of the Michelson-Morley experiment." But at about that time Lorentz, in Holland, and Fitzgerald, in Ireland, proposed an hypothesis to make compatible the results of the Michelson-Morley experiment and the earlier aberration experiments; and it was this hypothesis, now usually referred to as the Lorentz-Fitzgerald contraction hypothesis, on which Einstein founded his theory of relativity in 1905. The influences of this theory are too numerous and too profound to mention here, but suffice it to say that they have introduced entirely new and extremely interesting speculations as to the structure of atoms and in general the nature of things.

In the years 1921 to 1925 very extensive ether-drift experiments were carried out by Professor Miller at the Mount Wilson Observatory in California. Physicists the world over were astounded when Professor Miller announced an observed motion of the ether of about ten kilometers per second; for such a result was apparently in disagreement with the Michelson-Morley experiment and with the theory of relativity. Professor Miller then carefully repeated the experiment and verified this former result, but the same experiment was done independently at Mount Wilson by Dr. Roy Kennedy, who found no evidence of an ether-drift. A few years later Professor Michelson went to California and there repeated his ether-drift experiment, and in November of 1928 at Washington he announced to a very eager and attentive audience at a meeting of the Optical Society of America the result of this last and most precise experiment—no observ-

[4] This article has recently been republished in the *Scientific Monthly* for December, 1928.
[5] Michelson, *Astrophysical Journal* **60**, 260 (1924)



MODELS OF 1926 AND 1879

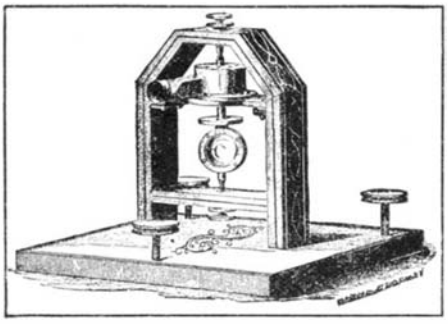
Above is the 12-sided mirror (made by the Sperry Gyroscope Co.) most recently used, and at right the simple mirror of the first determination, reproduced from the *Scientific American Supplement*, 1879

able ether-drift. The contrary results of Professor Miller's experiments, done under his keen supervision and skillful hand, still stand unexplained; but the situation, as recognized by the scientific world, is that relativity remains vindicated.

I wish to refer briefly to some of the other important achievements of Professor Michelson. I have mentioned the interferometer which was devised by him for the purpose of determining a possible ether-drift. This same instrument has found most remarkable applications in other fields of science, notably in the measurement of the distance between components of double stars and in the measurement of the diameter of the giant star Betelgeuse. In this latter instance an interferometer was mounted on the end of the 100-inch reflecting telescope at the Mount Wilson Observatory; the diameter of this great star, located in the constellation of Orion, was calculated to be 240,000,000 miles, a distance about equal to the diameter of the orbit of Mars.

THE international standard of length is the distance between two scratches on a particular bar of platinum-iridium kept at Sèvres near Paris, and is known as the standard meter. In order to establish permanently this standard of length so that it might never be lost to mankind due to material destruction, Professor Michelson spent the first year of his appointment at the University of Chicago in Paris in determining this length in terms of the wavelength of a particular red line in the spectrum of cadmium. For this purpose again the interferometer was brought into use and a most accurate determination yielded the result that one meter is equivalent to 1,553,163.5 wavelengths of this particular red cadmium line. And now we may rest assured that even though the standard meter of Paris be destroyed by war, by vandalism, or by natural causes, it could be again reproduced to within an accuracy of at least one part in 3,000,000. It is a remarkable thing and a fortunate one that the wavelengths of the light in the spectrum of any element such as cadmium are identical the world over and probably throughout the entire universe.

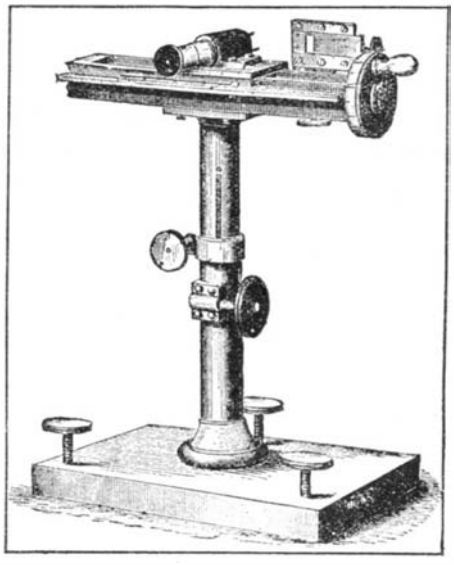
From the brief résumé of Professor Michelson's achievements it may be



concluded that their distinguishing feature is precision. The economic value of these experiments of precision can not be estimated in numbers but their use in promoting useful and properly directed thought is inestimable, and an interesting discussion of these uses has been given by Professor Millikan in *Science* for May 10, 1929. Certainly of greatest importance, in my mind, is the ether-drift experiment which triggered off the study of relativity, which in turn has promoted thought along the lines of atomic structure, has introduced the notion that energy is intimately related to mass, and has finally led to exceedingly interesting speculations as to the constitution of stars. Knowledge along this line certainly seems worth while in that, possibly, our future source of energy may be the stars, or, in particular, the sun.

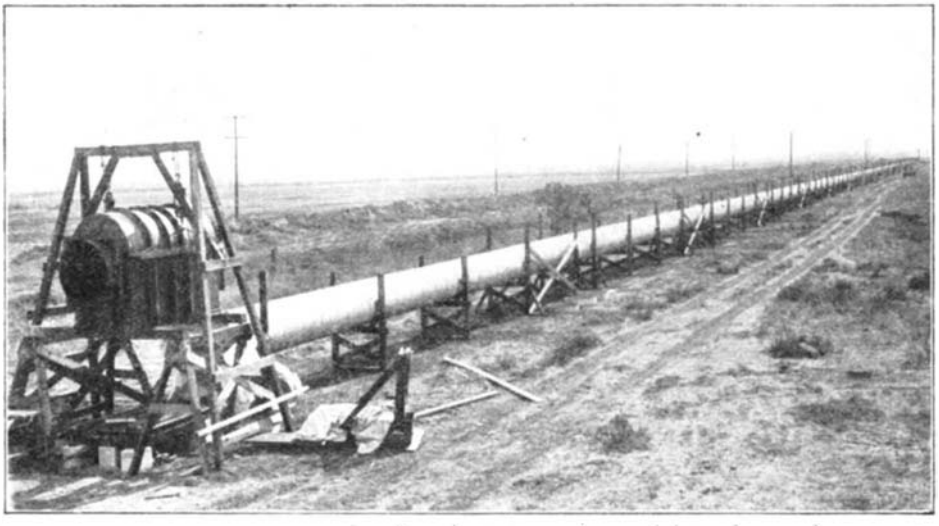
As the Copernican theory led mankind away from geocentric ideas, so has the theory of relativity led him away from egocentric ideas; that is to say, one can no longer honestly estimate velocities and accelerations with respect to himself but must also extend to other stars and even other universes the privilege of being the basis of reference. A most entertaining and illuminating discussion of this subject is to be found in Eddington's recent book, *The Nature of the Physical World.*

These valuable scientific researches in themselves stand as evidence to the skill and mental prowess of Professor A. A. Michelson as an investigator, and the United States Naval Academy may well be proud to count him as one of its graduates, but these researches are apparently not the last.



APPARATUS USED IN 1879

For measuring the deflection of the beam. Note screw head, divided circle, adjustable slit at the top, right, and eyepiece



PROFESSOR MICHELSON'S PRESENT EXPERIMENT

The 1926 determination was made on a 22-mile base line. Next an 82-mile base line was proposed but its atmospheric conditions were wrong. So Professor Michelson is now performing the experiment in a vacuum within this pipe line in Southern California

The Aerial Ferry Arrives

Operating at Frequent Intervals, Amphibions Carry Passengers on Regular Schedule

SHORT-HAUL air transportation has been tried out successfully in California between San Francisco and Oakland. The regular trip by boat and train ordinarily consumes 40 minutes, while the seven-passenger amphibion makes the trip in six minutes. The one-way fare is $1.50, but regular commuters may effect an economy by the use of scrip books. This is the shortest and most frequent air service in the world. In the first 19 days of operation the three Keystone-Loening amphibion air yachts carried 8330 passengers. Approximately 110,000 persons cross the bay daily and therefore there will always be potential patrons for the air-ferry service.

What made short-haul air service practical, however, was that Air Ferries, Ltd., brought its airplanes to the centers of business and transportation. The quick accessibility of the waterfront terminals and the amphibion equipment made it possible to turn to advantage the waters of San Francisco Bay—the same medium which has been the chief obstacle to transportation between the communities which lie inside the Golden Gate.

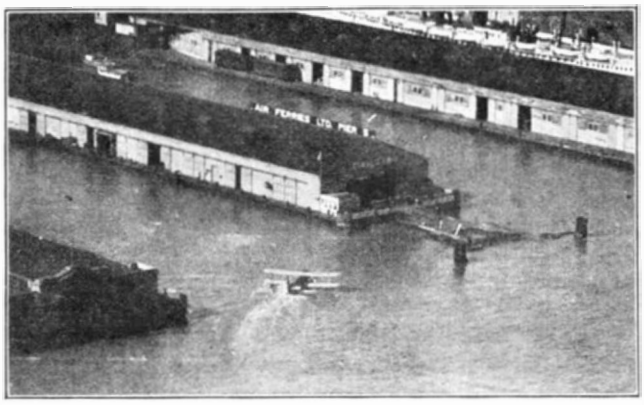
THE air ferries operate across the bay on a more frequent schedule than even the ferryboats, the long established means of transportation. The ferry steamers leave every 20 minutes. They debark passengers at Oakland mole, a trestle reaching far out into the bay, whence electric trains carry them through the East Bay district. By the use of air ferries, it is now possible to make the trip between the actual business centers of the two cities in approximately 18 minutes.

The 30,000-dollar Loening amphibions carry seven passengers and two pilots each, and cruise at a speed of 105 miles an hour. They take off from the waters of San Francisco Bay or Oakland estuary at a speed of 85 miles an hour, after an 18-second run, and have a landing speed of 55 miles an hour. They are powered with 525-horsepower Pratt and Whitney Hornets. Passengers step directly in and out of the planes, without having to travel in boats, climb ladders, or approach moving propellers. The air ferries are 34 feet 8 inches long, weigh 5900 pounds, have a wing span of 46 feet 8 inches, and can cruise 550 miles on a tankful of fuel. The gasoline consumption is about 26 gallons an hour.

Additional service will be provided soon to Vallejo, Sacramento, Stockton, and other points. The flying time to Sacramento—89 miles—will be 55 minutes. Night service is planned as soon as the necessary lighting equipment is installed.

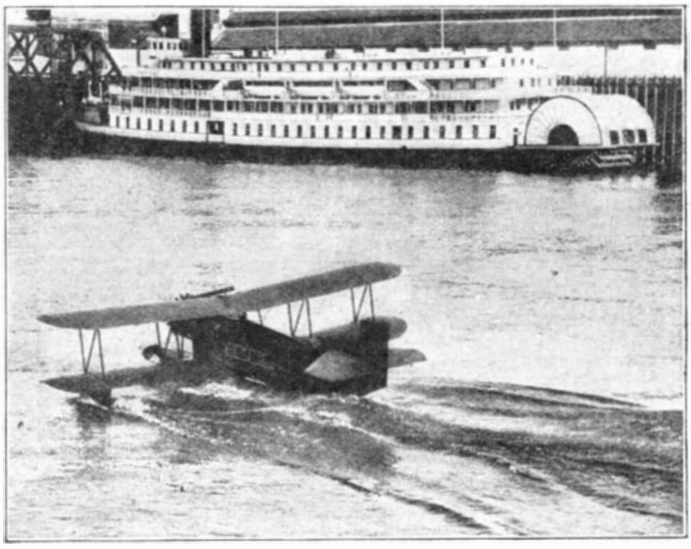
◄ ABOVE OAKLAND

The actual flying time between San Francisco and Oakland is six minutes



AIR VIEW OF DOCK

The amphibion is approaching the ramp where passengers will debark. The pier shed has been converted into a hangar



THE OLD AND THE NEW

In the foreground is one of the amphibion air ferrys. In the background is one of the stern-wheelers that are still in service

LIKE A DUCK

The amphibion air ferry lands on the water and taxies along the surface to a ramp up which it climbs under power of its engines

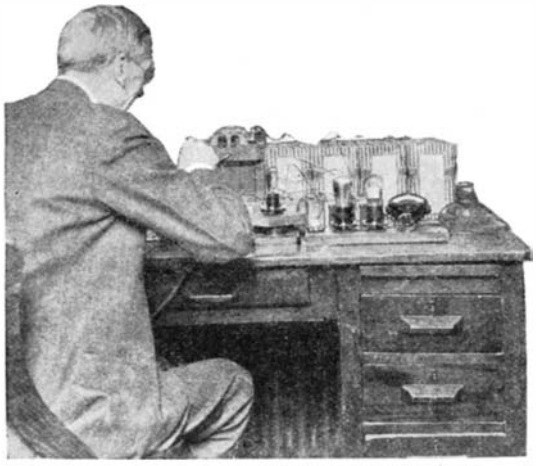


PHOTO-ELECTRIC CELL IN ACTION

Here we have H. B. Meller, head, Mellon Institute investigation, experimenting on the photo-electric cell for measuring atmospheric contamination

Our Air Analyzed

How Science Fights the Smoke and Dust Evils of Our Cities

THE nuisance of smoke and dirt is present wherever fuel, particularly soft coal, is burned. Everyone detests smoke, but until comparatively recently not much constructive effort was made to get rid of it. Now, however, smoke abatement is a live subject in communities throughout the country. One hundred and twenty-five cities of more than 30,000 population have smoke ordinances of one form or another, more or less strictly enforced. Scientific research is being carried on in a few centers, but unfortunately the efforts as yet are not concerted and there is some unnecessary duplication.

At least one of the most outstanding organizations in the field of smoke abatement is Mellon Institute of Industrial Research in Pittsburgh, which in the past has made two surveys of conditions in Pittsburgh, and now is engaged in a third of broader scope.

The first survey was made in 1912 to 1914. Not only were determinations made of the amount of sootfall in different parts of the city, but conditions in plants making unnecessary smoke were investigated. The effects of smoke on health, on vegetation, on meteorological conditions, and on paints, building materials, and interior decorations were studied.

SAMPLES of precipitated matter collected monthly for twelve months were analyzed to determine the percentages of tar, combustible matter other than tar, and ash. The results showed that an average of about 1000 tons of solid matter was being precipitated per square mile per year in the city of Pittsburgh. Of this 10 tons was tar, about 300 tons combustible matter other than tar, and about 700 tons ash.

Following this survey, an anti-smoke ordinance was passed and has since been in effect. This ordinance prohibits dense smoke of two minutes or more duration in any period of 15 minutes, and dense smoke is considered to be equivalent to Number 3 of the Ringlemann chart. In a practical way, this may be said to be smoke of such density that it is not possible to see through the stream as it leaves the stack. This is the limit placed in the average ordinance, because with available equipment and under present operating conditions, a closer limit had not seemed feasible.

After ten years, or in 1923, it was desired to determine what results had been attained under the ordinance. Samples were collected and analyzed exactly as in the first instance. The marked difference was in the reduction of tarry matter by about two thirds. In other words, enforcement of the ordinance was successful in materially reducing prohibited dense smoke. On the other hand, the total weight of solid material deposited had increased by about 40 percent.

This brought up the question of whether the purpose behind the ordinance was being served; but since there is at present no feasible universal method of eliminating solids not visible to the naked eye and noxious gases that may accompany these solids, it did not seem advisable to suggest any changes in the law. The need for further study of the problem was indicated, however, and in 1928 Mellon Institute entered upon its third survey, this to cover many phases not previously considered.

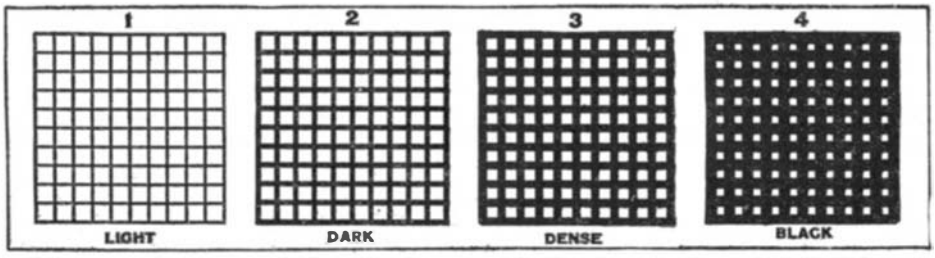
PHOTOGRAPHING DUST

Every specimen is mounted on a slide and photographed with high magnification

THE work now in progress may be grouped as follows: Determination of amounts and compositions of solid matter and gases at the sources; a study of the distribution and behavior of these solids and gases after they are introduced into the atmosphere and their effects, particularly in screening out sunshine; the possibility of developing methods to prevent such solid particles and objectionable gases from getting into the atmosphere.

In order to determine approximately the amount of contamination from stacks, it is necessary that tests be made of various kinds and sizes of boilers and furnaces, some hand-fired and some equipped with stokers, using the different kinds of fuel available in the district, with good draft and with poor draft, and with light load and heavy load; in other words, to make enough tests in a given case to say approximately what amount of pollution is being contributed. If it is desired to determine the approximate total for a city, it remains then to tabulate the plants in accordance with the grouping of the tests. These groupings may include stationary plants, locomotives, steamboats, and portable boilers such as steam shovels and hoists.

The automobile may be a greater source of contamination than is generally supposed. Aside from the products of incomplete combustion of fuel, which may enter the atmosphere



THE RINGLEMANN CHART USED IN PITTSBURGH

Place the chart on a line with a stack a sufficient distance from the eye to cause the lines to merge. Compare with the density of smoke under observation; if equal to or greater than 3, the smoke is a violation of the city ordinance and the operator is liable to penalty

directly, there is the fact that they are emitted at a low level, and therefore are more of a nuisance and more damaging than if they entered the atmosphere at the level of the ordinary chimney. There is the added fact that the movement of the wheels and the force of the exhaust raise dirt from the street.

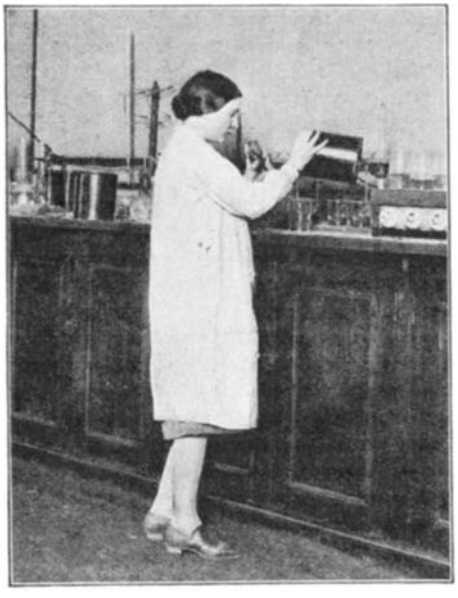
IN any study of air pollution in a city, it is important to determine how much is being contributed from outside the city. Obviously, if it is desired to clean up, plants not within the city limits but close enough to add materially to the dirt must be considered.

After the solids and gases leave the stack, they are acted upon by the wind currents. Gases are diffused and the heavier solids dropped almost at once to the ground. Those of intermediate weight drift slowly downward and reach the ground at greater or lesser distances from the source. The lighter solids are retained in suspension and travel with the wind, and naturally some of the particles that drop at one wind velocity may be picked up and dropped repeatedly as that velocity varies. And, of course, the nearer to the ground, the greater the percentage of intermediate or heavier particles in suspension.

To determine the amount of material that may drop, and the amount that may be in suspension, the two following methods have been employed:

1. Containers are placed at different locations (20 stations being used at present in the city of Pittsburgh), and the amount of material that drops into the container is weighed and analyzed. In order that the effects of various weather conditions may be considered, there are two containers at each station, one being changed daily for the purpose of determining the sootfall in 24 hours, and for the additional purpose of comparison with weather conditions during that period, and the other changed each month so that there shall be enough material for accurate chemical analysis.

2. The solid matter in suspension is sampled by means of the Owens Jet Dust Counter. The solid particles are precipitated on glass, and then this glass is mounted on a slide for study under the microscope. The number of particles is counted and the sizes are measured. Samples of this character are taken daily at strategic points, and these results also compared with the records obtained from the Weather Bureau.



COLLECTING AND MEASURING

Above: At twenty stations dust is collected daily and monthly for weighing and chemical examination. *Left:* The assistant is transferring a sample from a collecting vessel to a glass beaker

WEIGHING THE DUST

After drying the samples of collected dust deposits, the weights of the latter are ascertained with accuracy. The experiments are carried on with care and the results are tabulated

THE SPECTROGRAPH

A spectrograph is used daily, if the weather permits, to measure solar radiation

WHILE the effects of air pollution on vegetation, building materials, paints, and so forth, are fairly well understood and were studied carefully as a part of Mellon Institute's investigation of 1912 to 1914, what is considered one of the very important effects of atmospheric contamination is the reduction, through absorption and scattering by the solid particles, of the beneficial rays of the sun. To secure information concerning the extent of this screening, a quartz spectrograph is used as the basis for standardization of other instruments and other methods, and for taking, at stated intervals, photographs of the solar spectrum. Most of the work will use the photo-electric cell.

The behavior of various kinds of dusts is being studied in an air-tight dust chamber, so that it is possible to use samples having known quantities of definite kinds of solid material. The action of each of these is studied with the spectrograph and the photo-electric cell.

It is obvious that an investigation of this broad character, even assuming the possibility of securing all the data desired, would not be of maximum value unless methods were developed which would make possible the suppression of at least a considerable part of the evil. Consequently one phase of this research looks toward such development.

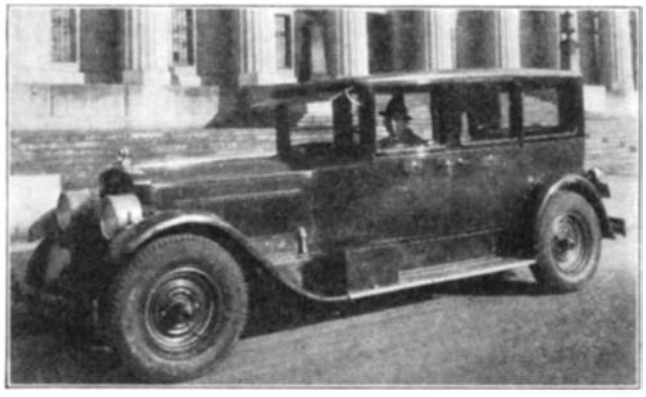
A Diesel Drives an Automobile

Stock Marine Diesel in 6000-pound Car Chassis Makes 2780 Miles on $7.72 Worth of Fuel Oil

By WILLIAM F. STURM

ONE of the most interesting engineering demonstrations of recent years, and one fraught with portent for the automotive industry, was a test trip made by a Diesel-engined automobile from Columbus, Indiana, to Indianapolis, New York, Detroit, and back to Columbus—which, for the benefit of those short on geography, is just 40 miles south of the Indiana state capital.

The trip of 2780 miles was important in that it marked the first time in America that a Diesel engine ever had been used to drive a regular automobile. The trip proved conclusively that the Diesel engine is flexible enough for automotive power plants and it opened the eyes of engineers to the possibilities of an engine that not only would perform satisfactorily in an automobile chassis but would do so on fuel oil which may be purchased at from eight to ten cents retail and which will drive a car at a speed of 55 miles an hour over all kinds of roads, hills, and detours.



THE DIESEL-ENGINED AUTOMOBILE

This car, the first in the country to be driven by a Diesel, was easily operated and its fuel economy was exceptional

THE engine used was of four cylinders, with a 4½-inch bore and a six-inch stroke, developing approximately 50 horsepower. The test trip engine was not one specially built for automobile use, but one taken from regular production for portable and marine use. The chassis was from a 1925 model of a well-known automobile, and the change was made simply by removing the automobile engine and replacing it with the Diesel. The heavy base of the Diesel was removed and fittings necessary to anchor it to the frame members of the automobile chasis were added. It was not necessary to change the hood or radiator alignment, nor to disturb the rest of the chassis in any way.

So well did the car perform, from the standpoint of flexibility, that no difference was discernible between it and the standard type of automobile. Mr. C. L. Cummins, president of the Cummins Engine Company, of Columbus, Indiana, drove the car into New York at the busiest hour of the day, between 4 and 5 P.M., and parked it at the Roosevelt Hotel. In all the larger cities he visited—New York, Philadelphia, Baltimore, Washington, Pittsburgh, and Detroit—he asked no odds of anyone in traffic. The greatest tribute to the engine performance is that until one came close enough to read the small sign, "Diesel Test Car—Cummins Engine Company," on the tire cover, he was not aware that it was not a conventional automobile.

No extensive experiments were made with the car prior to its long trip; in fact, the finishing touches were placed on the car at 9:30 in the morning and it left an hour and five minutes later for New York, making the trip in 25 hours driving time.

On the trip from Indianapolis to New York—792 miles—the fuel oil consumption was 30 gallons and the cost was $1.38. One must be honest, however, and say that this low cost was due to the fact that most of this oil was purchased at wholesale at the Cummins factory for 4 cents a gallon. But even had the top retail price of 10 cents a gallon been paid for the 30 gallons, the cost would have been only three dollars, as against 99 gallons of gasoline at a cost of $24.75 for the same chasis with a gasoline engine consuming a gallon of gas every eight miles. On the 2780-mile trip, 102 gallons of fuel were used. The cost of this was $7.72, as against a fuel cost of 86 dollars at 25 cents a gallon for a gasoline engine.

The actual average per gallon, with the car running wide open most of the time and no attempt made at fuel economy, was 27.2 miles, which includes distances between cities and mileage used within city limits in demonstrating the car. The full cost per mile was less that three mills, yet the car weighed 6000 pounds.

"We made the trip merely to demonstrate that the Diesel engine, as it is made today for marine and portable use, can be used successfully in an automobile," Mr. Cummins said. "I had listened so long to the statements that a Diesel is not flexible that I decided to demonstrate the falsity of the statement, at least so far as our product is concerned. The engine we used was not an automobile engine at all. But even without being especially adapted to automobile use, it met the occasion surprisingly well. We are certain that development can successfully meet the service conditions met with in trucks, buses, tractors, and similar services. It can be adapted to passenger car use—particularly for export—as easily as to trucks and buses.

"HOWEVER, the refinement of the motor, the path to passenger car use, lies through the truck field, simply because the matter of weight is not so vital in the truck and bus field as in the passenger-car field. I would like to make this plain—that the marine Diesel is entirely too heavy for even the contemplation of its use without refinements in the passenger car."

The matter of automotive adaptation is only one of engineering the engine to the problem at hand. When this is done, Mr. Cummins says that instead of 28 pounds per horsepower the weight can be reduced without injuring the life of the engine and its performance so that the automotive engine weight will not exceed 10 pounds per horsepower. This compares favorably with the average automobile engine of today.

The Diesel develops its power at low engine speeds, as evidenced by the engine used in the test trip. It was equipped with a governor which took the engine away from the driver at 1300 revolutions a minute, yet the car ran perfectly at a speed of 55 miles an hour. Further, one might expect the motor to vibrate considerably at low speeds, yet in the hundreds of miles the writer rode, he found its vibration no worse than any four-cylinder engine of its size. As the speed increased and 15 to 20 miles was reached, the engine smoothed out and ran as smoothly and as quietly as any gasoline engine. Its acceleration at 20 to 50 miles an hour was surprising,

especially in view of the 2½ to 1 gear which was used in the car, instead of the 4.69 to 1 used with the original eight-cylinder engine.

The engine was started with a 12-volt motor-generator which, after starting the engine, becomes a generator to re-charge the battery. By a turn of a lever on the dash, the compression in the cylinders was released while the starter turned the engine over. After 10 or 12 revolutions of the motor to get up speed, the compression-release lever was turned to re-establish compression, and the momentum engendered started the engine instantly and as easily as the normal car starts. There are no carbureter and carburation problems on a Diesel. If the oil in the cylinder walls is loose enough to permit the motor to turn over, that is all that is asked. Whether the atmosphere is 40 degrees above zero or 40 degrees below makes no difference to a Diesel. The car was left out on a parking lot at Pittsburgh for two nights at zero weather and it responded instantly after standing 13 hours. On the compression stroke the air charge becomes heated to approximately 1000 degrees, Fahrenheit, and away she goes.

IT may interest the lay public to know that, with the exception of the firing by heat induced by compression, and injection of the fuel into the explosion chamber thus heated, the four cycles or strokes are exactly the same as in the standard type of automobile engine. The engine which was used has neither spark plugs nor any other type of spark ignition and no carbureter. In place of plugs, it depends on heat generated by compression of the air charge in the cylinder to ignite the fuel. In the gasoline engine the charge consists of gasoline vapor and air mixed; in the Cummins engine pure air only is drawn into the cylinders. On the compression stroke this air is compressed to 500 pounds per square inch, which generates a heat of approximately 1000 degrees, Fahrenheit. While the air is at its highest compression and temperature, the fuel (in a gaseous state) is injected into the explosion chamber by suitable mechanism. On contact with the heated air it ignites and burns progressively, instead of explosively, as in the gasoline engine, and creates the power stroke of the engine.

Mr. Cummins says his engine differs from the conventional type of Diesel because in the latter the solid fuel is injected at pressures varying from 3000 to 10,000 pounds, and as considerable time, comparatively, is required to gasify the cold, wet fuel, it is injected considerably ahead of the top center stroke of the piston, which results in heavy explosive pressures in the cylinder, making extremely heavy moving parts mandatory to withstand the strain.

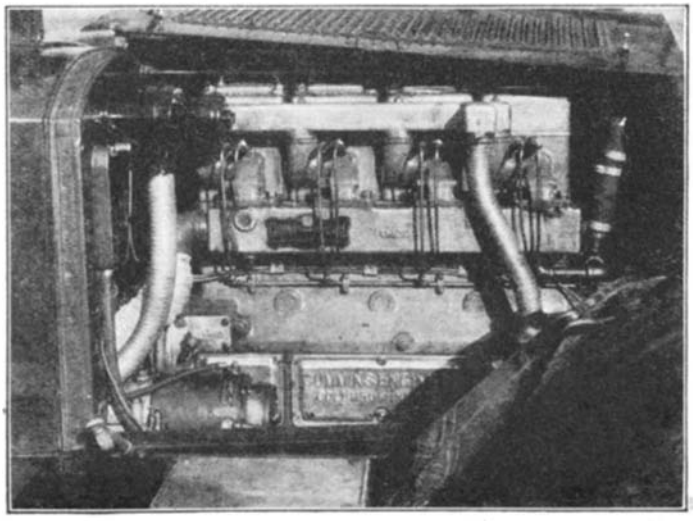
In the Cummins engine, the fuel is pre-heated by circulating it around through an annular space between two members of the injection plunger chamber. Fuel stands in this annular space through three cycles of the engine, namely, the compression stroke, the working stroke, and the exhaust stroke. At the beginning of the suction stroke, this pre-heated charge is forced out of the annular space into a small conical chamber, where it stands over the small distributing nozzles which lead out into the combustion chamber. A plunger operating in this chamber is slowly retracted at the time the fuel is delivered into the chamber, which prevents any of the fuel being forced out into the main combustion chamber. On the compression stroke, the final preparation of the fuel is completed. The highly compressed air charge from the main cylinder is forced through the nozzles up through this pool of previously heated fuel, thus cracking and gasifying the hot charge of wet fuel. When the piston is at approximately top center, the plunger is suddenly depressed, thus driving the rich gaseous charge of fuel out into the hot compressed air charge in the main cylinder, where ignition takes place and combustion follows.

Previous practice in Diesels has called for a plunger or valve for each cylinder, and it has been found impossible to keep these accurately adjusted to measure the proper amount of fuel under the extreme pressures under which the fuel is fed. In the Cummins engine, one plunger measures and delivers the fuel to all injectors, whether one or six, at a pressure of only 50 pounds. A distributor distributes this measured charge from the common plunger to the proper injector, thus eliminating any possibility of unequal distribution of fuel.

The entire fuel system may thus be divided into three divisions, the first of which covers the measuring of the fuel charge and delivering it to the injectors. The second covers the gasifying of the charge in the injectors and injection into the combustion chambers. The third division covers a means of obtaining the necessary turbulence or mixing of the combustion charge with the air in the cylinders.

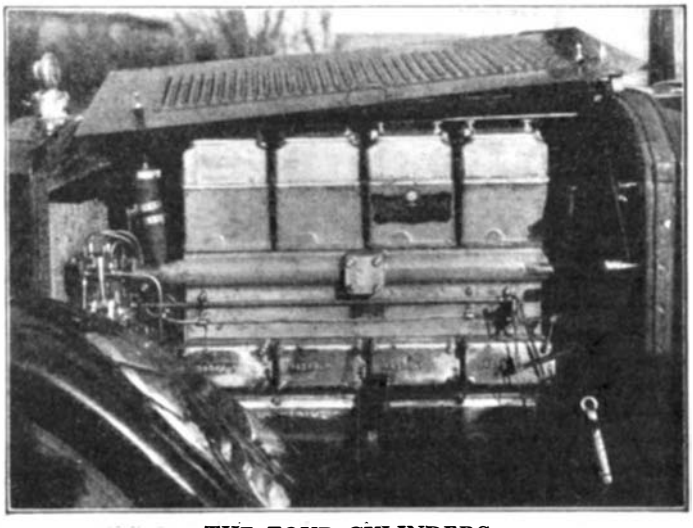
BECAUSE of this advanced preparation of fuel and the method of measuring, the Cummins engine will handle any kind of fuel from crankcase slop to gasoline.

The plan of the manufacturers is to adapt this engine to truck use first, by experiments under actual truck working conditions. Bus application will come next, with the passenger car last. This means that the engine should be perfected for trucks within a year or 18 months and that if the passenger car adaption comes, it will be a matter of four or five years before it is perfected.



FUEL OIL DISTRIBUTION

Right side of Diesel showing fuel lines. Right-hand lines carry oil to cylinders; left-hand lines carry excess oil back to reservoir



THE FOUR CYLINDERS

Left side of the Diesel showing the fuel distributing pump directly behind radiator. The rubber hose forward carries cooling water

Edison's Rubber

What Mr. Edison Is Doing in His Attempt to Develop an American Wartime, Emergency Rubber Industry in the South

By G. H. DACY

Mr. Edison Discloses

UNITED STATES Patent Number 1740079, December 17, 1929 (obtainable from Commissioner of Patents, Washington, D. C., ten cents), reveals Mr. Edison's method for extracting rubber from goldenrod and other plants. This method is described by the *India Rubber World* (New York, February 1) as "a modification of the process regularly employed for the extraction of rubber from guayule shrub." (See also page 332, April number, SCIENTIFIC AMERICAN.) In an article entitled "Guayule Rubber" Dr. D. T. MacDougal, Corresponding Editor of the SCIENTIFIC AMERICAN, outlined the guayule process. This was in our number for July, 1928.

—*The Editor.*

DOWN near the tip of our southernmost state where the climate is sub-tropical, Thomas A. Edison has dedicated his early octogenarian years to a problem which he says is of great significance and which may hatch out a successful future rubber-raising industry in the south. Mr. Edison seeks to discover an adaptable rubber plant which will grow prolifically in Florida and other warm-climate states and which may be produced on a commercial scale as a potential wartime necessity—and as a possible billion-dollar industry.

What Mr. Edison has sought from the start of his extensive experiments is plants that would prove suitable for rubber latex production as *emergency* materials. He has denied that he is seeking new sources of commercial rubber which would rival the trees of the tropics that now produce the world's supply of commercial rubber. Thomas Edison is, however, a genius at incubating apparent impossibilities into actuality.

In Edison's ten-acre experimental garden directly opposite his winter home at Fort Myers, Florida, 4000 different varieties of tropical and semi-tropical plants are being grown under the careful culture of experts whom he employs to sift all secrets from American rubber raising. After several years of garden tests Mr. Edison has already demonstrated that at least 1200 of these plants which are able to thrive in Florida will yield good rubber latex.

Like the government botanists and agronomists at Washington who try out the possibilities of new plants imported from all corners of the world in the national quest for more foods for man and animals, Mr. Edison is adverse to publishing his rubber research data until he finds what he is after—or proves conclusively that such plants can not be grown in the United States. He reports that it will involve four more years of intensive technical investigation to ascertain all the answers to the riddle which now occupies his full attention.

AFTER two years of thorough tests, he has eliminated all foreign and imported plants from the research roster, including the notorious *Madagascarensis*. For several months, it looked as though *Madagascarensis* would solve the stubborn secret, but subsequent experiments proved it unworthy. The current experiments are centralized on 1200 plants which either grow wild or are cultivated for ornamental purpose in the south. Most of these are tender tropical plants which can be grown successfully only in such frost-free regions as southern Florida and southern California.

The Edison herbarium at Fort Myers is a rambling structure of concrete in which the experimental specimens of plant life are dried, mounted, identified scientifically, and filed away in spacious fireproof vaults. Propagating material taken from the most promising varieties are planted in three separate propagating gardens, one at Fort Myers, another at Oneco, Florida, and the third at Orange, New Jersey, where Mr. Edison carries on his personal rubber studies during the summer months.

EDISON IN FLORIDA

The picture was snapped during Mr. Edison's inspection of his rubber garden

Many of these plants are catalogued in technical nomenclature as weeds, but some of these "weeds" have produced remarkable yields of rubber latex which has proved durable and qualified for specialized uses when manufactured into test samples of rubber. This multiplicity of experimental plants is grown in carefully identified concrete-bordered plots, each of which is four by seven feet in size. The visitor who gains admission to the Florida gardens—and only a few people are admitted, because souvenir seekers have despoiled valuable material—may well imagine himself in some state or national proving grounds of plant research, for that is what the large garden

ONE OF THE PLANTS UNDER INVESTIGATION

Many common plants contain rubber latex, but the plant selected for culture must also meet practical and economical requirements. It must be suited to machine harvesting

looks like. Accurate records are kept on the latex production during the plant growing period, and special cutting tests are made to ascertain the best seasons of harvest for the various plants.

The experimental plants are cut by hand and subsequently the harvested material, consisting of stems, leaves, and branches, are run through powerful presses in order to extract all the latex which they contain. Each specimen is analyzed and then is "manufactured" under laboratory conditions into small samples of research rubber. These rubber samples are subjected to a number of critical tests to determine their durability, quality, and suitability for the wide variety of uses to which the product would be put during times of war or peace.

The Florida laboratory, which is manned by a corps of eight scientists employed by Mr. Edison, is equipped with a battery of distillation retorts so that 36 distillation tests of latex specimens can be run simultaneously. The other equipment is complete for the rubber investigations now in progress. Mr. Edison's aides remain at Fort Myers throughout the year and during the summer carry on communication with their "chief" by correspondence, telegraph, and telephone.

HENRY FORD, who owns and operates a 3200-acre plantation farther north near Savannah, Georgia, has offered the use of as much of this land as is required by his friend Mr. Edison for later field tests of those rubber producing plants which prove to have commercial possibilities and which can be grown that far north.* Mr. Ford has also volunteered the services of his mechanical experts and the use of his shops for the development of special harvesting and milling machinery for the transformation of the field crops into finished rubber products. Harvey S. Firestone, the tire manufacturer, is also co-operating with Mr. Edison in these rubber research investigations.

"I believe," said Mr. Edison in discussing the rubber experiments which now monopolize his waking hours, "that those states bordering the Gulf of Mexico can produce plant rubber with profit to the farmer in case of future war prices, and it may be possible potentially to grow rubber in those sections which will compete with the tropics even on a peacetime basis.

"The chemical development of synthetic rubber has no future whatever when plant rubber is quoted at about $.23 a pound, " he continued. "I believe that the manufacture of rubber will be extended in the years to come to a point where it will be employed in the paving and repair of highways. Short sections of test roads made of rubber have now been in service in Scotland for five years with practical success.

"I HAVE found 1200 plants adaptable for culture in Florida which will produce rubber and in my advanced experiments I will cultivate 40 of these on a large scale. I hope to find a plant which may be cultivated successfully in southern Florida so that it will produce an emergency crop of rubber 12 months after planting."

The mechanical puzzles associated with the harvest of rubber plants and the extraction of their latex are not as complicated as they might appear to the layman. The shrub or bush which produces the milky latex will be cut with special tractor-operated mowers. The blades of these mowing machines will be adjustable for cutting the green growth of varying height and size. The arrangement will be such that the harvested twigs and branches will be delivered by special conveyor to wagons and motor trucks driven alongside the mower during the harvest operations. The harvested material will be hauled to powerful expressors which will extract all of the latex from the plant.

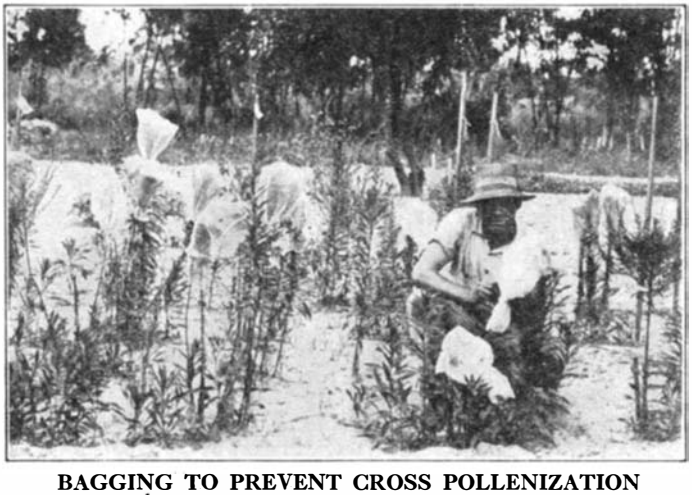
IT DID NOT MAKE GOOD

The wild plant from Madagascar which is not all it was "cracked up" to be

Mr. Edison has given a roving commission to five traveling botanists and plant hunters to scour the Gulf Coast States and procure specimens of all the rubber-producing plants of that area. This quintet of camp-car rovers has roamed highways and back roads searching for strange unidentified plants in half a dozen different states. They have traveled exclusively by motor car, carrying with them provisions, camp equipment, and miniature botanical laboratories on wheels. Their scouting trips through thousands of miles of Dixieland forests, jungles, and cultivated fields have yielded the wealth of experimental material which Mr. Edison is now utilizing intensively.

Mr. Edison has centralized his experiments in southern Florida because investigations carried on by the United States Department of Agriculture and the Department of Commerce demonstrate that region to be the best adapted for rubber production of any section in the United States.

* At the time of going to press, news reports state that Mr. Ford has prepared several hundred acres for planting, with the expectation of a harvest in the late summer.



BAGGING TO PREVENT CROSS POLLENIZATION

In plant breeding it is necessary, in order to prevent bees from cross pollenizing plants with other plants, thus depriving the test experiment of its value, to exclude the bees with netting

A FEW OF THE 1200 EDISON TEST PLOTS

When investigating the possibilities of rubber plants, Mr. Edison followed the old Edison technique: to try systematically everything under the sun, rather than sit and wait for inspiration

"How Do They Know?"

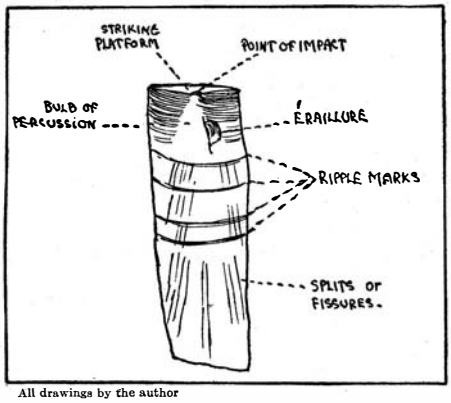
A Brief Glimpse of Some of the "Inside" Considerations Which Guide the Expert in Judging the Antiquity of Flint Implements

By J. REID MOIR

Fellow of the Royal Anthropological Institute; and Member of L' Institut International d' Anthropologie; President of the Ipswich Museum, England

IT is not so many years since the whole vast series of flint implements was divided up into two simple categories called Paleolithic and Neolithic, and prehistoric archeology was a more or less simple and straightforward subject. Now, not only has another and very important stage of ancient man's activities, the Eolithic, been added to the list, but in the case of the Paleolithic and the Neolithic phases these have been still further split up; and the process is not yet completed.

There are, however, still some archeologists of the older school who do not look with favor upon these modern methods of classification and



All drawings by the author

FIGURE 1

A drawing of a humanly struck flake of flint, showing its various characteristics

who hold that though Paleolithic hand axes, for example, which are found in deposits of widely varying ages, must themselves be of a dissimilar antiquity, yet it is not possible to say that these implements differ from one another in the way they are made. Such critics would no doubt admit that the hand axes of early Paleolithic-Chellean times are more roughly flaked than are those of the later Acheulean period, but this admission would be qualified by the claim that while this difference exists it does not testify to any actual dissimilarity of technique in vogue in the two epochs mentioned.

This conclusion, however, is the outcome of neglect to make a close and enlightened study of the actual flake scars to be observed upon flint implements of different periods. When such an examination is carried out by anyone with the requisite knowledge based upon practical experience in flint flaking, it becomes at once obvious that the manner of production of flint implements differed at various epochs of the past as markedly and as certainly as did, for instance, the method of carving wood in later times. In fact, when those who are familiar with these matters are able to examine a representative series of implements of prehistoric industries the dissimilarity in technique of these is seen to be as well defined as is that between a carved oak chest of Tudor and of Stuart times.

There are, perhaps, few aspects of prehistoric archeology more fascinating that that which deals with the way in which flint implements were made, as it enables the modern investigator to realize precisely the manner in which the ancient artificer held and flaked his flint, and to understand how, usually with consummate skill, he produced the type of artifact needed.

THE importance of this recognition is further heightened when it is found that implements of the same prehistoric period, though found many hundreds of miles apart, exhibit an identical technique. But it is not possible to enter into the implications of this remarkable fact in the present article.

I am, however, anxious to bring home to readers of the SCIENTIFIC AMERICAN the reality of the dissimilarity to be observed in the method of manufacture of flint implements of different ages. It would be a matter of little difficulty to do this with the artifacts, for example, of the Chellean and the Magdalenian phases because these two industries—one belonging to

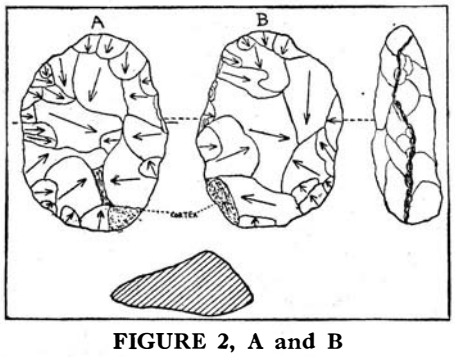


FIGURE 2, A and B

Two sides, edge, and horizontal section of a Chellean implement. Arrows show direction of the flake-removing blows

PERCUSSION FLAKING

Mr. Moir flaking an artifact, as photographed by a member of our editorial staff who visited his home in England

the beginning and the other to the very end of Paleolithic times—differ from one another in the most obvious manner. I have, in fact, selected for examination two ovate hand axes, one of which is referable to the Chellean epoch, while the other belongs to the Acheulean which succeeded the former. Further, these two implements are very closely similar in size, form, and even in weight, for the Chellean specimen weighs 7 1/2 ounces, measures in greatest length 3 11/16 inches, and in greatest width 2 3/4 inches, while the Acheulean weighs 7 ounces, measures in greatest length 3 11/16 inches, and in greatest width 2 15/16 inches. Moreover, the Chellean example exhibits 42 flake scars while the Acheulean carries 57, and there can not, therefore, be any doubt that these two specimens are very similar to each other in several ways. Many people might regard it as impossible to demonstrate that the technique of each is different. Let us, however, examine these two implements still more closely and see what we can learn about them.

NOW, in order to do this it is necessary to prepare what are known as flaking diagrams of the specimens in which their general outline and that of the flake-scars is carefully drawn and arrows inserted to indicate the direction in which each flake-making blow was delivered. When a flake is struck off a flint by means of a blow, the fracture surface of the specimen usually exhibits several well-marked characteristics. For the purposes of this article it is only needful to draw attention, in Figure 1, to these characteristics, which are (a) the bulb of percussion; (b) ripple marks; and (c) the splits or fissures. The flake illustrated bears upon its fracture surface the "positive" bulb of percussion, while the flint from which it was removed exhibits a corresponding hollow known as the "negative"

bulb of percussion. These hollows are often to be observed upon flint implements, while in nearly every case ripple marks and fissures are also present. As will be seen from Figure 1, the ripple marks have their concave side toward the point of impact where the flake-removing blow fell, while the fissures or splits also radiate from the same center. The recognition of these facts makes it easy, therefore, to ascertain from what direction each blow was delivered during the formation of a flint implement, and is the basis upon which the flaking diagrams accompanying this article were prepared.

If we now proceed to examine these diagrams it will be seen that the blows responsible for the formation of the Chellean ovate, Figure 2, A and B, were delivered somewhat less regularly around the periphery of the implement than is the case with the Acheulean specimen, Figure 3, A and B.

FURTHER, it is obvious that the forms of these flake scars differ in each implement, for the majority of these observable upon the Acheulean ovate tend to be long and narrow, while those exhibited by the Chellean specimen, no less definitely, tend to be short and broad. The reason for this difference is to be explained by the manner in which the ancient flint flakers held the flint while operating upon it with a hammer stone.

If it is desired to detach flakes which are long and narrow, it is necessary to hold the flint so that the fingers of the left hand are pressed against one side of the stone opposite to that upon which the blows are to fall. In Figure 4 the Acheulean ovate is held in the manner described, and the hammer stone would fall upon the flint just above the points of the fingers. The result of such manipulation will be that the detached flakes, for some reason, will run down under the fingers, and will more or less accord with their shape. Thus it is possible to say with a high degree of probability that the Acheulean man who made this particular implement actually held his flint in the manner shown in Figure 4, because the position and form of the flake scars on this specimen exactly resemble, both in form and position, those which can be produced today under the conditions described.

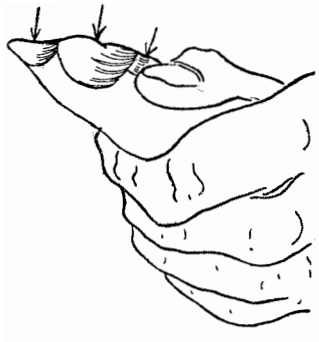


FIGURE 5

How Figure 2 was held. The arrows indicate where the blows of the hammer stone fell on the back face of the flint

When, however, it is needful to produce flake scars such as those exhibited by the Chellean ovate, an entirely different technique is adopted. In this case the flint is held firmly in the left hand, as shown in Figure 5, but the exact manner in which this is done does not matter. The hammer stone is directed first to one side of the edge and then to the other, and flakes are removed which, having no pressure of fingers or other support to influence their shape, assume a short and broad form.

The differences thus produced in the resulting implements do not, however, cease here. If the flake scars exhibited by the Chellean ovate are examined, it will be seen that while 12 of them are complete, no less than 30 are truncated or incomplete. On the other hand, in the case of the Acheulean ovate, the number of complete flake scars is 30, while 27 are truncated or incomplete. Thus it will be seen that the proportion of truncated or incomplete flake scars observable upon the Chellean ovate is very much greater than in the Acheulean example, and this is due almost entirely to the differing manners in which the two implements were made. A complete flake scar is one which has not been encroached upon by later flaking, while a truncated flake scar is one which has had its normal area reduced by the subsequent removal of other flakes.

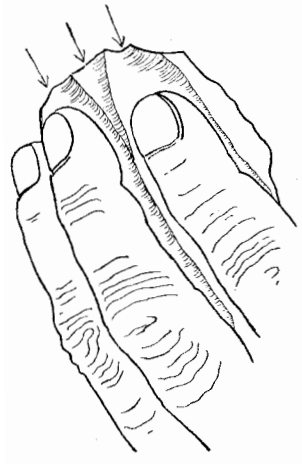


FIGURE 4

How the Acheulean flint was held. Blows fell on back side of flint, opposite the points indicated, producing long chips

Another clearly marked difference in the two implements under discussion is seen when their cutting edges are examined. In the case of the Chellean ovate, the edge is blunt and wavy, while in the Acheulean specimen, the edge is sharp and does not exhibit such a wavy outline. This dissimilarity is again traceable to the differing techniques adopted in the manufacture of the respective specimens.

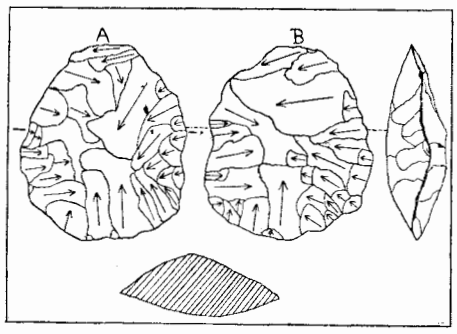


FIGURE 3, A and B

Flaking diagram of a typical implement of Acheulean age, one fourth of actual size. Arrows indicate where blows fell

It will thus be recognized that even in two implements closely resembling each other in weight, size, and the number of flake scars exhibited by each, there exist, nevertheless, fundamental differences in the specimens. These differences are the inevitable result of the manner in which the two artifacts were flaked and, being observable between most Chellean and Acheulean implements, serve to differentiate in a final manner the specimens of these two well-known prehistoric industries.

It is clear, also, that the two artifacts under examination have had different geological experiences in the past for, while the Chellean ovate is abraded and worn and exhibits upon its flake scars innumerable marks where other stones set in motion by rapidly running water have struck it, the Acheulean ovate shows few if any of such marks, and is very little abraded.

THIS difference in condition is generally to be seen between implements of Chellean and of Acheulean age from deposits of gravel both in England and as far away as Palestine. It points, unquestionably, to some drastic climatic conditions having occurred after the Chellean industrial phase, and through the researches carried out in East Anglia in England, it is now known that these conditions are to be associated with the second glacial epoch.

It is upon such lines as have been indicated in this article, that modern archeological research is moving, and in so doing is hastening the time when this study will take its place among the exact sciences. The method of examination of flint implements which I have here described is, however, but one of others which are being carried out at the present time, and these I hope to be able to describe on some future occasion.

¶ *We have on hand and expect soon to publish another of Dr. Paul R. Heyl's uniformly lucid articles, entitled "Is there an Ether?" The recent experiments of Dr. Dayton C. Miller have reopened this subject.*

Learning to Use Our Wings

Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City

A Mail Order Airplane

E. B. HEATH of Chicago has been building and flying airplanes since 1908, mostly of the low power or "flivver" variety. The opinion is often expressed that what aviation needs is a reliable, cheap airplane which can be purchased for a few hundred dollars. Perhaps the Heath *Parasol* is what is needed. At any rate, fully equipped and ready to fly, it costs less than 1000 dollars. All the parts, minus motor, can be bought for about 200 dollars. A small engine of under 30 horsepower can apparently be bought for about the same price. Blueprints can be purchased for a few dollars. The circular states that the *Parasol* can be constructed by the home-builder using a limited supply of tools!

We do not know whether it is advisable to have airplanes built at home, without Government license, even though they can be flown privately without a license. Nor does the circular from the company state whether the *Parasol* has a type certificate for the original model.

The *Parasol* has the following characteristics:

Span, 25 ft; chord, 4 ft. 6 in.; wing area 110 sq. ft.

Overall length, 16 ft. 9 in.; height overall, 5 ft. 10 in.

Weight empty, 260 lbs.; useful load, 300 lbs.

Gas capacity, 5 gallons.

High speed, 70 m. p. h.

Cruising radius, 200 miles.

Engine, Henderson converted motorcycle engine.

Our photographs give a very good idea of the trim little craft equipped as a seaplane, though otherwise not modified from its land conception. There is no reason why a good flier should not feel perfectly comfortable and happy in it. The short exhaust stacks should not be much of a handicap, in view of the low power involved. The little seaplane can be readily handled and launched by one man.

While we would like to have more engineering information, we do think that this is a very interesting small plane which may do as much to foster aviation as the huge tri-motor at the other end of the scale.

Glider Carnival Trophies

CONTINUING its traditional support of aviation, and to aid the spread of interest in one of the fundamental branches thereof, the SCIENTIFIC AMERICAN has offered a cup and second prize in Event Number Two, "Duration of Flight in the Primary Training Glider Event for Third Class Glider Pilots" to be competed for at the New York Glider Carnival in Bayside, Long Island, to be held April 25 and 26. Miss Amelia Earhart is chairman of the trophy committee and the women's events.

Considerable enthusiasm has already been aroused in this coming carnival and many prominent novices, as well as more experienced gliders will take part. The SCIENTIFIC AMERICAN will follow the developments and Professor Alexander Klemin, who is a member of the General Committee, and one of the Official Timers for the meet, will write a summary of the aeronautical advance and tell what deductions can be made therefrom.

Air Commerce in 1930

THERE is a depression in American aviation at this moment which is causing the industry much searching of heart. The article in the *Air Commerce Bulletin* which begins with the question "What is the outlook for commercial aeronautics in 1930?" is therefore very timely.

During the last three years, civil aviation has experienced tremendous growth. Air-transport planes fly on schedule almost 90,000 miles per day, yet these scheduled operations constitute only 15 percent of the total flown in the United States.

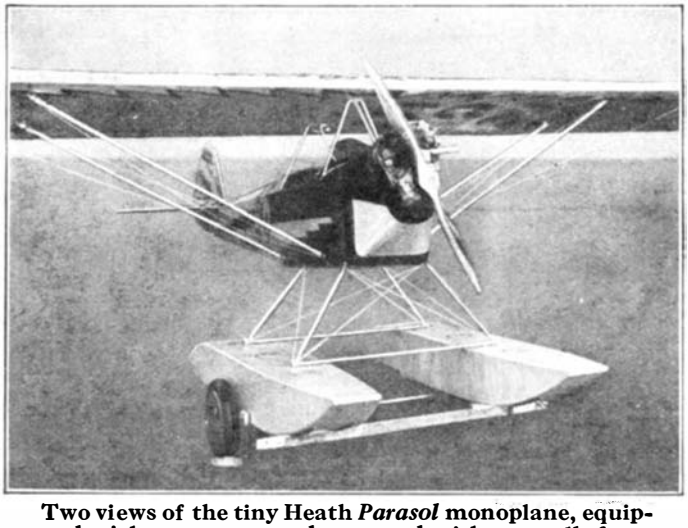
All phases of commercial aeronautics continue to grow at an average rate of 60 percent per annum. The expansion has been particularly marked during the last 18 months.

In this period of hasty development, a great number of new manufacturing facilities have been made available without reference to the consuming capacity of the market. Money has been forthcoming readily for financing, so readily in fact that marketing problems have been virtually forgotten. In air transport, on the other hand, the ample capital provided has on the whole been put wisely to work, and there is no excess. The operators have just enough money to meet the difficulties of getting passengers to fly, of perfecting their organizations, of securing safe operations, and so forth.

It is therefore mainly from the manufacturing point of view that depression has come upon us. It is to be expected that this depression will disappear in the course of a year or even less. Some of the weaker units will vanish via a receivership; others will merge; more powerful manufacturers will revise their production figures and gradually dispose of accumulated planes. While the manufacturers are retrenching at one end, the industry on the other hand will be constantly expanding and providing a larger market.

The *Air Commerce Bulletin* gives the following very encouraging statistics:

During 1929 approximately 16,000,000 miles were flown in scheduled operation as compared with 10,673,000 in 1928. Eighty

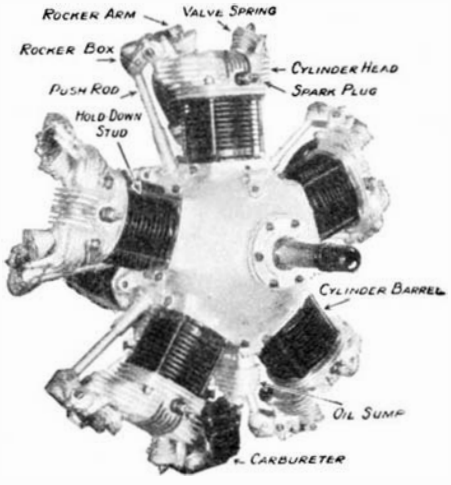


Two views of the tiny Heath *Parasol* monoplane, equipped with pontoons and powered with a small four-cylinder air-cooled motor. This plane is also available with a wheeled landing gear for land operation

five thousand passengers and 8,000,000 pounds of mail were transported in 1929, as compared with 49,000 passengers and 4,000,000 pounds mail in the previous year. Miscellaneous flying has shown at least an equal rate of growth. In 1926, miscellaneous flying totaled 18,000,000 miles; in 1927 it rose to 30,000,000 miles, and in 1929 we have the astounding figure of 125,000,000 miles.

Inside an Aircraft Engine

OUR photographs of the Lambert R-266 aircraft engine are quite instructive. This is a 90-horsepower, five-cylinder air-cooled motor with a speed of 2375 revolutions per minute, yet it weighs only 214 pounds, and is well adapted for a training plane or a sportsman's two-seater. It has rather a large bore (4.25 inches) and a short

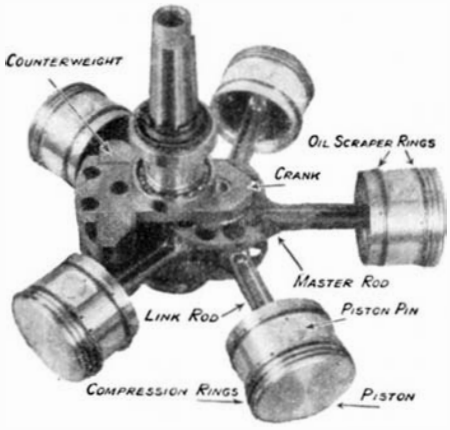


stroke (3.75 inches) which helps to make its frontal area compact.

Refer to the front view: The Y metal cylinder heads (which retain their strength at high temperatures) are seated on a nickel-steel cylinder barrel, with a copper-asbestos gasket between cylinder and barrel. Four long studs screwed into the crankcase hold the heads down. The barrels can be replaced separately. It is interesting to see how generous modern aircraft engine designers are of fin area. Cooling fins embrace the whole of the barrel and head. The valve rods and overhead valves and rocker arms are neatly enclosed. There are no accessories in front of the engine. This enables the plane designer to fit a smooth cowling over the engine.

Lightness is the keyword in aircraft practice; accordingly the crankcase is made of heat-treated magnesium alloy. It is split on a plane through the cylinder centers with valve lifters and intake passage in the rear.

The intake ring is inside the crank case,



Upper right: **Rear view of the Lambert engine described in the text.** ***Above:*** **Piston, connecting rod, and crank assembly.** ***Left:*** **Front view of the same radial engine**

and leads the gas from a single carbureter to all five cylinders. Distribution of gas is helped by partial baffling inside the rim between two of the cylinders.

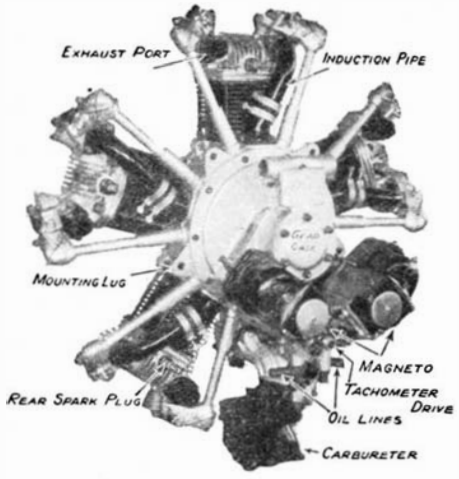
The gear case at the rear is also of magnesium alloy. A compact set of gears working from the main shaft drives the valve gear, two magnetos, and the lubrication pump.

A single master connecting rod works on the crankshaft, with other connecting rod ends working in the master.

A Flying Wing

A NEW plane, secretly developed and flown by the Northrop Aircraft Corporation of Burbank, California, approaches closely to the ideal "flying wing" and with an engine of only 60 horsepower has flown

The Northrop "Flying Wing"



at a speed of over 100 miles per hour.

The wing itself, 30 feet in span, is internally braced, with not a single exposed brace. It is quite thick at its center, thick enough, in fact, to contain a comfortable cockpit. There is no fuselage, the tail surfaces being supported by two long streamlined outriggers running from the wing. A four-cylinder inverted air-cooled engine, carefully cowled in, projects from the forward center of the wing. The "pusher" propeller is placed at the rear and is driven by a long shaft extending from the rear of the engine. Since it is not convenient to carry a tail skid or tail wheel on outriggers, a three wheel landing gear is placed under the wing, with the rear wheel steerable for taxying on the ground. The center rear wheel is somewhat nearer to the wing than the others, so that a suitable low-tail landing attitude can be readily assumed.

Besides the internal bracing of the wing, the two factors tending to increase efficiency are: one, the disappearance of the fuselage and the hiding of the pilot in the wing; two, the use of a "pusher" propeller, which interferes less with the flow over the wing, and the slipstream from which meets fewer parts, so that resistance here is reduced.

There is no doubt that the design constitutes a decided step forward in aerodynamic efficiency. It is creating much interest in aviation circles and its progress will be carefully watched.

An Interesting Amphibion

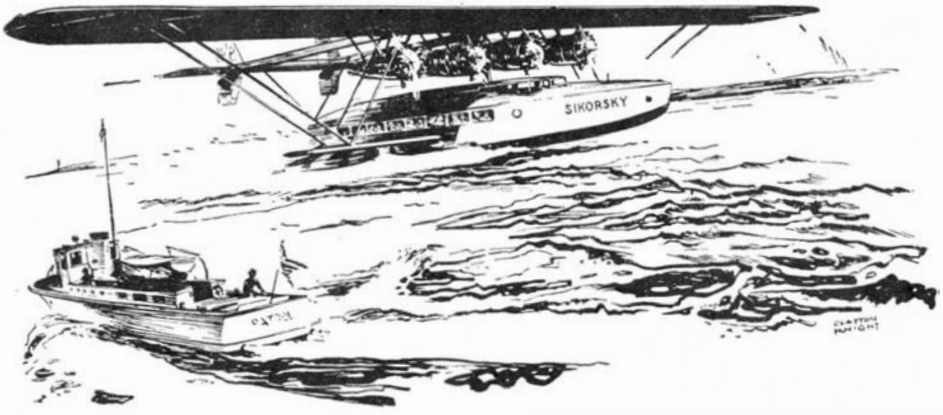
A PROJECTED Sikorsky amphibion, the *S-40*, which follows on the heels of much service experience with the now famous Sikorsky *S-38* is shown in the accompanying artist's sketch. The design of the *S-40* has been carried out with care and has been thoroughly tested in the wind tunnel and the model basin.

If passengers are to make long journeys, such as from New York to Buenos Aires by air, they must be comfortable. Therefore the design provides for large passenger compartments, large windows with unobstructed vision, perfect ventilation, roomy toilets, washrooms, and kitchen and permanent quarters for the crew.

A flying boat must not only be satisfactory in the air; it must also incorporate the sound principles of surface vessels in the matter of marine equipment. The *S-40* can be towed from the bow; davits are provided in the front marine compartments; cleats for mooring a launch are available. A walk-way is provided along the lower structure to the pontoons. A

hoisting sling allows the entire ship to be hoisted on a beam. To give seaworthiness, large excess buoyancy for the hull has been provided.

Power plant reliability is paramount for passenger service. The four engines insure reliability, because the plane can fly on full load with any one engine out of commission, as long as the fuel holds out. Also, storage space and hoisting arrangements



An artist's conception of the projected Sikorsky amphibion, *S-40*

are to be provided for carrying a spare engine. The fuel tanks, located in the wing to give gravity feed, have capacity for four hours' flight. The remainder of the fuel is carried in tanks located on top of the side floats. Cross feed valves will permit any engine to be supplied from any tank.

In the construction of the hull, drainage has been provided from all parts. There are five water-tight compartments, any two of which will keep the ship afloat; the gas tanks provide emergency flotation.

In the positioning of the power plant, certain definite principles have been kept in view. Thus no part of the passenger or crew accommodations are in the plane of rotation of the propellers. The engine nacelles are so located with reference to the wing that there is a minimum of interference between them and the wing. The propeller clearance is 80 inches from the water, an important item when we consider the spray and rough water a flying boat has to encounter.

These large flying boats are to be built entirely of dural except for the fabric covering of the wings. Corrosion has to be taken into consideration. The high position of the wing above the water is a help. The use of the non-corrodible metal Alclad in covering the hull is an important feature.

The outriggers for carrying the tail surfaces run from the high wing, so that the tail surfaces are well above the waves. The structure follows the well tried Sikorsky principles.

The specifications of the new craft are to be as follows: Wing spread, 114 feet; chord, 192 inches; overall height, 22 feet 11 inches; over all length 72 feet 11 inches; wing area, 1980 square feet; power plant, four Pratt and Whitney Hornets, B, with a total horsepower of 2300; useful load, 11,250 pounds; high speed, 129 miles per hour; cruising speed, 108 miles per hour; climb, 675 feet per minute; stalling speed, 65 miles per hour.

A Mobile Weather Bureau

SIMULTANEOUSLY with advances in communication between airplane pilots and the ground, our large air transport companies are developing their weather services to the fullest extent. For example, the meteorologists of the Transcontinental Air Transport—Maddux Air Lines give the pilot, in advance of each flight, reports showing the location of storm areas, the direction and speed of their movement, regions of low ceiling and poor visibility, and areas of low pressure.

In addition to the regular meteorological equipment, new equipment has been added consisting of small rubber balloons, a special inflation device, and hydrogen tanks. These additions have been made in order that observers may gage accurately the height of low hanging clouds so prevalent in winter months, and the direction and velocity of winds at higher altitudes.

The Boeing Air Transport system is equally awake to the importance of weather service and has provided something of an innovation in the form of a "mobile" weather bureau. In addition to meteorological equipment the mobile bureau is equipped for radio transmission, with an aerial mast attached to the automobile.

A Minimum Altitude

TRANSPORT planes have heretofore been required to maintain a minimum altitude of 500 feet except when forced to fly lower by exigency of the weather. As a result of the T. A. T.—Maddux Air Lines crash, which led to the death of 16 passengers, the Department of Commerce has issued a new ruling. By this ruling, if a plane is forced to fly under 500 feet, under any circumstances, it must alight at the nearest possible landing place and do that as quickly as possible. This may effect a hardship on those operators wishing to maintain a schedule in conditions of low ceiling. Nevertheless, the rule should lead to safety, and safety is paramount.

Lindbergh Buys a Plane

IN spite of the fortune that he has undoubtedly accumulated, Colonel Charles A. Lindbergh remains as busily at work as ever, rendering consulting service to the most important air transport companies in the country. He has just purchased, paying over 17,000 dollars, the fastest two-seater sport plane ever built, the Lockheed *Sirius*, constructed by a subsidiary of the Detroit Aircraft Corporation.

In its coloring Lindbergh's new ship is distinctive. The entire fuselage is black and has a wide gold stripe along the mid section of each side. The wings, extending from the lower side of the fuselage, and the tail surfaces, are painted red.

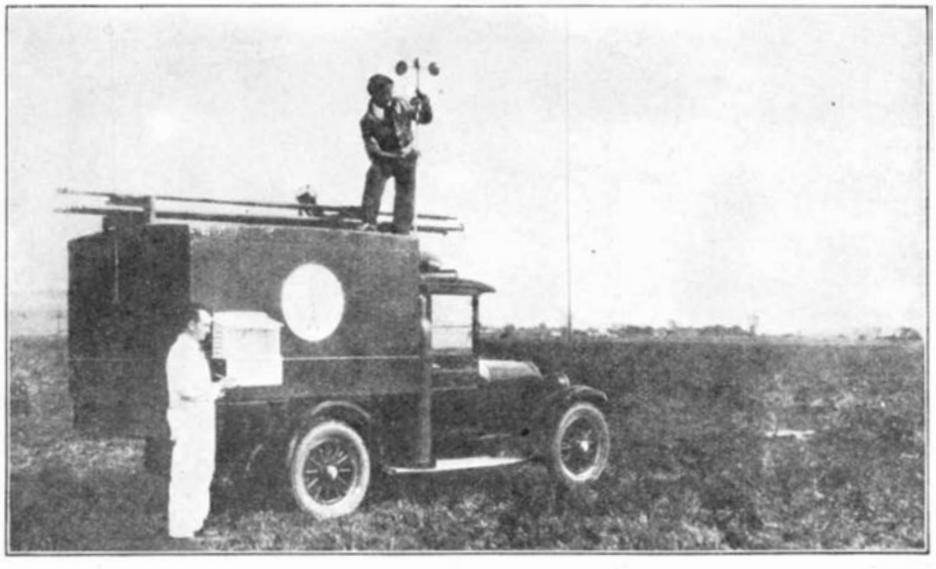
The Lockheed engineers designed the new plane in consultation with Colonel Lindbergh. It has some very interesting characteristics.

To begin with, the plane is the last word in streamlining. The wings are internally braced, without the slightest exposed bracing. The fuselage is an almost perfect streamline and blends into the wings. The cowling, of the Venturi type, encloses the engine and reduces head resistance, yet allows perfect cooling. At the front there is a wide opening allowing plenty of air to impinge on the engine. But this air passes out through an opening at the rear which closely embraces the fuselage. Hence the air is not widely disturbed but follows the lines of the fuselage in streamline form. The wheels are almost entirely enclosed in special streamline housings, commonly termed "pants."

A Pratt and Whitney Wasp engine is employed, developing 425 horsepower at 2000 revolutions per minute.

The two cockpits, which Colonel and Mrs. Lindbergh will occupy so often, are located well to the rear of the fuselage so as to give maximum protection in a crash.

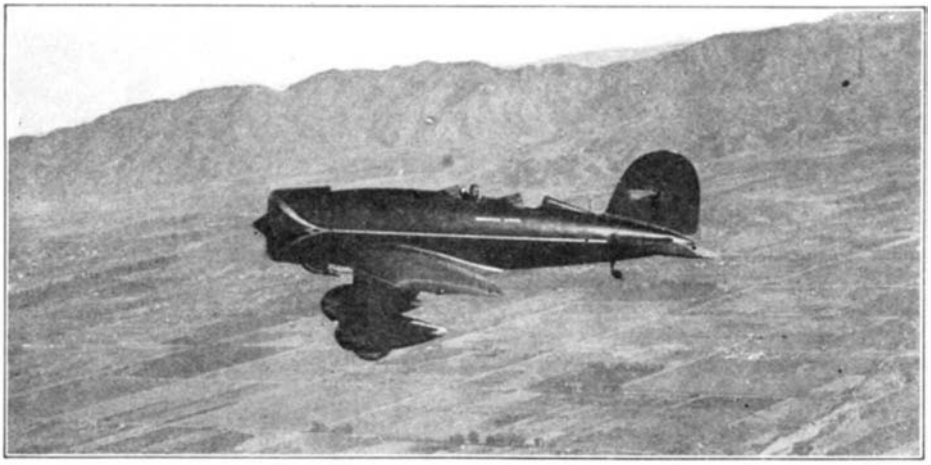
The wings of the plane have a span of 42 feet 10 inches, and their area is 265 square



The mobile weather bureau in operation in the field

feet. Weight empty is 2950 pounds. For average use, the useful load is: 150 gallons of gas, 12 gallons of oil, pilot, passenger, parachutes, and baggage. The gross weight with this load is 4400 pounds.

Lindbergh desired a possible range of 3300 miles; therefore 320 gallons of gasoline may be carried in the fuselage, and 120 gallons in the wing. The plane will certainly be fast, even though performance data are not issued to date.



***Above*: Colonel Lingbergh's new plane with cowled air-cooled engine. *Below*: The *Sirius* in flight**

Details of a French Catapult

MANY authorities believe that sooner or later airplane catapults will be used on all ocean liners carrying international mail, and that they may even be brought into service for launching heavily loaded land planes at airports of restricted size. We do not believe that the use of catapults in land operations will ever be found necessary, but see no reason why their use should not become general in liner service.

The United States Navy has developed catapults to as high a degree of efficiency an any other organization but the navy is somewhat chary, and rightly so, of disclosing full details of its apparatus. Details of the French system "Penhoët," as employed on the *Ile de France*, and described in *L'Aeronautique*, are therefore of real interest, particularly as the Penhoët system seems to be well worked out and reliable.

In Figure 1, the seaplane, 5, has its float or hull mounted on the chariot, 3. To the front end of the chariot is attached a cable, 12, which passes over a large pulley, 8, placed at the end of the runway. The cable then passes over a system of six pulleys. The pulleys to the right are movable and mounted on a rod which is rigidly attached to a piston in the compressed-air motor, 2. The motor is actuated by a great volume of compressed air contained in the cylinder, 1. There is, between the cylinder and the compressed-air motor, a valve, 9, which can have its air outlet regulated by the mechanism, 10. The value of this regulating valve is that it allows the chariot to be launched with constant acceleration and with a well defined final velocity—important factors for the efficiency of launching and the comfort and safety of the pilot.

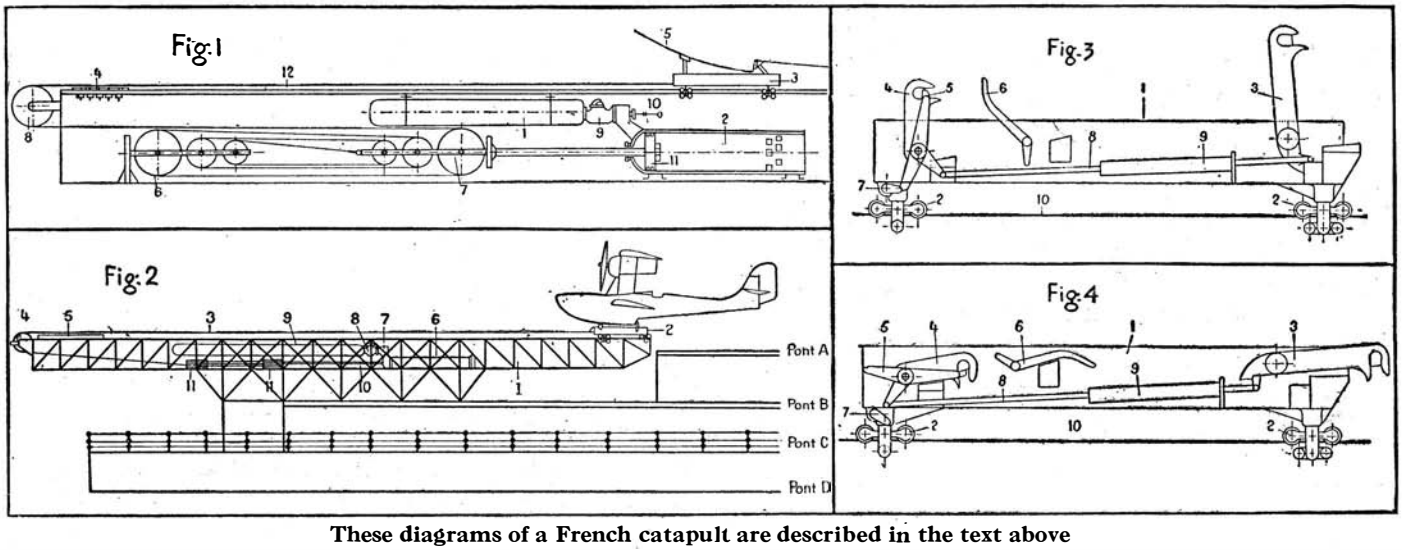
The chariot itself is a metal structure which must be very light so as to have the minimum inertia, and quite strong because of the large and peculiar forces involved.

Figure 2 shows the general arrangement of the system. The truss, 1, is a huge, solid structure mounted on the C and B decks of the *Ile de France*. The chariot, 2, is mounted on suitable rollers. The compressed air cylinder, the compressed air motor, the cable and the pulley system are all mounted within the truss, in a manner which is immediately intelligible from the diagram.

Figure 3 shows details of the chariot mounting when in process of being launched. Figure 4 shows the mechanism when the brakes are applied at the end of the run. The seaplane is held some four inches above the chariot, being suspended at the ends of the hooks, 3 and 4. At the end of the run, when the seaplane leaves the chariot by inertia effect, it actuates the trigger, 6. The trigger releases a spring, 9, which in turn brings down the hooks, and applies the brake, 7. The action of the brake is regulated also by compressed air. The deceleration of the chariot is about 15 to 20 times gravitational acceleration.

It would appear that in practice the pilot can stand an acceleration of some three times that of gravity. On the commercial steamship where space is not at such a premium as on a warship, the catapult can be 100 feet or more in length and the acceleration in launching can be less. The plane can be launched at an air speed a few miles higher than the minimum flying speed without any difficulty. For reasons of space, the *Ile de France* had its catapult mounted at the stern.

Theoretically the catapult should be mounted at the bow. The speed of the seaplane, relative to the air, is then equal to the speed of the ship plus the speed of the chariot and the acceleration relative to the ship and all the forces involved are much smaller. In the design of new ocean liners, naval architects will probably have these considerations in mind.



These diagrams of a French catapult are described in the text above

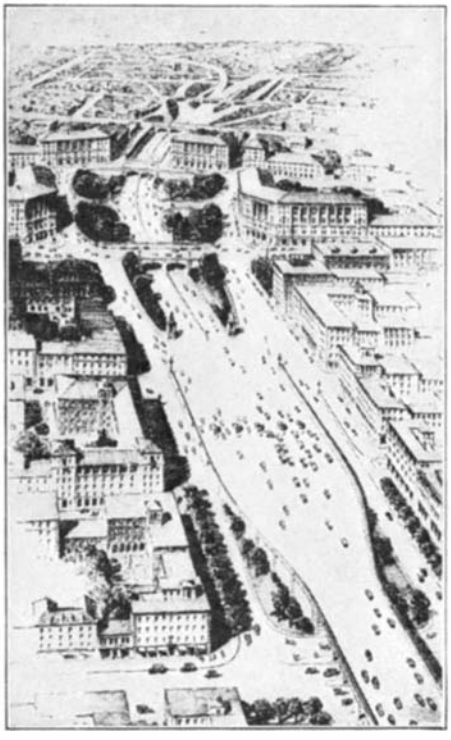
The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Hudson River Bridge Approach

TRAFFIC handling methods of an advanced nature have been introduced in the approach arrangements of the new Hudson River Bridge between Fort Lee, New Jersey, and West 179th Street, Manhattan.

No intersecting crossings at grade and



Plan of the New Jersey approach to the new Hudson River Bridge

no left-hand turns feature the scheme for expediting the movement of vehicles to and from the bridge. The plan of traffic distribution also seeks to accommodate motor travel without stops for lights or other signals. A handful of traffic men, it is declared, will be able to take care of the entire flow of traffic. The scheme is capable of handling the ultimate capacity of the bridge. Four lanes of traffic are contemplated initially.

In discussing the approach innovation, Frank C. Ferguson, vice-chairman of the Port of New York Authority, commented:

"The Port Authority has discarded the old circular plaza idea, which lent itself to civic planning but throttled motor vehicle performance. Such plazas, which then adequately served their purposes, are now a relic of the horsedrawn vehicle days with speeds of 10 miles an hour. American cities having circles or circular plazas today are either confronted by a traffic tangle, as exists at Du Pont Circle in Washington, or are discarding the circular movement of traffic as has been done at Columbus Circle, New York. Berlin has a similar problem at Belle Alliance Place. Traffic distribution must be as definite as the routing of railroad trains, with definite paths of travel in both directions."

The Fort Lee approach arrangement shows that direct access will be afforded to Hudson Terrace. The latter, which will be crossed by an overhead structure, is the first intersecting street in Fort Lee after one leaves the span itself. After passing over Hudson Terrace, the bridge approach will continue to rise until a broad, level traffic distributing point will be reached, from which northbound connections will be made with Lemoine Avenue.

Continuing, the bridge approach will pass under Lemoine Avenue and then distribute and collect southbound Lemoine Avenue traffic. Direct access also will be given to Center Avenue. The bridge approach will underpass Center, Linwood, and Fletcher Avenues. The Public Service Railway's right of way east of Center Avenue will be maintained without a grade crossing.

At Fletcher Avenue, a distributing basin is reached for State highway routes numbers 1, 4, and 6, the Bergen Boulevard, and County Road.

The entire bridge approach from Hudson Terrace to Fletcher Avenue will be flanked by marginal streets in order that local traffic may be accommodated without interference with bridge and through route traffic. The maximum grade will not exceed 4 percent, except on certain secondary connections where this rate will be somewhat higher, but well within motor operating conditions.

German Locomotive Has 1700-Pound Pressure

THERE had just been completed at the Berliner - Maschinenbau - A. G., formerly L. Schwartzkopff, a passenger express locomotive employing the unprecedented working pressure of 1700 pounds per square inch at 900 degrees, Fahrenheit. The new locomotive was manufactured by the aforementioned firm in closest co-operation with experts of the German railways. Its weight was kept within the limits prescribed for the standard locomotive. Test runs will be made in the near future and the locomotive will be exhibited at the World Power Conference in June.

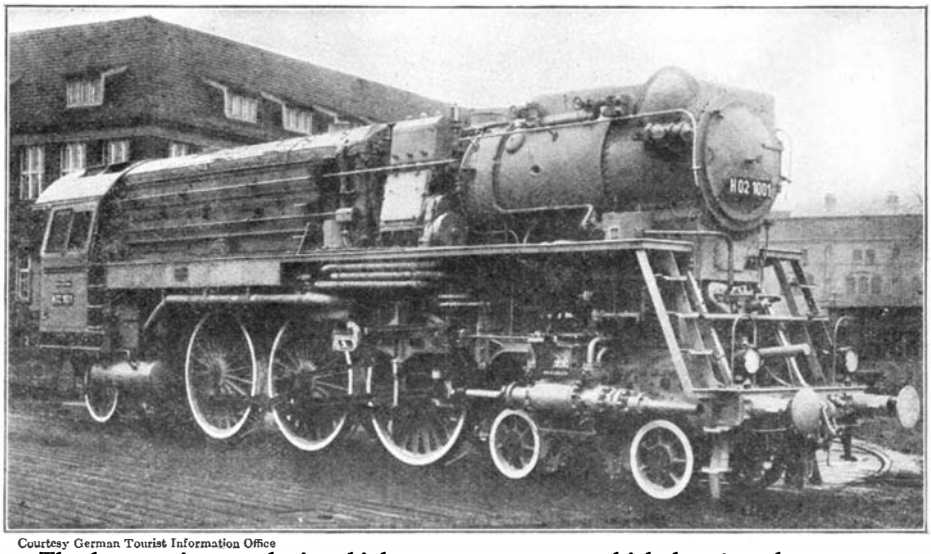
The new and unique method of generating high-pressure steam employed in this locomotive was developed by the late Prof. Dr. Löffler. It is claimed that it may prove especially successful in connection with locomotives because it overcomes the problem of the formation of "fur" within the boiler in a very simple manner, and its fuel economy is very high.

The characteristic feature of the method is that water is evaporated in a non-heated boiler drum. This drum receives heat indirectly from the grate by means of superheated steam. The high temperature of the heating vapor is transferred to a superheater, the heating surfaces of which are not subject to the formation of "fur." The locomotive factory in Wien-Floridsdorf proved the practicability of the method by applying it in a small stationary test arrangement, before the order for the locomotive was given.

World's Largest Underwater Tunnel

WORK is now going forward on a single-tube vehicular tunnel under the Mersey River to connect Liverpool and Birkenhead, England, which will have a total length of 2.16 miles and an interior diameter in the underwater section of 46 feet 3 inches. The tunnel will carry four lines of vehicles abreast, with ample space for ventilating air ducts. Although the tunnel cross-section shows a space beneath the roadway for street cars, these have not been definitely decided upon.

Plans for improving communication between the two boroughs have been under consideration for more than three quarters of a century. In 1922, a committee of three engineers was appointed to make a study of the problem and to report upon the feasibility of improving facilities for cross-river traffic by means of a bridge or a

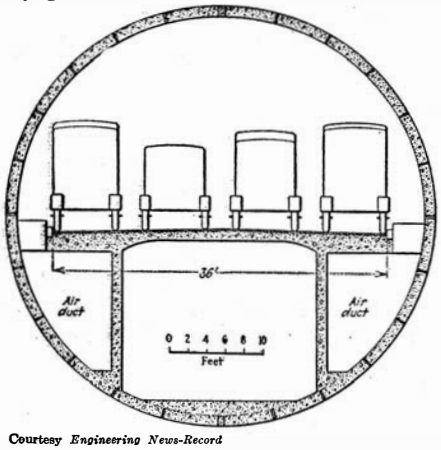


Courtesy German Tourist Information Office

The locomotive employing high pressure steam, which has just been completed in Germany. Note its very small cylinder and construction features

tunnel. After an exhaustive study, these engineers reached the unanimous conclusion that a tunnel would best meet traffic requirements. Accordingly, after approval of the plans had been secured from parliament in 1925, work was started in that year on the driving of a preliminary tunnel along the line of the future main tunnel to explore the ground. The two headings of the preliminary tunnel met beneath the middle of the river in April, 1928, and shortly thereafter a contract for the enlargement to full section of the underwater portion was awarded. The approaches in Liverpool and Birkenhead were awarded on separate contracts in November, 1928, and March, 1929.

Double approaches are provided on both sides of the river. The 36-foot roadway used in the underwater section is continued throughout the main approaches on each side and, in addition, branch approaches from sections near the riverfront are provided with roadway widths of 18 feet, accommodating two lines of traffic. Roadway gradients are, for the most part, 1 in



Courtesy *Engineering News-Record*

Cross-section of the Mersey River vehicular tunnel, showing space which may be used for street cars

30, with a maximum of 1 in 29.4 on the Liverpool approach. The usual cast-iron lining is to be used, sealed with concrete grout and concrete on both exterior and interior.

Ventilation will be taken care of by three plants on each side of the river which will supply a total of nearly 4,000,000 cubic feet of fresh air per minute. It is expected that the maximum proportion of carbon monoxide will not exceed 4 parts in 10,000. The system of ventilation to be used has not been definitely determined; studies are now being made of the relative advantages of transverse and longitudinal ventilation.

Present plans call for completion of the tunnel in June, 1932, at an estimated cost of approximately 25,000,000 dollars, of which the English government will contribute over 12,000,000 dollars. The balance of the cost will be met by loans, secured by toll charges to be maintained for a maximum periods of 25 years, and also by funds to be provided by the two cities.—*Engineering News-Record*

Glass Resists 15-Ton Pressure

A BIT of glass about a sixteenth of a square inch in area bearing a load of approximately 15 tons, is the simple new weapon of science developed by Professor Thomas C. Poulter of Iowa Wesleyan University.

It served as a tiny window looking into a pressure-chamber, where experiments are performed under the tremendous pressure of 30,000 atmospheres. The little glass window is ground perfectly flat and set against a ring of high-speed steel, also ground perfectly flat. There is no gasket; the pressure attends to the sealing of glass against metal.—*Science Service.*

Zinc Treatment Kills Weed Seeds Without Injuring Sprouting Trees

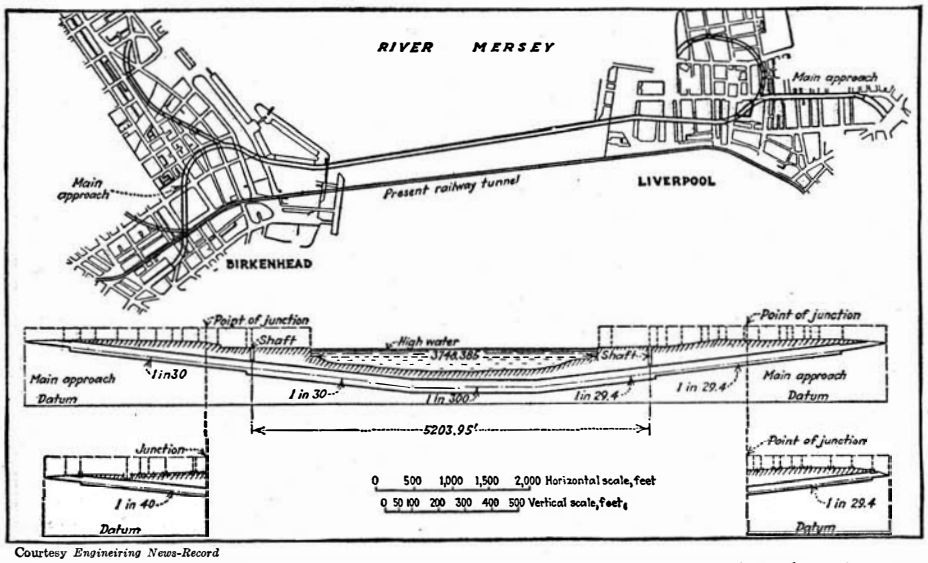
A METHOD of chemical weeding for seedling beds of evergreen trees has been worked out at the Northern Rocky Mountain Forest Experiment Station of Missoula, Montana. According to W. G. Wahlenberg, formerly of the United States Forest Service, who describes the work in detail in a new technical publication of the United States Department of Agriculture, this method saves 27 percent of the cost of producing two-year-old tree seedlings, besides saving many young trees that would be destroyed or damaged by the old laborious process of hand weeding.

The new method, as worked out during several years past at the Savenac nursery, consists in applying one and one eighth ounces of zinc sulfate dissolved in one quart of water to every four square feet of seedbed soil. This attacked and poisoned the roots of the weeds as they tried to leave the germinating seeds. The roots of the sprouting evergreens were more resistant and were not injured. The situation was roughly analogous to that in the blood of a malaria patient who takes quinine. The drug kills the germs but does not harm the body tissues.

During the experiments, other chemicals were tried, but zinc sulfate proved to be the most effective. Higher and lower concentrations of the zinc sulfate were also tried, but the higher concentrations sometimes injured the tree seedlings, and the lower ones were not so effective against the weeds. The concentration to be used for best effect must depend partly on the nature of the soil, Mr. Wahlenberg says. A finer-grained soil than the one at Savenac would require more of the sulfate, a coarser-grained soil less.

The method is not without its disadvantages, which must be guarded against. The sulfate tends to make the soil acid, and liming will be necessary in some localities to correct this. If the soil is stirred after applying the sulfate to the surface, the effect is lost; weeds sprout readily in spaded or plowed places after treatment. Fresh treatment of a seed bed is therefore necessary every time a new lot of tree seeds is planted.

One incidental advantage seems to come from the treatment. After the seedlings are taken up and the soil re-plowed, field peas are frequently planted as a green manure crop. The residual zinc in the soil does not injure the peas but rather increases their growth, apparently through encouraging the colonies of nitrogen-fixing bacteria on their roots.—*Science Service*



Courtesy *Engineering News-Record*

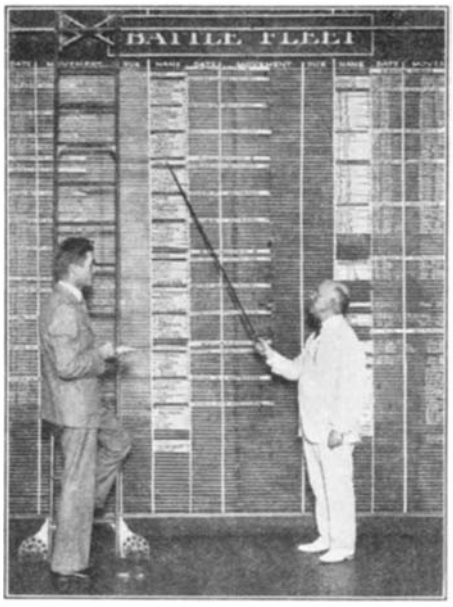
Plan and profile of the vehicular tunnel connecting Liverpool and Birkenhead, England. It will be larger in diameter than those in this country

In a clay pit at Woodbridge, New Jersey, footprints of dinosaurs were found in January and others have been found since then. The photograph shows scientists at Rutgers University examining one of the prints in a cut-out block of the clay

Huge Steel Balls to Carry Helium

SIX huge steel balls mounted on a flat car to appear on American railroads soon will not be globes consigned to a mammoth pawn shop, but efficient containers for precious helium to carry the gas from Texas oil fields to distant airship hangars.

When tested at Milwaukee recently, one of these six-foot spheres, made of steel an



A glance at this chart tells officials of the Navy the location of any vessel of the fleet. It is revised as ships are re-assigned or travel from port to port over the world

inch and a half thick and mounted on a flat car, was filled with helium at 1250 pounds per square inch pressure and run off a 25-foot bank. It was unharmed. It finally exploded under a pressure of 4500 pounds per square inch.

The odd-shaped container is used because it can carry twice as much gas as a cylinder of the same volume. That sounds contradictory, but because of its spherical shape, double the pressure in the cylinder is required in the sphere to stress the steel equally. Consequently at double pressure the sphere will hold double volume.—*Science Service.*

"Sub-Soiling" Deep Tillage

FOR unknown thousands of years man has scratched the surface of the ground before planting his seeds. The power for this work was the strength of his own back, the implements were a forked stick or a pointed heavy limb. Then the horse was domesticated and he did the work for ages. The farmer of today has the power of a tractor. How shall he make the most of that power? By deeper plowing? Possibly—but there is another way.

A new technique of soil tillage has been developed in the semi-arid areas of the Pacific Coast states. It has been found that the tractor may be put to profitable use for stirring and breaking the hard packed sub-strata of soil without turning them to the surface. This has been called "deep tillage," and "sub-soiling," but the word "subbing" is a short, descriptive phrase for this improvement in agricultural practice.

"Sub-soiling," done either by tractors with specially constructed implements called sub-soilers, or by blasting with dynamite, is an operation by which a hard stratum of a sediment, at many places of an almost rocky nature, is broken up and is made permeable to water. The latter, by its physical and chemical action, will disintegrate that stratum, so the roots of plants may penetrate it and obtain from it and also from the soil beneath it, the necessary plant food. A study of the results of experiments in subbing compels one to the belief that it is generally well worth the cost to rid field or orchard or vineyard of this stratum of impervious soil that limits the productive depth of the farm.

Subbing, as practiced in California, is usually associated with a complete system of tillage, particularly in orchard districts. The sub-soiler is used in the fall—when the soil is dry—after which the soil is prepared by cultivation for the green-manure crop. A leguminous cover-crop is raised in the winter or early spring.

Instead of turning under this cover-crop with the plow, so that the vegetation is buried under a heavy layer of earth, those who favor deep tillage employ a heavy duty tractor disk harrow of special type, to chop the cover-crop and mix it thoroughly with the surface soil.

In preparation for irrigation, a heavy duty "chisel" cultivator is employed to stir the soil to a considerable depth. To this are sometimes attached "crowders" or furrowers to make the irrigation ditches. No plowing is done.

A prominent western authority on tillage and soil management recently made the rather startling prediction that within a few years in many districts, the new system would make the plow obsolete.

The foundation of the deep tillage system is the "subber," or sub-soiler, a sturdy implement carrying one, three, or five standards, depending upon the depth to which it is desired to subsoil, and upon the power available for sub-soiling to that depth. These standards are composed of a stout metal shank to which is usually attached a renewable chisel-like tooth. This is sunk into the ground beneath the stratum of under-crust, and is customarily pulled by a stoutly-built tractor that is generously powered. It cuts to a depth of 12 to 30 inches, although special outfits may go as deep as 40 inches or more. The sub-soiler is pulled only when the ground is dry and more readily fractured, and the ground is thus shattered to a considerable distance on each side of the standard, the exact width of the effective work varying with the depth of the blade and the type of the soil.

Sub-soiler in operation in a vineyard. The sub-soil is loosened but the surface soil is hardly broken

The chisel cultivator is stoutly built. This stirs the soil without turning it up. To the frame are sometimes attached right and left moldboards. These may be used to form a furrow in which fertilizer can be placed, these moldboards being reversed on the second passage over the ground to cover the fertilizer.

The chisel cultivator is especially favored for field crops. Although it does not work as deep as the sub-soiler, it is effective in the destruction of plow-pan. This implement is now being used successfully by many grain growers in place of the plow. Users generally agree that this method is cheaper than plowing. Some farmers, however, state that the cost of the two methods is about the same. The heavier chisel-cultivators will work at a depth of 12 inches.

The disk harrow is a tool widely used by advocates of deep tillage—ordinarily being of heavy and sturdy construction. One of the larger, heavy-duty implements has 44 disks (20 or 22 inch) and weighs more than a ton.

The furrower is a light, V-shaped device attached to the shank of the chisel cultivator and sometimes is called a "crowder." The furrower makes an extremely deep furrow and a very narrow one. Measured from ground level, the furrow seems about 14 to 16 inches deep, to say nothing of the way the sides are built up by the soil thrown out, and only about a foot wide at the top. Therefore, when irrigation water is turned into a furrow like this it goes deep and leaves the surface of the ground dry. Loss from surface evaporation is reduced and the very harmful effect of hot sun shining

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The sub-soiler equipment is useful also for uprooting the matted and gnarled roots of old worn-out vines when necessary to replace them with new ones

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

"Parrot Disease"

IN 1904, three cases of psittacosis or "parrot disease" were reported in Boston. Last fall an outbreak of this disease was reported in Buenos Aires and more outbreaks have recently been reported in the United States.

In Hamburg, Germany, 28 cases with five deaths occurred last fall. In the epidemic of psittacosis which occurred in Paris in 1892, there were 49 cases and 16 deaths and it was reported that the infection had been caused by parrots brought from South America.

The symptoms resemble those of other infectious diseases and one should be certain that the disease is actually psittacosis and not pneumonia or other infection of the lungs.

Obviously, the first step is to get the suspected parrot and to find out whether or not it contains the germs which are responsible. There is great doubt as to the exact organism that causes psittacosis. The most recent evidence seems to indicate that the germ is of the filtrable virus type. Experts are doubtful that the germs now commonly associated with the disease are the actual cause and they are more inclined to believe that it is probably a filtrable virus; that is to say, an organism that will pass through a mesh of clay filter and is too small to be seen in the ordinary microscope, but the presence of which can be determined by the fact that the disease can be produced on infection and by the reflection that it causes when specimens are looked at with the supra-ultra microscope.

The occurrence of such cases in the United States is new evidence of the fact that methods of transportation, exchange of products among various nations, and the complete abolition of boundary lines between peoples makes it impossible any longer for a nation to be isolated. The disease of one people will sooner or later appear among others.

Already cases of many of the tropical diseases have been found among the sick in the United States. It is probable that more and more cases are likely to appear in the future, notwithstanding the fact that the United States Public Health Service and all of the health organizations of various nations are concerning themselves with the prevention of such transmission.

Cancer

THROUGHOUT the world in hundreds of laboratories in research institutions efforts are being made to find the cause of cancer, to learn the nature of cancer, to aid in its early diagnosis, and to discover some specific cure. Recently, Dr. Charles F. Geschickter toured Europe and visited most of the cancer laboratories to find out what was being done in these various phases of cancer study.

It has been recognized for many years that workers with certain dyes, with tar and with pitch, were likely to develop cancer. Therefore, research workers use this method to produce cancers in mice and then study the cancer in the animal in a way that is not possible in the human being. Other workers were able to transplant cancer cells and have used this method in developing tumors in animals which are then studied by modern methods.

There are many workers who are convinced that cancer begins as a general systemic disease and that it represents in a way perhaps the natural end of man. However, this view has not been scientifically confirmed by experimentation.

Studies have been made of the chemistry of cancer, of the way in which the cancer cells use sugar as contrasted with the way normal tissues use sugar, and all of this has been of importance in learning about the nature of cancer, but has not led to immediate practical results.

It has been known for years that a cancer may arise from repeated irritation of certain cells in the body. Recent investigations tend to indicate that it is the cells of the body which are important in this connection, or the material that is used to bring about irritation, or perhaps even the irritation itself. Nevertheless, the irritation is a contributing factor, and for this reason repeated rubbing of dangerous spots should be avoided. This is particularly important as it relates to cancer in the mouth. Much can be done in prevention of cancer of the mouth by early attention to decaying teeth, rough edges, and similar sources of irritation.

Practically no serious worker in the field of cancer is willing to admit that there is an infectious origin or that the condition is in any way to be compared to infectious diseases. Many investigators are inclined to the view that no one cause, either inside or outside the body, is alone responsible for this disease, but that there may be several contributing factors. Cancer probably begins as a small lesion in one spot and then by a change in the nature of the tissue spreads throughout the body. Apparently the age of the patient has much to do with the manner of the spreading.

The search for a cancer cure is becoming widespread. Radium treatment has been receiving more and more attention, particularly as a means of treating cancers on the surface of the body. The lead treatment of which so much was heard five years ago is now practically discontinued throughout the world. Experiments are being conducted with it but it is not in any sense of the word a practically successful method.

Attempts have been made to suffocate tumors by putting around them an atmosphere deficient in oxygen. Other attempts have been made, notably by Sokoloff who made a small sensation with his method in the International Congress on Physiology, to eliminate the cancer by overbreathing. This work is of interest but in no sense of the word established.

Recently two investigators in the United States have noted interesting changes in cancer following the injection of extracts of glandular substances. The theory behind the use of this is complicated. Changes have been noticed in the tumors, but the evidence is not yet sufficient to warrant the belief that anything certain has been accomplished for the treatment of cancer by medical means.

Doctor Geschickter has established such criteria. He says: "A series of criteria for judging alleged cancer cures is easily formulated, although compliance with its requirements is difficult. We all know what we want or wish for any patient suffering from this disease. First, we want to face the facts and know for certain whether or not the patient actually has cancer. This implies biopsy. Secondly, we want to be able to cure cases in all stages, even in the face of recurrences and generalized metastases. Thirdly, we want the cure to be permanent. These three criteria, histologic diagnosis, cure of metastatic cases, and permanent cures established by follow-up examinations, extending over five year periods, should be applied to all alleged cancer cures.

"From this point of view immediate cures of local tumors in experimental animals, however intriguing, are false alarms. Serious and extensive clinical trial of any method by workers other than its advocate should await, first, the submission of the sections to substantiate the diagnosis in all cured cases; second, proof that the disease had progressed to dissemination at the time of treatment and, third, a five year follow-up to show the permanence of the cure."

Scarlet Fever

IN addition to treating scarlet fever by the use of specific antitoxin, it is possible to provide the sufferer with antitoxin through the blood of a person who has had the disease and who recovered. The health department in Detroit arranged to collect blood from people who had recently recovered and to keep it available for the use of those who might develop the disease. It was also used to protect people who had been exposed to scarlet fever against the disease.

The quarantine period for scarlet fever is 28 days. It was found that the convalescent serum protected people for short periods, but apparently the immunity created did not last longer than three or four weeks. The chief value of the method seems to be that it prevents outbreaks of scarlet fever in hospitals and in other institutions after one or two cases have developed. The method is also particularly suitable to use in young people who may react unfavorably to injection of the special fever antitoxin.

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

Spray Drying of Latex Revolutionizes Rubber Manufacture

ONE of the most interesting developments in the rubber industry in recent years was the development, by Ernest Hopkinson of the United States Rubber Company, of a revolutionary new process

A latex spray-drying unit in a plant on the eastern coast of Sumatra

for the preparation of crude rubber from the sap of the rubber tree, which is known as latex. The process, as carried out at the plantations in Sumatra, is described by Hendrik de Leeuw, in a recent issue of *Chemical and Metallurgical Engineering.*

"The method for spray-drying rubber consists of atomizing latex by pouring it upon a disk installed at the top of a drying chamber, rotating at a high speed. Air heated to 350 degrees, Fahrenheit, intermingles with the particles of latex, drying them without raising the temperature to a point which would be detrimental to the rubber. The falling dried material resembles snowflakes. The mass of rubber is removed at intervals and pressed.

"A spray unit consists of a tank holding several hundred gallons, the spraying apparatus, and the drying chamber. Latex is forced through a rubber hose from the tank to the top of the cone, where it is led to the spray rotor which atomizes it, the fineness of the atomization being controlled by the speed of the rotation of the electrically driven 18-inch disk. The spraying apparatus is shaped like an inverted truncated cone. It reaches a diameter of 30 feet and is covered with steel plates. The heated air is produced by an oil-burning furnace located near the unit. The hot air is forced to the top of the cone through insulated pipe.

"The drying chamber or lower compartment is a concrete-walled room, 30 feet square and 30 feet high. At the bottom there is a series of parallel floors mounted on rollers. These floors can be withdrawn one at a time so that the dried rubber which has accumulated on them can be removed.

"Rubber as it comes from the drying room is in a spongy mass. It is pressed into a more compact mass by hydraulic presses, baled in heavy burlap and shipped to Belawan, the seaport of Deli."

Roast Beef In a Salt Shaker

THERE has recently appeared on the American market an Oriental condiment, Ajinomoto, advertised as imparting a meat-like flavor to soups, gravy, sauces, or vegetables. Inquiries that have reached this department reveal an apparently general assumption that this condiment is a concentrated meat extract. As a matter of fact, it is really an entirely synthetic flavor, the chemical name of its active principle being monosodium glutamate. [See also page 159, February, 1930 SCIENTIFIC AMERICAN. Editor.] In recent years, this product has become so popular that it is freely used like salt and sugar in the average Chinese home. The Chinese alone used 1,130,000 dollars worth of it in 1928. In the tropics people live principally on vegetable diet, and they resort to monosodium glutamate to improve the flavor of their simple food.

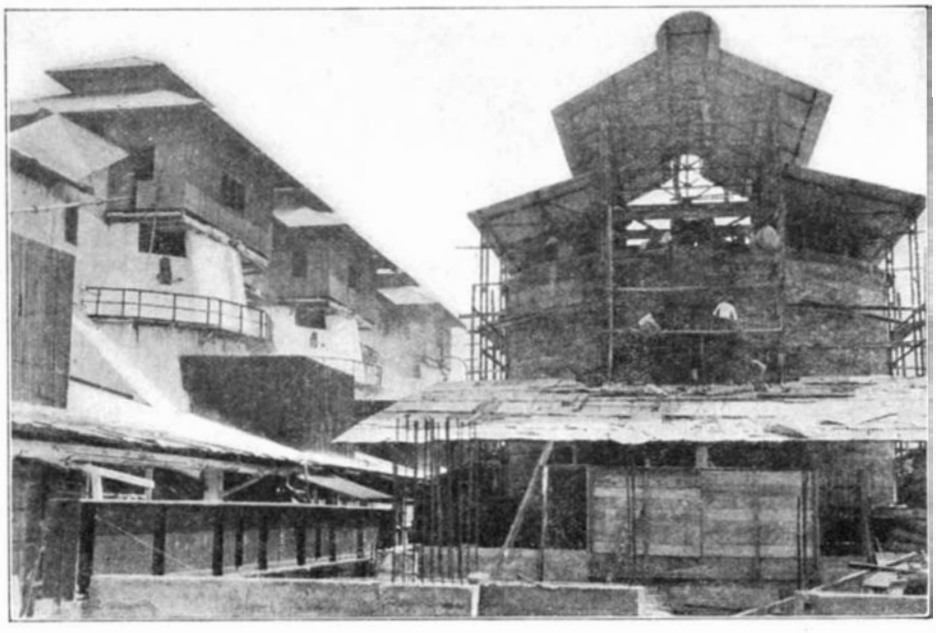
The Chinese process for the manufacturing monosodium glutamate is described by J. E. S. Han in a recent issue of *Industrial and Engineering Chemistry.* Gluten and concentrated hydrochloric acid are placed in a stoneware vessel provided with a reflux condenser, and heated over an oil bath at a moderate temperature until the protein in the gluten is dissolved. The temperature of the oil bath is then raised and the acid kept boiling until hydrolysis is complete. The product is filtered, the glutamic acid hydrochloride crystallized and purified, and finally neutralized with soda. The monosodium glutamate so obtained is crystallized, dried, and ground to a fine powder.

Coolies dusting and weighing the sponge rubber delivered from the drying chamber described in the text

How to Flame-Proof Fabric

A REPORT published in the British Fire Prevention Committee Red Books, outlines the method generally known as "non-flame" process which gives a good fire-retardant effect and has the further merit that this effect remains after the material has been subjected to washing or the weather. In tests made by the British Fire Prevention Committee, flannelettes were found to have been little changed after 20 washings. The process consists in steeping the cloth in a solution of three pounds of sodium stannate per gallon of water used (specific gravity 1.07). After wringing and drying it is rinsed several times in running water and finally dried.

A less permanent treatment can be made by subjecting the cloth to a solution consisting of two pounds of ammonium sulfate



Plant in Sumatra where crude rubber is produced by spray-drying latex

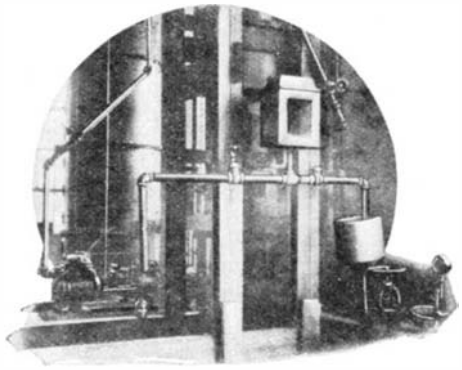
and four pounds of ammonium chloride (sal ammoniac) in three gallons of water.

Sodium silicate is fairly effective for interior decorations where change of color or luster is not important. For this purpose one volume of commercial water glass (1.39 specific gravity) is diluted with one to five volumes of water, depending upon the kind of fabric and the degree of fire-retardant effect desired.

Where Does the Bootlegger Get His Alcohol?

"RECENT indictment of corn sugar manufacturers, yeast companies, and industrial establishments engaged in various branches of the chemical industry has attracted attention to a new phase of alcohol control," points out I. D. Foos in a recent article in *Chemical and Metallurgical Engineering*. "There have been three cycles in prohibition enforcement. In its first stage, the authorities concentrated their energies on preventing the diversion of existing stocks of whisky. Next, they turned their attention to checking widespread diversion of industrial alcohol. Now they are attempting to block the movement of otherwise legitimate products to illicit distilleries and hence have brought yeast, corn sugar, and other industrial materials into the prohibition limelight.

"Through it all, the manufacture of 'moonshine,' defended by the southern highlander as a birthright, has persisted. But as the diverted supply of industrial alcohol has diminished, moonshining has assumed the characteristics and proportions of an industry. The moonshiner's kettle in the swamps and mountains has been supplemented by column stills, operated on a factory scale, located in or close to all the larger cities, particularly in the north. Here corn sugar mash is



When the "big-time" bootlegger sets up a plant in the city, his equipment usually includes vertical stills like the one illustrated above

used in preference to cane and beet sugar, cornmeal, or molasses, because of its rapid fermentation. Usually, it is necessary only to add yeast to this, as the protein content of this type of sugar provides sufficient yeast food so that when accelerated by heat, a ripe mash is produced within 24 hours. Ordinarily, such corn sugar also enjoys a price differential of approximately $1.50 per hundred-weight; this, of course, is an advantage, even though cost is not a primary factor in this business.

"Estimated at one billon pounds last year, the production of corn sugar has increased sevenfold since 1921.

"The increase in production of this material from approximately 152,000,000 pounds in 1921 to 538,000,000 pounds two years later may not have had any prohibition significance, but the federal authorities certainly believe that the rapid increase which took place after 1926 was of serious import. They point out that this increase of corn-sugar manufacture occurred simultaneously with the voluntary curtailment of industrial alcohol. Furthermore, it is certain that not only this curtailment but also the improvement of denaturing formulas, did much to make more difficult and expensive the reclaiming for beverage purposes of alcohol from either partly denatured or fully denatured forms. In any event, seizures of stills conclusively prove that the art of bootlegging has taken on many of the improvements which have been currently effective in other industries which also demand chemical-engineering skill and equipment."

Two Gases Make Fertilizer

RECOVERY of ammonia as sulfate in gasworks and elsewhere is now confronted by so many economic difficulties that any process which promises to lower costs deserves serious consideration, says *Chemical Age*. A German chemist, Dr.

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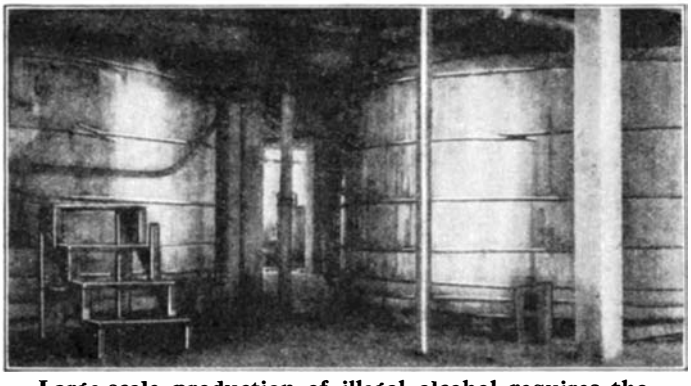
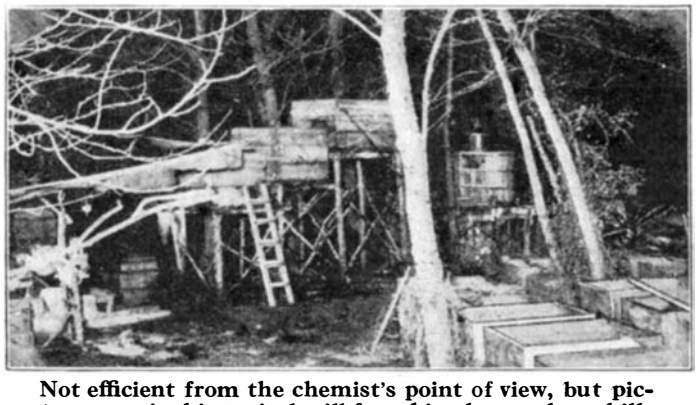
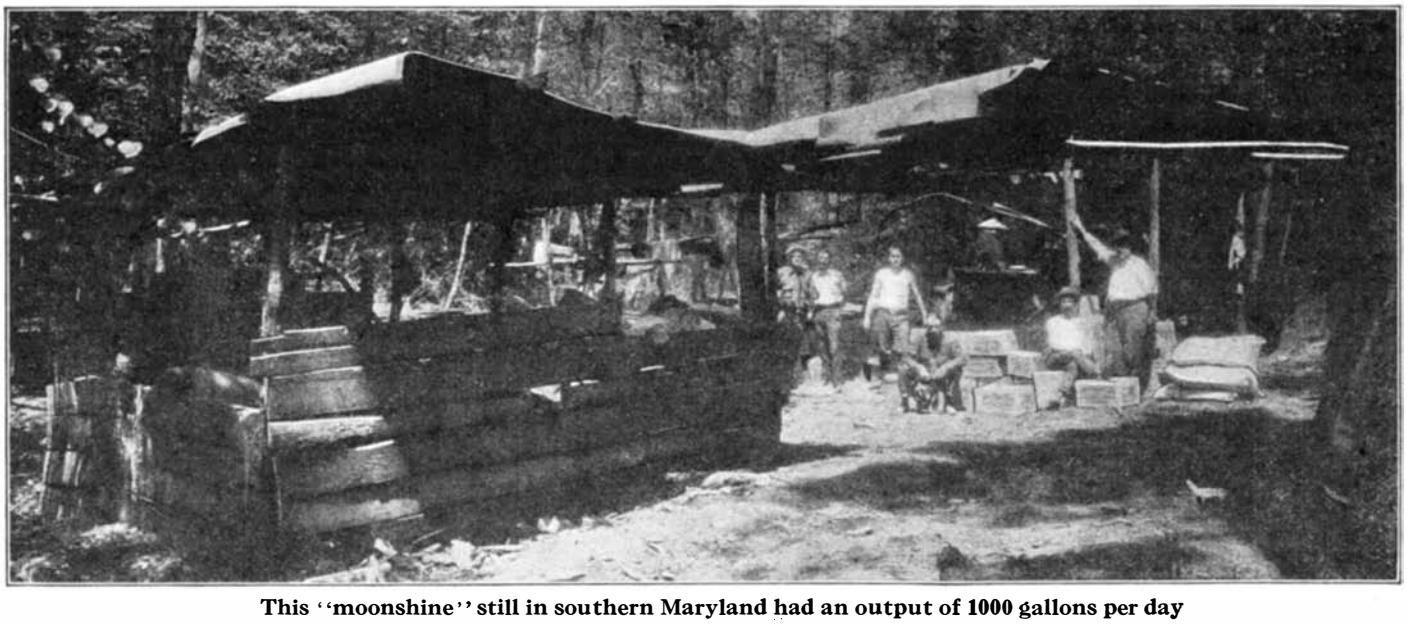


Large-scale production of illegal alcohol requires the installation of huge mash tanks such as the ones shown



Not efficient from the chemist's point of view, but picturesque, is this typical still found in the southern hills



This "moonshine" still in southern Maryland had an output of 1000 gallons per day

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Agriculture

FRESH AND CANNED FRUIT INDUSTRY OF PORTO RICO. (Trade Information Bulletin Number 669. Department of Commerce). A general survey of the Porto Rican fruit industry. *Superintendent of Documents, Washington, D. C.—10 cents, (coin).*

FOREST PLANTATIONS AT BILTMORE, N. C., by Ferdinand W. Haasis. (Miscellaneous Publication Number 61, United States Department of Agriculture). Describes one of the earliest large-scale reforestation projects. Fully illustrated. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

INDIAN CORN, by James B. McNair. (Leaflet, Botany Number 14, Field Museum of Natural History). Pamphlet deals with the origin, geographic distribution and varieties of Indian corn, its uses by the American Indian, and the modern industrial and experimental products. *Field Museum of Natural History, Chicago, Ill.—25 cents.*

THE CORN BORER IN CENTRAL EUROPE, by K. W. Babcock and A. M. Vance (Technical Bulletin Number 135, Department of Agriculture), is a report of a four-year research program carried on in central Europe in an effort to obtain information which might help to check the spread of the corn borer in the United States. *U. S Government Printing Office, Washington, D. C.—20 cents (coin).*

SELECTIVE LOGGING IN THE NORTHERN HARDWOODS OF THE LAKE STATES, by Raphael Zon and R. D. Garver (Technical Bulletin Number 164, United States Department of Agriculture). Selective logging is fundamental to industry of forestry in the hardwood forests. The pamphlet gives a wealth of information. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

INVESTIGATIONS IN WEED CONTROL BY ZINC SULFATE AND OTHER CHEMICALS AT THE SARENAC FOREST NURSERY, by W. G. Wahlenberg. (Technical Bulletin, Number 156, United States Department of Agriculture.) Pamphlet shows how the weed problem was solved at a tree nursery. It represents ten years of investigation. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

Metals

THE RELATION OF CARBON RESIDUE TO LUBRICATING PERFORMANCE. This issue of *Lubrication* gives valuable information on the subject. *The Texas Company, 17 Battery Place, New York.—Gratis.*

SIGNIFICANT DEVELOPMENTS REGARDING SOIL CORROSION, by Henry W. Hough. This reprint gives the important developments in soil corrosion research, the significant trends, and their effects is ameliorating the ever present corrosion problem. *Henry W. Hough, 46 Carnegie Ave., East Orange, New Jersey.—Gratis.*

COMMERCIAL CHROMIUM PLATING, by Richard Schneidwind (Circular Series Number 3). This pamphlet of 60 pages deals with general information necessary for the design of chromium plating equipment, and discusses the defects of chromium plating. *Department of Engineering Research, University of Michigan, Ann Arbor, Mich.—50 cents.*

Periodicals

CELLULOSE. A new trade paper devoted to cellulose, its derivatives and products. *The Cellulose Publishing Co., 114 East 32nd Street, New York City.—$3.50 a year, 35 cents a copy.*

MACHINE DESIGN. A new trade paper devoted to machine design as it affects engineering, production, and sales. It is now in its second volume. *The Johnson Publishing Co., Penton Building, Cleveland, Ohio.—$3.00 a year.*

SPORTING GOODS JOURNAL CATALOG 1930, edited by H. C. Tilton. A combined catalogue of sporting goods manufacturers and cyclopedia of sports. A valuable treatise on sports. Supplied gratis to subscribers to the *Sporting Goods Journal, 521 Fifth Ave., New York City.—$2.00 a year.*

AIR TRAVEL GUIDE—A ready reference handbook published and revised on the first of each month and containing latest authoritative information for those who travel, mail, or ship by air. Full timetables and rates given. Excellent air passenger maps. *Air Travel Guide, Ltd., 565 Market St., San Francisco, Cal.—35 cents.*

Science

MOTION PICTURES AND ILLUSTRATED LECTURES. Illustrated catalogue of motion pictures, technical and non-technical, and films with synchronized sound, made and distributed by the General Electric Co. These films are of great educational value. *General Electric Co., Schenectady, N. Y.—Gratis.*

ETHNOLOGY OF AFRICA by Wilfred D. Hambly, Assistant Curator of Ethnology at Field Museum. Systematically sets the puzzled reader straight about the many African races—negro, Bushman, Bantu and especially the mixed white-black races of northern Africa. Virtually a text book. 222 pages, 42 plates. *Field Museum of Natural History, Chicago.—$1.59.*

ROOSEVELT WILD LIFE BULLETIN and ROOSEVELT WILD LIFE ANNALS. Two serial publications of interest to nature lovers, containing illustrated studies of bird life, fishes, trees, and so on. Each number is in the nature of a monograph. *Roosevelt Wild Life Forest Experiment Station, Syracuse, N. Y.—Bulletin $1.00 an issue and Annals $1.25.*

HOW TO MAKE AN INSECT COLLECTION, HOW TO MAKE SKELETONS, NOTES ON MARINE AQUARIA, and INSECT-EATING PLANTS are a few representative titles from the TURTOX SERVICE LEAFLETS. TURTOX NEWS, a monthly bulletin issued by the same firm, is sent to approximately 20,000 biology teachers in the United States and foreign countries. *General Biological Supply House, 761 East 69th Street, Chicago—Gratis.*

BRIEF HISTORY OF POLAR EXPLORATION SINCE THE INTRODUCTION OF FLYING, by W. L. Joerg. American Geographical Society's 50-page history of all arctic and antarctic expeditions using aviation. Colored maps (23 by 18) of arctic with all relevant data, and bathrymetric map (14 by 26) of southern seas and Antarctica. Both maps worthy of this society of professional geographers. *American Geographical Society, Broadway at 156th St., New York City.—$5.00.*

Miscellaneous

BIRTHSTONES. A beautiful little brochure, in which the gems are shown in color in the matrix, as cut, and as presented in jewelry. There is a "birthstone" map. Printed in full color. *Cartier, Fifth Ave. and 52nd St., New York City.—Gratis.*

TAKING THE RISK OUT OF HIDES deals with the hide futures market, explaining how it is used by packers, tanners, importers, exporters, dealers, and manufacturers. Other publications of a similar nature deal with such commodities as grain, sugar, rubber, cotton, and raw silk. *Harris and Vose, 60 Beaver Street, New York—Gratis.*

WATER POLLUTION RESEARCH, SUMMARY OF CURRENT LITERATURE (ABSTRACTS 1 TO 119), contains summaries under six main headings as follows: Water Supplies, Analysis and Examination of Water, Sewage, Trade Waste Waters, Pollution of Natural Waters, and Miscellaneous. *Department of Scientific and Industrial research, 16 Old Queen Street, Westminster, S. W.1, England—35 cents (money order).*

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TIMKEN BEARING EQUIPPED

CROSSES INDICATE "TIMKEN BEARING EQUIPPED" POINTS

MAKE	MODELS	Front Wheels	Rear Wheels	Pinion	Steering	Differential
Auburn	All	x	x	x		x
Cadillac	All				x	x
Chrysler	66, 70, 77	x	x	x		x
	Imperial	x				x
Cord	All	x	x		x	x
Cunningham	All	x	x	x		x
DeSoto	All	x	x	x		x
Dodge	All	x	x	x		x
Durant	614	x	x	x	x	x
	617	x	x	x		x
Elcar	75	x	x	x		x
	95, 96, 120	x	x			x
Erskine	All	x	x	x	x	x
Essex	All	x	x	x		x
Ford	All	x		x	x	x
Franklin	All	x	x	x	x	x
Gardner	All	x	x	x		x
Graham	Standard Six	x	x	x	x	x
	Special Six	x	x			x
	Eights	x	x		x	x
Henney	All	x	x	x		x
Hudson	All	x	x	x		x
Hupmobile	S & C	x	x	x	x	x
	H & U	x	x	x		x
Jordan	All	x	x	x		x
Kissel	73 & 95	x	x	x		x
	126	x	x	x	x	x
Kleiber	All	x	x	x		x
LaSalle	All					x
Lincoln	All	x	x	x	x	x
Locomobile	86 & 88	x	x			x
Marmon	69	x				x
	79 & H	x	x			x
McFarlan	All	x	x	x		x
Moon	All	x	x	x		x
Nash	Std. 6	x	x	x	x	x
*	All	x	x		x	x
Peerless	B & C	x	x			x
	A	x				x
Pierce-Arrow	All	x	x	x	x	x
Plymouth	All	x	x	x		x
Reo Flying Cloud	20 & 25	x	x		x	x
	15	x	x			x
Roamer	All	x	x	x		x
Roosevelt	All	x	x	x		x
Studebaker	All	x	x	x	x	x
Stutz	All	x	x	x		x
Whippet	All	x	x	x	x	x
Willys-Knight	All	x	x	x	x	x

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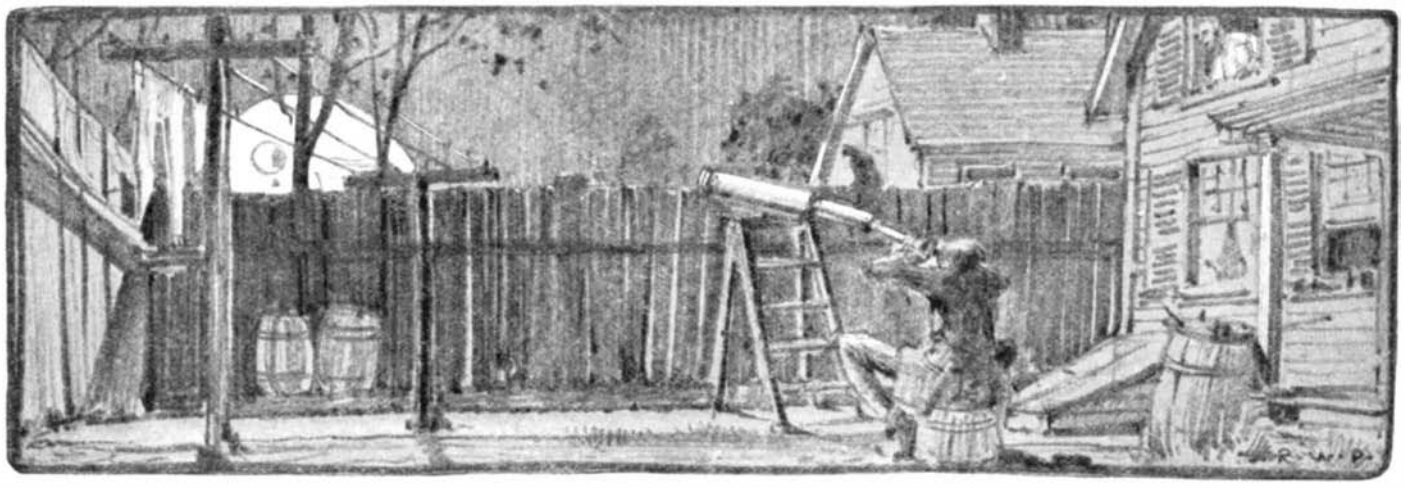
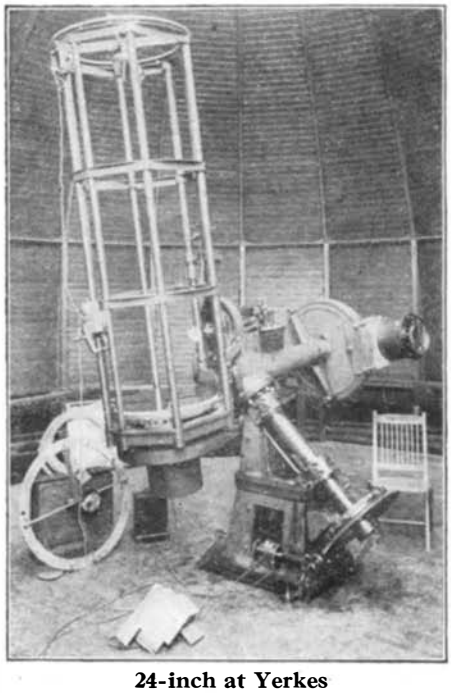


The Amateur Astronomer

AMATEUR telescope makers who recall the publication of the Reverend W. F. A. Ellison's picture in the March number, and the suggestion there made that it be clipped out and pasted in the instruction book, "Amateur Telescope Making," may wish to do as much with the photograph which appears at the right. This picture of Mr. Porter, which was taken by Dr. Clyde Fisher, president of the *Amateur Astronomer's Association*, (American Museum of Natural History, New York), is a much better likeness than the one on page 19 of "Amateur Telescope Making." Mr. Porter is still at Pasadena co-operating on various pieces of work, optical, mechanical, and architectural, preliminary to the final construction of the 200-inch reflecting telescope.

THIS month we shall discuss the merits of the open or skeleton tube reflector, in contradistinction to the more common closed or solid-sided tube, and two open-tube telescopes of this type are shown here. Of these the one below is a strictly professional job. The mirror was made some years ago by Ritchey, who also supervised



24-inch at Yerkes

Russell W. Porter

the construction of the mounting. The figure of the mirror is very perfect, and extremely fine photographs of nebulae have been obtained with it, according to Director E. B. Frost of Yerkes Observatory, mainly by Ritchey, when the latter was connected with this Williams Bay, Wisconsin, institution. A detailed description of this reflector will be found in Volume 14 of the *Astrophysical Journal*, and a large photograph for those who care to study its structural detail may be had from the Observatory, for 50 cents.

The other skeleton tube telescope is one recently built by Professor Dinsmore Alter of the University of Kansas and Mr. William Pitt, retired manufacturer. As several requests for information have failed to bring forth much satisfaction (the photograph itself having been purchased from a news photograph agency), no details can be stated here, except that it has been known among astronomers for several years that Professor Alter was engaged in making the instrument. The 27-inch mirror was made from a 27-inch disk of Pyrex four inches thick.

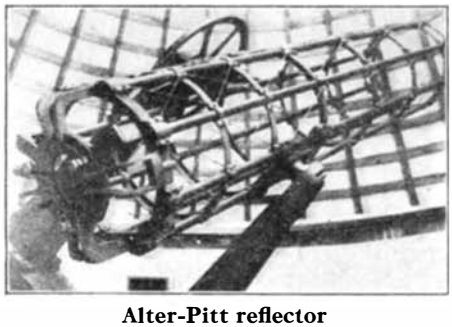
OPEN-TUBE telescopes of the kind just mentioned are strongly advocated by the Reverend T. E. R. Phillips, M.A., F.R.A.S., and F. J. Hargreaves, F.R.A.S., in comment reproduced by kind permission from the *Journal of the British Astronomical Association* (London). The Reverend Phillips is Director of the Section on Jupiter, and Mr. Hargreaves of the Section on Photography, of that organization. They write:

"There is a widely held view that reflectors are much inferior to refractors in defining power, assuming equal optical quality, and there can be little doubt that in most cases this is so, especially when the reflector tube is of metal and closed on all sides. Experience over a long period at Headley with an 8-inch refractor and a 12¼-inch reflector in an iron tube shows that the number of nights when the image in the reflector is as good as that in the refractor is very small.

"A third instrument at Headley, the Association's 18-inch reflector, formerly the property of the late N. E. Green, has recently been remounted in the dome formerly occupied by the 12¼-inch, and its performance since remounting is worthy of record insofar as it affects the question of the relative merits of the two types of instrument.

"Before the remounting, the 18-inch mirror was carried by a square wooden tube, completely closed on all sides, and the image usually had the well-known reflector characteristics—unsteadiness, lack

(*Please turn to page* 405)



Alter-Pitt reflector

Our Point of View

France and the Naval Conference

(*Continued from page* 349)

building program; and, thanks to their large additions to the cruiser strength made since 1921, they are in an excellent position to resume competitive building.

The economic position of France is better than at any time since the World War. There is no unemployment problem, her gold reserve is large, the reconquest of Alsace and Lorraine makes her self-sufficing for coal and iron, and as long as she controls the Mediterranean route to Algiers, her supply of foodstuffs is secure. So France faces the future with confidence, is encircling her land frontiers with modern fortifications, and purposes to provide sufficient naval force to secure her position in the Mediterranean. Tardieu's demand on Stimson and MacDonald for guarantees in exchange for naval limitation is suggestive of Clemenceau's demand on Wilson and Lloyd George for a security pact in exchange for the League of Nations. France pursues a consistent course in her foreign policy.

Italy stolidly reiterates her claim to absolute parity with France. England claims she must maintain a navy equal to the combined navies of the next highest European navies; and her agreement to reduce her tonnage to an amount acceptable to us is contingent on her tonnage being equal to the combined tonnage of France and Italy.

Britain is willing to give the guarantees required by France if we will countersign the guarantee, but our delegation well knows that though the American public is anxious for naval limitation, it will not purchase limitation by again involving the country in Europe's affairs. When the British delegation is asked to find a formula acceptable to France they point to their existing obligations under the Locarno and the Lausanne agreements to use their fleet to support the decisions of the League of Nations against an aggressor nation, pointedly remind us that we have not accepted any such obligation, and request us to share any further responsibilities Great Britain is called upon to assume. This part of the problem therefore is developing just as anticipated.

Great Britain and the United States could agree on a parity at a tonnage not in excess of that which the United States is willing to build, if France and Italy combined would not build a larger fleet than Britain's. If France insists on 700,000 tons, and Italy insists on as much, then Great Britain must have 1,400,000, which is more than the United States wants to build. Great Britain, on the other hand, is willing to build the larger tonnage and expresses a perfect willingness for us to achieve parity by building up to her requirements.

There is a small but influential section in Great Britain that rather welcomes the threatened impasse on the theory that the United States is unwilling to spend the money on its fleet necessary to achieve parity, and that Great Britain, having made its gesture of accepting parity with the United States, will, if the Conference fails, be free to continue its building program and once again achieve an overwhelming sea supremacy. For our part we believe that the American people are resolved to have a navy second to none and while they would prefer to spend their revenues on internal improvements, they are prepared to maintain their fleet if the complexities of European jealousies make this necessary. Ours are a busy people, more intent on their daily tasks than on world politics. They are a peaceful people, enjoying more prosperity than others and consequently unenvious of others, but they are fully aware that their prosperity is dependent on their sea-borne commerce, inter-coastal as well as foreign. In the World War, they saw the sea-borne commerce of Germany, who possessed the second best navy in the world, swept off the seas within 30 days and we are confident that never again will the United States be content with a navy that is not equal in every class of vessels to that of any other nation.

Japan and the United States are discussing the ratio of cruisers, destroyers, and submarines; Japan demands 70 percent but the United States claims that Japan is morally committed to a 60 percent ratio, the same as in capital ships. Japan has the legal right on her side, but unquestionably it was the understanding of this country when it agreed to restrict the fortifications of its Far East posses-

(*Continued on page* 407)

SHIP-BUILDING PROGRAM, 1921-1929—CRUISERS.

UNITED STATES			GREAT BRITAIN			JAPAN		
No.	Tonnage	Cal. Guns	No.	Tonnage	Cal. Guns	No.	Tonnage	Cal. Guns
10	7,000	6"	7	5 to 8,000	6"	13	5,200	5.5"
1	10,000	8"	13	10,000	7.5" or 8"	8	7 to 10,000	8"
11	80,000	6" to 8"	20	169,000	6" to 8"	21	136,000	5.5" to 8"
DESTROYERS								
None			30	38,400	4.7"	61	73,700	4.7"
SUBMARINES								
38	800	4"	8	800 to 1,000	4"	36	800 to 1,000	4.7"
4	2 to 3,000	5" to 6"	11	1,500 to 2,500	4" to 5"	19	1,400 to 2,000	4.7"
42	39,400		19	24,200		55	66,000	

The Scientific American Digest

(*Continued from page* 394)

on a wet soil is prevented. Water will sink through that kind of a furrow several times faster than from a shallow furrow.

The advantages of the deep-tillage system (with sub-soiling and without plowing) and cover crop culture have been summarized by the Agricultural Extension Division, University of California, as follows:

(1) The cost, as compared to plowing and ordinary tillage methods is reduced in some cases as much as 50 percent. (2) All cultural operations are speeded up, making it possible to take advantage of favorable weather conditions. (3) Incorporation of the organic matter (cover-crop) throughout the entire area of the soil, is facilitated. (4) The humus content of the soil is increased. (5) The soil is given greater water-holding capacity. (6) The soil (especially in orchards) is more easily kept level. This is important in irrigated districts. (7) By conservation of moisture, the number of necessary irrigations is lessened. (8) More complete aeration of the soil results, with consequent increase in the beneficial activity of soil bacteria and fungi. (9) Roots (of fruit trees) are pruned, with the result that fine feeder roots are put out, increasing the assimilation of moisture and plant food. (10) The friability and general physical condition of the soil are improved.

Strange Stone Head Discovered in Texas

A GREAT stone, naturally shaped like a human head and carved with teeth, ears, eyes, and flattened chin, is a strange new discovery from Texas, unearthed from its resting place beneath 16 feet of undisturbed gravel.

Dr. E. H. Sellards, geologist of the University of Texas, brought news of the discovery to the Paleontological Society. The stone head appears to be a new piece of evidence that man existed in America in ancient times.

Judging by the geological conditions of the region, the stone must have lain in place while the gravel from nearby streams washed over it forming finally a layer more than 16 feet deep, Dr. Sellards said. The streams have long since ceased to wash gravel over the site. The stone weighs at least 75 pounds, possibly 100, he reported. —*Science Service.*

Ford Adopts New Alloy

WHEN the redesigned Model A Ford was announced late last December, the official description stated that exterior metal parts were made of rustless steel. It is now learned that the metal referred to is not the usual rustless steel, but an entirely new alloy never before used in automobiles. The Ford company's adoption of the product has more than doubled its output in this country.

The new alloy is known as Allegheny metal. The original formula for its manufacture was developed in Germany during the war, when armament plants were seeking the hardest possible substance suitable for gun lining. At about the same time, the English also worked out the formula. It was not until after the war, however,

that the commercial production of the alloy was contemplated and it was only a few years ago that methods for its economical manufacture in large tonnage were developed.

The Ford requirements are said to be about 1000 tons a month. This represents two thirds of the entire output of the American factories and one third of the output of the world, which is now about 3000 tons. When he adopted the alloy, Mr. Ford had to scrap several million dollars' worth of equipment originally installed for fabricating and polishing the nickel used in the original Model A.

Allegheny metal is said to be nonrusting, untarnishable, non-corrosive, and not affected by weather in any way. It is also one of the hardest metals known to the steel industry. It is an alloy of refined steel combined with about 18 percent of chromium, 8 percent of nickel and smaller proportions of carbon, manganese, silicon, phosphorus, and sulfur. It is the complicated method of combining these elements that gives the alloy its properties, it is explained.

Before its adoption by the Ford Company, production of the alloy was limited, because it was used only for building trim, cooking utensils, dairy equipment, and other articles for which it met special requirements. It is now being considered for use in the bars of State penitentiaries, according to report, because it is so hard that it cannot be sawed or otherwise cut by any hand tool.—*The New York Times*

Measure Wind Passing Through Brick Walls

WIND blows right through brick walls. A well-laid 13-inch wall in the face of a 30-mile-an-hour wind will allow 14.75 cubic feet of air to pass through it every hour, G. L. Larson, D. W. Nelson, and C. Braatz reported to the International Heating and Ventilating Exposition in Philadelphia recently. This data is obtained from researches they have conducted at the University of Wisconsin.

But proper plastering with gypsum directly on brick, they find, will stop 96 percent of the leakage. Less air will leak through a wall which has been well constructed and in which all spaces between bricks are filled with mortar.—*Science Service*

Test Shows Efficacy of Auto Oil Filter

IF automobiles are equipped with oil filters, frequent changes of oil in crankcases are unnecessary, a test trip across the continent by A. H. Hoffman, associate agricultural engineer at the University of California agricultural experiment station, tends to show.

On the trip, during which the speedometer showed 10,025 miles of travel, Mr. Hoffman found that after a change of oil, the viscosity dropped rapidly for about 200 miles, and then changed little for 5000 miles.

The tests on acidity were much the same, the acidity rapidly rising for about 200 or 300 miles, then showing small variation.

Only one machine was used in the experiment. In addition to the oil filter it had a crankcase ventilator, and both carbureter and breather were protected against dust. The test was made in warm weather.—*Science Service.*

The Amateur Astronomer

(*Continued from page* 400)

of crispness, and inability to bear high magnification.

"The sides of this wooden tube were made after the manner of a door, with stiles, rails, and panels. The panels having for the most part rotted, they were removed prior to the re-mounting of the instrument, and it was decided not to close in at once the large openings left by their removal, in order to observe the effect of allowing the air to circulate freely through the tube. In brief, the effect is to remove completely the characteristic defects of the reflector, so far as planetary images are concerned.

"The performance of this instrument has surpassed all expectations—so much so that in spite of the great disparity of aperture it is now rare to find, on occasions of poor seeing, that the refractor image is steadier or better-defined than that of the reflector.

"It should be understood that no claim is made for novelty in the idea of the skeleton tube, which, of course, is used for all the very large reflectors; it is only desired to point out the very great benefits to be obtained by adopting this type of tube for the smaller instruments, for which it has not hitherto been generally used.

"Experiments have shown that when the external temperature is falling, as of course is the general rule at night, it is impossible to keep the temperature of the air inside a "closed" tube uniform and equal to that of the external air. An electric blower sending a current of air up the tube is a help in the smaller sizes, but the trouble begins again as soon as the blower is stopped. In the case of a metal tube, the upper wall becomes colder than the lower wall by radiation, thus setting up convection currents within the tube. If the tube is lagged with felt, or if it is of wood, this trouble is avoided in part, but the tube and the air within it will then remain warmer than the external air during the whole time that the temperature is falling, and for some time after.

"The presence of this mass of relatively warm air can be made visible readily when the conditions are suitable. The telescope should be directed to a bright star and the eye-piece racked out considerably to give a large out-of-focus disk, which will be seen to be irregularly in motion. If an assistant then opens the door near the bottom of the tube and flaps a piece of cardboard vigorously in front of the opening, the out-of-focus disk will "boil," owing to the inrush of the cooler air. The air within the tube can be readily set in rotation by this means, and the rotation is visible in the eyepiece; but no amount of flapping will bring about uniform conditions."

So much for one side of the question. In a long article entitled "Reflectors versus Refractors," in the March number of *Popular Astronomy* (Northfield, Minn.) Prof. W. H. Pickering discusses both sides.

STILL another telescope, a 19-inch reflector having an open tube, is described in the January, 1930, number of the *Journal of the Royal Astronomical Society of Canada*, by its maker, Professor R. K. Young, of the Department of Astronomy at the University of Toronto. The illustrated article is detailed (16 pages) and ought to be obtained by every amateur who aspires to

make a fairly large telescope at some future date. The address is *Journal of the R. A. S. C.*, Mr. H. W. Baker, Treasurer, 198 College Street, Toronto, and the price is 25 cents.

Another current scientific journal which those who are especially interested in the Hale spectrohelioscope should not miss is the December, 1929, number of the *Astrophysical Journal* (5750 Ellis Avenue, Chicago; 75 cents), containing a 46-page article on that instrument written by Dr. Hale and strikingly illustrated by R. W. Porter. Since the publication of "Amateur Telescope Making" with its description of the spectrohelioscope, numerous alterations in design have been made.

Professor Charles W. Woodworth of the University of California, is making a mosaic type of telescope containing 400 mirrors, each 15 inches in diameter, and all attached to a single rigid backing. Each is to be adjusted, if possible, to the position called for by theory. Dr. Woodworth submitted his idea to this journal a year or more ago and the opinion given through one of its corresponding editors was that the theory was correct but in practice the difficulties would probably prove insuperable (see "A. T. M.", page 242, near bottom). He is now trying it out, and this is the correct procedure in cases where there is any doubt. Dr. Woodworth is an entomologist who has specialized on microscope theory, with which telescope theory has much in common. The amateur fraternity will wish him success.

—*A. G. I., Tel. Ed.*

The Heavens in May

By PROF. HENRY NORRIS RUSSELL, Ph.D.

At 11 o'clock: May 7.
At 10½ o'clock: May 15.
At 10 o'clock: May 22.
At 9½ o'clock: May 30.
At 9 o'clock: June 7.
At 8½ o'clock: June 14.
At 8 o'clock: June 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on May 7, etc.

NIGHT SKY: MAY AND JUNE

MERCURY is an evening star till the 20th and then a morning star, but can be well seen only during the first few days of the month. Venus is an evening star, growing more and more conspicuous as she comes north and gets farther from the sun. She sets at 8:30 when the month begins and 9:30 at its close. Mars rises in the neighborhood of 3 A.M. but is still almost 200,000,000 miles away and in consequence looks but little brighter than a star of the second magnitude. Jupiter is still an evening star but is getting low in the west. By the end of the month he sets a little after 8 P.M. and can hardly be seen. Saturn is in Sagittarius and rises at 10:30 P.M. in the middle of the month. Uranus is a morning star rising at 3 A.M. in the middle of the month, while Neptune is in quadrature on the 22nd and becomes an evening star.

The moon is in her first quarter at noon on the 5th; full at noon on the 12th; in her last quarter at 11 A.M. on the 20th; and new at 1 A.M. on the 28th. She is nearest us on the 4th, farthest off on the 19th, and nearest again on the 31st. As she circles the sky she passes near Jupiter on the 1st, Neptune on the 6th, Saturn on the 16th, Uranus on the 24th, Mars on the 25th, Mercury on the 27th, Jupiter again on the 29th, and finally Venus on the 30th of the month.

Our Point of View

France and the Naval Program

(Continued from page 402)

sions that the 5 : 5 : 3 ratio applied to all classes. Australia, New Zealand, and Canada object as decidedly as we to an increase in Japan's auxiliary craft, but Great Britain is permitting our delegation to do the negotiating with Japan. If Japan proves obdurate, our only recourse will be to refuse to extend the agreement in the Far East in 1931.

Unquestionably both Great Britain and Japan are relying somewhat on our reluctance to spend the money necessary to create a navy, and they have some reason because of the ship-building program from 1921–1929 of the three countries, of cruisers, destroyers, and submarines, as shown in th table on page 402.

Thus since 1921, in the types of naval vessels not limited by the Washington Conference, Great Britain has built practically twice as many cruisers and Japan 40 percent more cruisers than the United States; in destroyers we have built none, while Great Britain has added 38,000 and Japan 74,000 tons. It should be added, however, that in 1921 we had a considerably larger number of modern destroyers than either Japan or Great Britain. In submarines, Japan has built over twice as many as Great Britain and 40 percent more than the United States. For eight years we practically refrained from adding to our fleet, with the result that except in capital ships we have been outbuilt by both Great Britain and Japan. If the Conference succeeds we will have to build to catch up with Great Britain and to regain the 5 : 3 ratio with Japan; if the Conference fails we will have to build still more or expose our commerce to the not over tender mercies of belligerent cruisers when we are neutral, or to the hostile action of enemy cruisers when we are a belligerent. As we go to press it looks as if the action of France would eventually decide the size of our Navy; to such curious results do international agreements lead.

Chemistry in Industry

(Continued from page 397)

M. R. Tern, of Zinnowitz, has lately been developing a process whereby the production of the sulfate is carried out without the use of sulfuric acid, and the process is said to have been successfully tried out on the large scale in Germany, where it has been attracting a good deal of attention.

The production of ammonium sulfate by passing ammonia gas through dilute sulfuric acid is such an old established process that no one but a German chemist would have thought it feasible to revolutionize the process. Dr. Tern's invention brings two gases together to form a shower of crystals, completely eliminating the saturators in which the ammonia gas is bubbled through acid. He produces sulfur dioxide gas by roasting the spent oxide, which is a waste product of the gas plant. Then he passes this gas through an electric arc, oxidizing it to sulfur trioxide. This gas then mixes with ammonia gas in an

electro-filter and crystalline ammonium sulfate rains down, ready to be put in bags for sale as fertilizer. The amount of current used in the process (which is known as the Tern "Elektrostickstoff" system) is so small that by its use the saving through the elimination of sulfuric acid is sufficient to pay in a short time for the installation of the simple apparatus required. The ammonium sulfate obtained, known as "Elektroammon," is pure white, and contains about 20 percent of nitrogen. Installations having an annual output of 37,000 tons per annum are projected in Germany, where a large plant is already in operation.

Chemicals Do Not Fool Chickens

THE United States Department of Agriculture warns that no known drug or combination of drugs when fed to poultry will increase egg production. It has objected repeatedly to the use of any label on drug preparations for fowls which indicates that the preparations will increase egg production, and will continue actively its action against any preparations appearing in interstate commerce violating the law in this manner.

Enzyme in Bleaching Flour

GIVE us our daily bread and give it to us white, say Mr. and Mrs. American Public; wherefore flour millers, at the insistence of bakers, bleach the flour with chemicals before it goes on the market. This demand for white flour is largely a psychological one, for the carotin in wheat which normally colors it is entirely harmless and the bleached flour is neither purer nor more nutritious.

Until recently all flour-bleaching processes were based on rather potent oxidizing agents. Chemicals such as chlorine gas, nitrogen tri-chloride, nitrogen peroxide, and benzoyl peroxide are the oxidizing agents generally employed by flour millers for bleaching flour. Three of these are used in gaseous form, the fourth being a powder. In addition to their bleaching effect, all these bleaching agents effect an alteration in the baking characteristics (volume, grain, and texture) of the flour so treated. The chemicals effect the desired whitening of the color of the bread, but they also act on the flour protein, which forms the gluten of the dough. It follows that the flour is not only bleached by the bleaching agents but is also more or less modified in its other characteristics. Moderate treatment seems to improve the baking quality of the flour; over-treatment (overbleaching) may have undesirable effects in terms of its adaptability to yeast-bread production.

The latest development in the field of flour bleaching is the utilization of color-removing enzymes. The first compound containing these enzymes in activated form has just been announced under the trade name of "Do-White," a finely-ground, white-colored powder with a pleasing leguminous taste. Do-White is a pure, edible, plant product, containing no added chemical salts. It is partially soluble in water; in a small quantity of water it has a tendency to form a stiff jelly. Its active principle is an enzyme that has the ability to destroy or decolorize the natural, carotinoid pigment of flour. One half to one pound of it will completely

bleach 100 pounds of unbleached flour when added to the ingredients in the dough mixer. Action is very rapid, the dough as it leaves the mixers being already considerably whitened. Bleaching continues throughout the fermentation, until the high heat of the oven during baking kills the enzyme. Like other enzymes, it is more active at high temperatures below its death-point, as in pan-proof, than it is at lower temperatures.

New Plastic Material from Cornstalks

OUT in the "corn belt," chemists have dreamed of converting the useless cornstalks into a useful article of commerce. Indeed, the dreams have been realized to a certain extent by the recent perfection of a process for making wall board from the stalks that were formerly useful only as Hallowe'en decorations. The most obvious use however, namely their conversion into paper, has thwarted the efforts of chemists, mainly because of the difficulty of overcoming the tendency of the pulp to hydrate, a property which seems characteristic of this material.

Scientists at Iowa State College finally hit upon the idea of turning this stumbling block into a benefit, and have produced a new material known as "maizolith." This material is somewhat like hard rubber in appearance and properties. It is believed that cornstalks may eventually find their way into the manufacture of insulating material, noiseless gears, and similar products. It has been found rather easy by severe chemical and mechanical treatment to hydrate the cornstalk completely so that the product is a jellylike mass with no vestige of fibrous structure. Maizolith is prepared by drying this jelly and then machining the finished piece into the desired shape.

Russian Chewing Gum Proves to be Rubber

A PLANT having a larval parasite which produces cocoons of a rubber-like substance has been discovered in Soviet Russia, following the search in that country for new sources of rubber, according to information obtained by the Department of Commerce from a Soviet publication. These cocoons have long been known to the local population and are used as a sort of chewing gum, but in the opinion of Soviet investigators they are thought to consist of rubber.

The constant development of the rubber industry in Soviet Russia has involved an increasing expenditure of foreign currency for the purchase of raw materials. Two methods have been suggested to remedy this situation: the manufacture of synthetic rubber and the cultivation of rubber-bearing plants. The Rezinotrest (the Russian rubber trust) has experimented in cultivating guayule shrubs in several of the southern regions of the Soviet Union, but these experiments cannot as yet be pronounced successful. Attempts have been made also to find other plants capable of producing rubber.

In Kazakstan, in the sands of Barkhan, several varieties of Chondrilla are found, which secrete a sort of rubber and which also is used by the Kazaks for chewing gum. This material has been examined by the Supreme Council of National Economy and Rezinotrest chemists, who classify the gum as rubber.

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By Paul R. Heyl, Ph.D., Physicist U. S. Bur. Standards

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By Floyd L. Darrow

THE fact that the Editorial Committee of the "Scientific Book Club" (a new scientific-book-of-the-month-club composed of five of the "biggest guns" in all American science) has chosen this book, is far from remarkable. Had they passed it up they would have merited boiling in red ink. Darrow, the author, has performed another of his periodic miracles of popularization, the best known previous "miracle" being his "Story of Chemistry" (1927) which in next to no time became a scientific best seller and roundly deserved that distinction. "The New World of Physical Discovery" is just as good as the other book (it couldn't be better). Darrow writes for a wide, not a special, audience, and his books are "comfortable" for the average mortal who wants instruction—yes—but interest also, and now and then some brightness, rather than a headache. The present book (358 pages) covers the whole of physics, both old and new, not merely the new. From it the reader will learn how physical science started; how it grew; what it is today; and *why* it is what it is. Authenticity, instruction, interest, legitimate romance, and again authenticity—these are its earmarks.

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

American Corporations in Mexico

THE Supreme Court of Mexico has recently decided in a suit instituted by The Palmolive Company against an infringer of its trademark registrations in Mexico, that a foreign corporation, whether it be doing business in Mexico or not, is precluded from bringing suit in the Mexican Courts unless and until it is registered in the Commercial Registry. Such registration might be rather expensive, the fee depending largely on the amount of the capital of the corporation; thus, a corporation capitalized for 100,000 dollars would be required to pay from approximately 1000 to 1500 dollars for recording and legal fees. The registration referred to is not the registration of trademarks in Mexico but the registration of the corporation as doing business in Mexico.

The suit by The Palmolive Company was on its trademark, which had been duly registered in Mexico; actual infringement had been established but nevertheless the Supreme Court held that the plaintiff corporation has no standing in the Mexican Courts, because not being registered as doing business in Mexico, it has no existence in Mexico. This decision unless modified will have a far-reaching effect on the rights of American corporations in connection with their trademarks and other industrial property in Mexico. Although clearly erroneous, it will nevertheless be the law of Mexico unless it shall be set aside. The Department of Commerce has already laid the matter before our State Department.

Such a condition of affairs should not be permitted to continue. The Courts of every land should be open to afford complete relief to the owner of a registered trademark, and to prevent infringement thereof and imposition on the purchasing public by the substitution of the infringer's merchandise for that of the owner of the trademark.

Patents and Taxes

A RECENT decision of the Court of Claims in the matter of the claim of the Westclox Company for recovery of excess taxes paid by that company, reported in the *United States Daily* of February 6, 1930, is of considerable interest, not alone in showing that in computing income-and-profits taxes due consideration must be given to the advantages accruing to an industry because of patent protection, but also as outlining a rule for estimating the value of the savings resulting from the employment of the patented invention as compared with other processes and machines employed by competitors in the same line of business.

The patents covered a machine for automatically producing pinions and wheels, and also other patents for the design of the clocks manufactured by the claimant. Using as a basis the cost of producing ten thousand such wheels by the patented machine as compared with the machines and processes in use by others, the Court finally estimates the savings attributable to the patents; this is multiplied by the remaining life of the patents, in order to estimate the deduction which should have been made by the tax payer before computing the amount of its income-and-profits taxes.

In addition to the patents which were discussed, the value of the trademarks under which the clocks were sold was considered, and on the whole case as presented, the Court ordered that the parties compute the amount of the recovery and come to some stipulation with regard thereto.

This was a case where the patented inventions were not manufactured and sold, but offered protection only for the exclusive use of the machines employed in producing certain parts of the clocks. This is true, of course, excepting as to the Design Patents which covered the ornamental appearance of the clocks themselves.

If the protection of the exclusive right to use a certain machine, as compared with what one's competitor is compelled to use, is of so much value, it must follow that the exclusive patent protection for something that is manufactured and sold is of far more value. The theory on which the claim was allowed was that these protective patents were gradually expiring and that in time they would no longer be a source of profit to the owner, as upon their expiration the subject-matter thereof would be free to competitors.

Agreements Voided for Pooling Patents

THE United States District Court for the Northern District of Illinois has entered a decree in the so-called "oil-cracking case" by which agreements between several oil companies for pooling certain patents have been declared void. The case, as reported by the *United States Daily*, concerns agreements made between the Standard Oil Company of Indiana, the Texas Company, the Standard Oil Company of New Jersey, the Gasoline Products Company, *et al.* The patents involved covered processes and apparatus for producing gasoline by "cracking" petroleum. The agreements dealt with royalties for the use of such processes, as well as with the various patents. The suit was brought by the United States against the oil companies for alleged violation of the Sherman Anti-trust Law.

In addition to holding the agreements null and void, the court said: "It is further ordered, adjudged, and decreed that the primary defendants and the secondary defendants and each and all of their respective officers, directors, agents, servants, and employees, and all persons acting or claiming to act on behalf of them, or any of them, be, and they are perpetually enjoined and restrained from further executing and performing said agreements.

"It is further ordered, adjudged, and decreed that jurisdiction of this cause be retained by this court for the purpose of carrying out the terms of this decree."

Junior Applicant Wins Stoker Patent

RULING that the patent application of Chauncey L. C. Magee, covering certain improvements in mechanical stokers or grates, was filed after the invention had been disclosed to Magee by John C. Heavey, the Court of Customs and Patent Appeals has sustained the latter's claims. This decision confirms the opinion of the Commissioner of Patents, which had affirmed the decision of the examiners-in-chief, which in turn affirmed the decision of the examiner of interferences. All of the tribunals found that the junior party had disclosed the invention to the senior party, who had then filed application for a patent covering the device.

The appellant contended that the invention had originated with him, that the testimony of the junior applicant had failed to establish disclosure of the invention to him, and that the junior applicant's testimony had failed to overcome the prior record date of the Magee application. The courts, after investigating the facts involved, decided that Heavey had invented the device in question and had persuaded the manager of a large building in Chicago to have the apparatus installed by Magee, who was engaged in such work. It was disclosed that Magee had sent one of his draftsmen to Heavey to obtain the details of the apparatus. The equipment was made and installed, and Magee filed application for patent on the apparatus soon thereafter. Heavey filed application for patent some six months later, with the result that the Patent Office declared an interference to determine which of the claimants deserved the patent.

The invention relates to certain improvements in stokers or grates for furnaces of the type in which the grate bars travel through the furnace, supporting the fuel. The fuel is consumed as the grate moves. The particular improvement claimed consists of certain provisions for dividing the area of the moving grates into zones or sections for the purpose of supplying air upwardly through the different sections of the moving grate. This arrangement enables the air to be cut off from one section or zone and to be supplied to another by means of sliding dampers.

Court Finds Copyrighted Maps Were Copied

BECAUSE the maker of a composite map entitled, "Cleartype Road Map, Featuring Main Travel Routes within the Greater Metropolitan Area," had repro-

duced many errors, misspellings, and other peculiarities of certain maps copyrighted by the General Drafting Company, Inc., the District Court for the Southern District of New York ruled the defendant guilty of infringement. The case in suit was General Drafting Company, Inc., *versus* Lews H. Andrews, *et al.*

After pointing out that automobile road maps similar to those in suit are clearly the subject of copyright, the court appraised the method by which the maps had been prepared. It was found that the plaintiff had gone to considerable trouble and expense to prepare its maps, and had shown a noteworthy amount of originality in their preparation. The elements of the copyright consist, according to the court, in the selection, arrangement, and presentation of the component parts. The plaintiff's maps are sold in great numbers to the highway departments of several states, and to a number of the larger oil companies, for distribution to motorists.

The court ruled that if the defendant's map had been constructed after an independent investigation of the original sources in the public domain, without copying, the plaintiff would have no complaint. It was found, however, that the differences between the defendant's composite map and the several maps of the plaintiff were superficial. The defendant rested its case on the testimony of one Tudor, who described the manner in which he made the composite map. The testimony of this witness was shown to be of doubtful credibility, upon cross examination.

The case of the plaintiff was based upon the *prima facie* evidence showing the similarity, in unimportant and almost minute details, between the maps. Some 20 common misspellings were introduced, as well as 17 common errors in population symbols, the inadvertent misplacing of part of a river, arbitrary endings for roads at points actually not their endings, and the meanderings of highways, which in maps of this type are rather freely drawn. The court ruled that the defendant should pay damages and attorney's fees.

"Back of the Brawn, the Brain"

FROM a recent article in the *Journal of the Royal Society of Arts* (London), we are reprinting a tribute in verse to the world's inventors, and all those who design, build, and operate machinery.

"Back of the motors humming,
Back of the belts that sing,
Back of the hammers drumming,
Back of the cranes that swing,

"There is an eye which scans them,
Watching through stress and strain,
There is the Mind which plans them,
Back of the Brawn, the Brain."

—Berton Braley.

Wood Preservative Process Patented

ALTHOUGH the use of oil and sugar in treating wood is not new, patent has been awarded to George Elton Rice (Number 1732420) for a process of treating wood with oil and sugar which involves a function not present in the prior art and eliminates one step from the prior art processes. This decision of the Board of Appeals of the Patent Office, *ex parte* George Elton Rice, held that the examiner improperly rejected claims in an application for patent, because none of the references cited anticipate the process claims which cover the dehydrating as well as the impregnating of wood by treatment with a solution which contains oil and sugar.

Although it is old to preserve wood by impregnating it with preservatives carried in oil, and it is also old to preserve it by impregnating it with sugar in aqueous solution, the applicant had substituted oil for water with sugar and in so doing eliminated the necessity of drying the wood either before or after the impregnation process. This process involves more than the mere substitution of one preservative for another, in view of the fact that the drying process or step is eliminated. In the absence of any showing by the examiner that the result urged by the appellant is old or obvious, the claims were considered valid and allowable.

Patent Holder Must Give Notice of Alleged Infringement

THE owner of a patented article must give notice of his right therein, either to the public by marking his article "patented" or to the particular defendant by informing him of its infringement. Unless this is done, according to the District Court for the Western District of Pennsylvania in General Electric Company *versus* George J. Hagan Company, the owner of the patent may not obtain an accounting for damages and profits, even though the infringer had knowledge of the patent for several years and had built the devices for a time under a license.

The suit was tried on submission of decree for profits and damages for infringement of claims 7 to 11 of patent Number 1310060 to Collins for an electric resistance furnace. The court found that the defendant had knowledge of plaintiff's patent in 1919. Under an oral license from the plaintiff, the defendant built furnaces from 1919 to 1923, then conducted negotiations about a renewal license. It was found that at no time did the plaintiff comply with the statutory provisions of notice to the public by marking, and at no time did the plaintiff either verbally or in writing notify the defendant that it was infringing the patent in suit. It was held, therefore, that the plaintiff was not entitled to an accounting for profits and damages.

Section 4900 of the Revised Statutes, title 35, section 49, reads: "Patented articles marked as such; notice of infringement.—It shall be the duty of all patentees, and their assigns and legal representatives, and of all persons making or vending any patented article for or under them, to give sufficient notice to the public that the same is patented; either by fixing thereon the word "patented," together with the day and year the patent was granted; or when, from the character of the article, this can not be done, by fixing to it, or to the package wherein one or more of them is inclosed, a label containing the like notice; and in any suit for infringement, by the party failing so to mark, no damages shall be recovered by the plaintiff, except on proof that the defendant was duly notified of the infringement, and continued, after such notice, to make, use, or vend the article so patented."

Patents Recently Issued

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Pertaining to Aeronautics

AIRPLANE WING—The surface of which is made in a plurality of sections arranged in stepped relation affording air passages between the sections which, incident to the velocity of the plane, creates a maximum vacuum over the entire wing surface. Patent 1746140. Jarrot Bobo.

AEROPLANE STEERING MECHANISM—A combined steering mechanism and joy stick whereby an aeroplane may be controlled in flight in the usual manner or steered on the ground, and manually operable means for locking the wheels in landing position. Patent 1747344. Harry S. Bell.

AEROPLANE—Having a water tight fuselage, and equipped with a parachute and means for releasing the forepart of the plane from the fuselage so that the latter will be permitted to slowly descend in case of trouble. Patent 1748811. Charles C. Warren.

PONTOON FOR AIRPLANES—Providing means whereby an airplane may be used as a hydroplane, the pontoons being equipped with retractable wheels, which may be drawn for travel on the ground surface, thus combining several body units in one assembly. Patent 1747563. Joseph G. Yonkese.

CONTROL MECHANISM FOR AIRCRAFT—Whereby a slight movement of the joy stick will enable the pilot to handle and control the elevators, rudders and ailerons of a large passenger carrying plane as easily as a small scout machine. Patent 1747564. Joseph G. Yonkese.

EMPENNAGE STRUCTURE FOR AIRCRAFT—More particularly adapted for large double bodied aircraft, wherein means is provided for guiding the craft when rising or alighting, the operating mechanism being particularly strong, and enclosed in such manner as to present a smooth stream-line box-tail construction. Patent 1747565. Joseph G. Yonkese.

Pertaining to Apparel

HEEL GRIP—Of resilient material, shaped to the contour of the heel so that in its movement it will cause the boot or shoe to move almost as if it formed an integral part of the foot. Patent 1745726. Chester R. Snow.

Chemical Processes

PROCESS OF MAKING FUEL MIXTURES—Which comprises passing acetylene gas through pentane, whereby the acetylene gas will act as a vehicle for carrying predetermined quantities of the pentane, and so modify the mixture that the flame will give off no carbon monoxide. Patent 1746172. Paul E. and Frank A. Webb.

PROCESS FOR RETTING TEXTILE FIBERS—Consisting in agitating raw fibers from flax, or other vascular fibers, for about fifteen minutes in water and nitrogen fixing bacteria at 100 degrees Fahrenheit, letting the fibers remain immersed for three hours, draining, and drying the fibers. Patent 1746316. Morris Marcus.

Designs

DESIGN FOR A KEY TAG—Patent 80435. Benjamin C. Da Shiell.

DESIGN FOR A DOLL HEAD OR SIMILAR ARTICLE—Patent 80481. Adolph Gramlich.

DESIGN FOR A GOBLET—Patent 80512. George Dougherty.

DESIGN FOR A TOY SOLDIER—Patent 80531. Peter J. Hemmer.

DESIGN FOR DISH OR SIMILAR ARTICLE—The inventor has been granted four patents for ornamental designs of a similar nature. Patents 80520, 80521, 80522 and 80523. William P. Graham.

DESIGN FOR A DRESS—Patent 80574. Dorothy Long.

DESIGN FOR A COASTER—Patent 80591. Albert S. Valchek.

Electrical Devices

DYNAMIC RADIO RECEIVER AND AMPLIFIER—A transformer especially adapted for radio, providing a simple and efficient receiving circuit in conjunction with an amplifier which does away with the use of a battery and vacuum tubes and gives greater amplification. Patent 1747137. George Wald.

ELECTROSTATIC LOUD-SPEAKER—Wherein a soft ductile membrane co-operates with a rigid perforated metallic plate, the perforations being parabolic so that even with large amplitude vibrations the electrostatic forces upon the membrane remain proportional to the applied electrical amplitudes. Patent 1747952. Eugen Reisz.

MEMBRANE FOR ELECTROSTATIC LOUD-SPEAKER—A process for manufacturing a metallic coated insulating membrane which includes the step of sticking metallic foil coating upon the rubber or other insulating membrane by means of a vegetable or castor oil. Patent 1748901. Eugen Reisz.

Of Interest to Farmers

CULTIVATOR ATTACHMENT—Having a plurality of rotatable earth working elements which may be simultaneously adjusted to various angles with respect to the path of travel, particularly adapted for side hill cultivation. Patent 1747058. Daniel W. Duellman.

CULTIVATOR—Having an angularly disposed wing at the side, by means of which grass and other vegetation may be uprooted from the ground in close proximity to the roots of growing plants, while the row is being cultivated. Patent 1747059. George F. Dugger.

STOCK MUZZLE—Having means whereby the size of the central feeding opening may be quickly adjusted to permit the animal to bite off more or less grass, according to the height, and thus prevent dangerous bloating. Patent 1748027. Chris M. Rasmussen.

Of General Interest

JEWELER'S TAG—Of bendable material, which may be easily connected with an article of jewelery, and if desired easily removed for use on another article, a button structure securing the tag in folded position. Patent 1742982. Charles T. Wittstein.

ROAD AND STREET CONSTRUCTION—In which the road base is covered with bituminous rock, or a mixture of bituminous rock and clean hard stone, forming a levelling course, after which the wearing surface is formed of ground bituminus rock rolled cold. Patent 1747125. Guy F. Murphy.

STRUCTURAL FORM FOR CONCRETE WORK—A metal form framing and retaining unit of general application and use in the building of walls, stairs, columns and the like, wherein the form serves as molds within which the concrete is poured and held until set. Patent 1747036. John H. Sullivan.

REFRIGERATING SYSTEM — Particularly adapted for cooling syrup cans in soda fountains, the cooling mechanism taking up a minimum space, high pressure in one refrigerant being utilized to force the liquid through an additional cooling line to other containers. Patent 1746896. Franklin B. Hunt.

CARD HOLDER—Which may be permanently fixed to a trunk, box or package, in such a manner that a card may be inserted or removed at will, a holding means retaining the card against accidental displacement. Patent 1747077. Irwin M. Ikelheimer.

ICE-CREAM HOLDER—Which can be conveniently handled without soiling the hands from the melting cream, and which will be edible constituting in effect an ice-cream sandwich having a handle for holding the same. Patent 1747112. Warren E. Good.

HAND PROTECTOR—A covering guard particularly designed as a shield for the hand when manipulating a spoon in basting meat, or a fork or other culinary implement in the presence of hot grease or steam. Patent 1747097. Alvah D. Young.

RACK FOR PIECE GOODS—Especially designed for holding bolts of cloth or goods on shelving in the aisles of stores so that the goods may be conveniently displayed to prospective customers, thereby reducing to a minimum the handling of the goods. Patent 1747026. William W. Phillips.

COLLAPSIBLE CASE—Simulating the commonly known suit case, having a plurality of sections which enable the case to be enlarged or contracted, operating with equal facility at any adjustment, the handle being positioned according to the weight within the case. Patent 1748024. William W. Machemer

COMBINED SOAP HOLDER AND MASSAGING DEVICE—Functioning as a soap cup of sponge rubber, having in addition one face with projections and the other face formed as a receptacle for soap with a pair of spaced handles permitting a secure grip for massaging. Patent 1748008. Harry Barnowitz.

CURTAIN AND SHADE GUARD—In the form of a rod and brackets whereby curtains and shades may be kept from being soiled by the action of rain and dirt, and to tearing action on being blown outside of the room. Patent 1746269. Henry W. and Margaret Lupton.

VACUUM CLEANER ATTACHMENT—Whereby one of the two hooks, usually attached to the handle for holding the electric cord when not extended in use, may be swingable, so that the cord may be instantly released without unwinding Patent 1746246. Frederick W. Elworthy.

TIE WIRE AND SPREADER—An elongated member having eyelets which may be secured to forms for concrete, and the like, at a number of points, thereby strengthening the connections between the inside form and the outside form. Patent 1746298. Charles M. Ally.

PLANT PROTECTOR—For protecting young plants against destructive insect and worm life, as well as against injurious cold weather or frost, designed to hold more moisture in the soil about the roots that is usually possible. Patent 1747967. Robert B. Bell.

EXPANSION PLUG FOR PIPES—Having an expansion head adapted to effect a closure of the pipe, and in which ample clearance, irrespective of elbow bends, is provided for the operation involved in expanding the head. Patent 1747933. Patrick Goodman and Beni Leone.

FIRE HOSE—Characterized by properties of high resistance, reinforced against permanent creasing which results in rapid deterioration and cracking, and reinforced against wear while being drawn over the ground or conveyed within the hose wagon. Patent 1747584. Russell P. Howard.

JUICE EXTRACTOR—Embodying a cutter for dividing the fruit and a receptacle in which the extracted juice and pulp of oranges, lemons or limes is collected, and the juice strained from the pulp before being discharged. Patent 1747641. Robert C. Morris.

VACUUM CLEANER—Including a wheeled carriage constituting a solid base for electric motor and blower, is relatively small and compact, can be conveniently carried from place to place or may be readily stored within the carriage. Patent 1748853. Etta M. Squires.

Hardware and Tools

PIVOT-STRAIGHTENING DEVICE—Particularly adapted for straightening the balance staff pivots and train pivots of watches, a tool with which accurate temperatures are assured, and which may be manipulated with the thumb and fingers without burning the hand. Patent 1747136. George F. Putnam.

CAN OPENER—Comprising a pair of handles, a cutter and a can-moving wheel, the cutter being riveted at two points will not work loose, and the movement of the can-moving wheel away from the cutter is limited. Patent 1744573. Axel W. Peterson.

BED-RAIL CONNECTER—So constructed as to render the side bed rails reversible to accommodate flat bed springs or coil or box bed springs, each being supported at the same level on the bed frame. Patent 1745653. Adolf Weston.

TRUNK LOCK—Comprising threaded means adapted to be secured to the trunk body in spanning relation to its door opening, for providing a fluid tight joint between the closure and the truck body and effectively lock the closure. Patent 1745422. Charles Hinde.

VISE—A portable tool with means for attachment to a bench, a pair of jaws of the screw adjustable type to function as a wrench when detached from its support, thereby being usable under varying conditions. Patent 1748886. Abelardo Linares.

SCREW ADJUSTABLE MECHANISM—A combination tool, combining a wrench structure with a support for its fixed jaw, and a hanger or jacking element for its movable jaw, to form a jack, the parts being separable for storage or shipment. Patent 1748888. Abelardo Linares.

INTERMITTENT-GRIP DEVICE—A rotatable element having a ratchet wheel thereon, and a detachably mounted handle and co-operating pawl element, said member being demountable for convenience in storage or shipment, and being reversible for effecting reverse rotation. Patent 1748887. Abelardo Linares.

Heating and Lighting

GRATE—Wherein a maximum natural draught will keep the interchangeable grate elements in a cool state, the construction being such as to give a maximum life to the grate, and a more perfect combustion to the fuel. Patent 1746126. Morton K. Moore.

APPARATUS FOR MAKING ILLUMINATING AND HEATING GAS—In which compressed air is forced through gasoline or oil, whereby a combustible gas is produced and stored in confined space, before being conducted to the burners or any form of motor power operated by gas. Patent 1747094. John Whikehart.

Machines and Mechanical Devices

SLIP FLASK—For molds, wherein the alignment and holding of the cope in proper position on the drag receives special attention, the planks of the flask being so clamped and reinforced as to prolong their period of usefulness. Patent 1746146. Adam Diehl.

SNOWPLOW—Of the type adapted for use with tractors, whereby the necessary parts may be controlled by the operator from his seat, effective means being provided for gathering and delivering snow on either or both sides. Patent 1746167. Richard Robertson.

COTTON-FEEDER MECHANISM—For cotton cleaners, burr extractors, boll breakers, etc., which is entirely automatic, the speed of the feed being regulated with extreme accuracy by the pressure of the cotton in the roll box. Patent 1746135. Jackson L. Walker.

PAINT STIRRING AND MIXING DEVICE—Including a rotary blade and manipulating crank, adapted to be attached to a paint can for facilitating the stirring and remixing of the liquid and solid ingredients, after they have settled in the container. Patent 1747032. Frederick Schlageter and Fabian Maletsky.

MECHANISM FOR CUTTING AND FACILITATING THE REMOVAL OF MATERIAL FROM MACHINES—A machine for manufacturing noodles, which insures the separation and cutting of the noodles into uniform quantities, thus obviating the necessity of weighing, means being provided for their removal without physical contact, whereby sanitation is insured. Patent 1747075. Joseph Horowitz.

BALL-AND-SOCKET JOINT—Which is simple in construction, easy to assemble and effective in operation, and is particularly useful in lubricating systems in lieu of flexible tubing. Patent 1745755. Coy C. Goodrich.

GLASS-GOB CUTTER—Adapted to be positioned near the outflow of glass from a melting tank, for cutting the glass gobs, at right or various angles by a liquid or gaseous substance, without leaving any visable mark. Patent 1747087. Charles H. Schlalz.

SURFACING MACHINE—For finishing the interior of manhole casings, a portable machine which is rotatably supported on the work, and incident to its rotation about the same, automatically feeds a cutting element evenly over the entire surface. Patent 1747944. Charles H. Lyne.

WAVE MOTOR—Which is characterized by its responsiveness to record every impulse of the water due to wave motion, roll, weight of water and undertow, and to convert such impulses into power to perform useful work. Patent 1746613. Chester E. Shuler.

DEVELOPING RACK—A manually rotatable disk support, whereon photographic films may be detachably held without contacting with each other, and may be passed through the developing, washing, fixing, and washing processes, and eventually dried by centrifugal action. Patent 1747930. Irving L. Cook.

HARNESS-TAPE-SELVAGE MOTION FOR LOOMS—A salvage harness so constructed that it may be used with the heddles used in connection with the usual harness, reducing wear of the parts to a minimum, and is readily removable for retying warps. Patent 1748001. Edward P. Taft, Payton L. Videtto, and James A. Gaddy.

AUTOMATIC CONTROL FOR WELL-FLOWING DEVICES—Wherein no delicate springs or other unsubstantial elements are used to urge the plunger or valve element to an open position or to resist its action in closing, the action being governed by the velocity of the liquid column, is therefore positive in operation. The inventor has been granted three patents of a simular nature, Nos. 1747570, 1747571 and 1747572. Alexander Boynton.

CURRENT MOTOR—Particularly adapted for use in bodies of flowing water, such as rivers or streams, is capable of being adjusted with respect to the direction of the water, whereby the power of the flow may be utilized. Patent 1745356. William H. Crofton.

VALVE MECHANISM—For air compressors, functioning as either an inlet or outlet valve means, comprising a cup shaped element having an axially disposed duct there through and a flat annular valve seat surrounding the inner end of the duct. Patent 1746612. Elmer F. Seager.

GAS-ORIFICE METER-CHART CALCULATING MACHINE—By which the pressure and differential curves of such charts are employed as indices for the production of a computation of the quantity of fuel that has passed through an orifice during any determined period. Patent 1748783. John B. McGaughy.

GRADUATED MAGNETIC CONTROL OF BRAKES OR CLUTCHES—A brake mechanism having means for controlling the same, whereby the brake may be either gradually or quickly applied and held at any degree of application, by combined electromagnetic and fluid operated means. Patent 1748773. Frank L. Johnston.

MARGIN-ADJUSTING DEVICE FOR WRITING MACHINES—Adapted for open front paper carriage machines, whereby the margin may be set and fixed by displacing the carriage as a whole, or may be locked on the carriage or left free to slide. Patent 1748896. Camillo Olivetti.

APPARATUS FOR APPLYING SOFT-METAL LININGS TO HARD-METAL TUBES—Which facilitates the application of soft metal, such as lead, to hard metal tubes, the lining operation being continuous, and the lining uniform, without necessitating subsequent finishing operations. Patent 1748851. Warren R. Smith.

DISH-WASHING MACHINE—By means of which dishes of various sizes, as well as table silver, may be washed and rinsed thoroughly and rapidly, the soiled dishes being continuously fed to the machine. Patent 1748530. Aurelio R. Torres.

Musical Devices

PIANO—Wherein the percussion strokes of the hammers are automatically shortened or lengthened correspondingly with the actuation of the soft pedal control, and a greater range of volume and tone is obtained, with precision not heretofore possible. Patent 1748777. Bernhard F. Laukandt.

Plumbing and Fittings

FAUCET FITTING—Comprising a pipe divided interiorly into passages, and outlet ports for separately conducting hot and cold water to a single nozzle, the valve seats are readily accessible for replacement when necessary. Patent 1747640. George J. Morris.

Prime Movers and Their Accessories

SAFETY DEVICE FOR LIQUID-SUPPLY LINES—Adapted for use in preventing failure of a supply of fuel for internal combustion engines, in the event of a break or other source of leakage in the supply line, particularly adapted for air craft. Patent 1746095. Frank E. Tugwell.

VALVE CONSTRUCTION—Which has means for receiving the general formation of carbon and directing the same so that it will not interfere with the valve operation, the contacting portions being out of the path of the exhaust gases may be lubricated. Patent 1746927. Carl F. Burgmann.

Railways and their Accessories

RAILROAD TIE—A tie structure in which both sections are identical, whereby any two sections may be properly mated, eliminating the number of operations required for the production of a complete tie, thereby effecting economy in labor. Patent 1747054. George B. Cox.

WHEEL-FLANGE LUBRICATOR—Using grease in stick form for lubricating the flanges of railway cars, locomotives, street cars or other vehicles running on rails, whereby the lubricant will be constantly applied, and the stick easily replenished. Patent 1748028. Lester J. Rickard.

HINGED TOP FOR BOX CARS—By means of which the entire top of the car may be opened, permitting the use of cranes, instead of human effort, for unloading, resulting in cheaper handling, the construction forms an entirely watertight closure. Patent 1747423. Blair B. Campbell.

Pertaining to Recreation

TOY—A combat device in the form of two boxers or fencers, the arms of the figures being manually operable to deliver or parry blows, and to automatically become inoperative when the target portion of the body has been struck. Patent 1745434. John F. McIntosh.

SWIMMING APPLIANCE—In the form of a glove with rubber webbing, or the like between the fingers and thumb, as an aid in swimming, and to increase the effectiveness of the propelling stroke. Patent 1748317. Thomas B. Sykes.

Pertaining to Vehicles

VISOR FOR MOTOR VEHICLES—Having a window and a shutter, and means within reach of the driver for regulating the vision area of the window whereby an unobstructed view of elevated traffic signals may be had. Patent 1745197. Joseph E. Tirpak.

CYLINDER GRINDER—Which may be secured to the engine block, and has means for automatically centering the mechanism within the cylinder for grinding automobile motor cylinders, without removing the motor from the chassis. Patent 1745015. John Johnson.

BRAKE EQUALIZING AND OPERATING MECHANISM—For vehicles, comprising a plurality of brake actuating members and a wedge-shaped member contacting therewith, the wedge-shaped member having a slight rotative motion and means for imparting endwise motion for operating the brake members. Patent 1744643. Nicholas A. Kristmann.

METHOD OF MAKING TIRES—A built up tread portion for pneumatic tires comprising a central section of annular fabric rings and alternate annular rubber tread webs, their edges forming a wearing surface which will prevent lateral slipping. Patent 1744025. Virgil C. Anderson.

OIL-GAUGE-ROD WIPER—For use in connection with cleaning automobile gauge rods, before use in testing the amount of oil in a crank case, whereby the wiping may be accomplished by a single stroke, without the operator handling the wiper. Patent 1747100. Alton W. Ashworth.

FOOT CONTROL FOR MOTOR CARS—Adjustable to a given point in a range of settings for the throttle valve of the carburetor, and when adjusted may be left at that point so that the speed of the car will be substantially held. Patent 1747083. Henry J. Ries.

BLOW-OFF GAUGE—Adapted to be applied to the valve stem of an inflated tire for allowing only a predetermined amount of air under pressure to pass the valve stem, having a novel means for forming an air-tight connection. Patent 1746923. Esten B. Beeler.

WATER GAUGE FOR AUTOMOBILE RADIATORS—Having a supportng plate and a floating member with signs indicating the water level, the entire formation covering only a part of the radiator opening, thereby permitting water to be inserted while the gauge is in use. Patent 1747022. Albrecht zur Nieden.

COLLAPSIBLE WHEEL CHUCK—A block which will be strong, yet can be carried in a relatively small space, opened and placed in operative position under and at the rear of a wheel, to prevent any possible movement of the wheel. Patent 1746415. Joseph A. Burkart.

THREE-WHEEL VEHICLE CHASSIS—Having means for moving the front wheel slightly to one side when turning to carry the weight directly to the ball bearings removing the strain from the chassis and preventing the device from turning over. Patent 1747526. Ernest L. Pearson.

ANTIGLARE DEVICE—Which is applicable to automobiles of the closed or open type, and when in applied position may be adjusted to effectively intercept glare producing lights, yet permit an unobstructed vision of the roadway. Patent 1745695. William O. Hunter.

RUMBLE-SEAT TOP—Wherein a top and sides are provided and so arranged that the top may be used alone or in connection with the sides, thereby providing a complete enclosure, the cover is removably connected. Patent 1748031. Julius N. Wiener and Henry Aretsky.

BUS SEAT SWITCH—A double deck bus, wherein the operator may act as driver and conductor, all passengers being compelled to pass him in entering and leaving, and a signalling device indicating the vacant seats on the upper deck. Patent 1747960. Charles Weiss.

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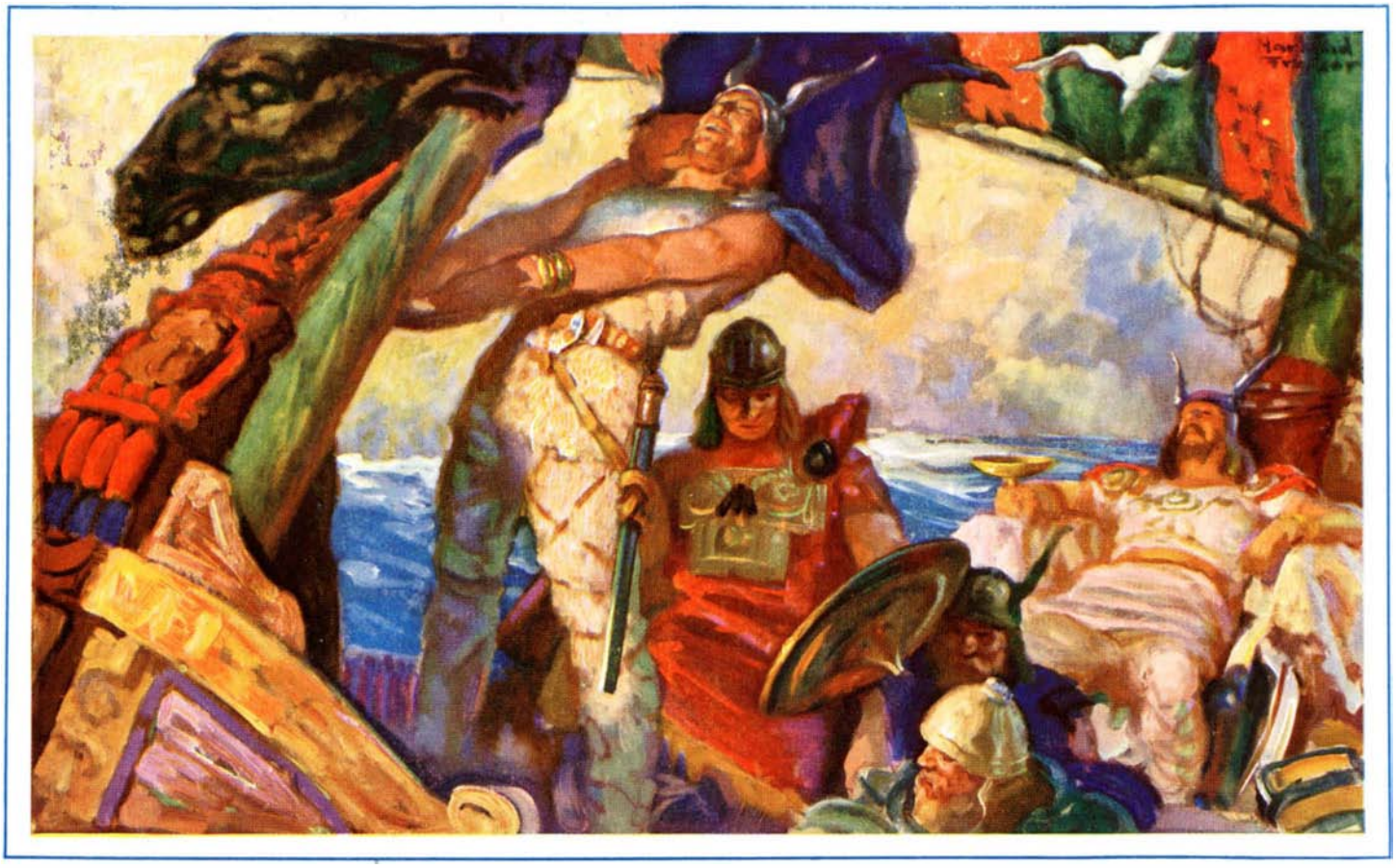

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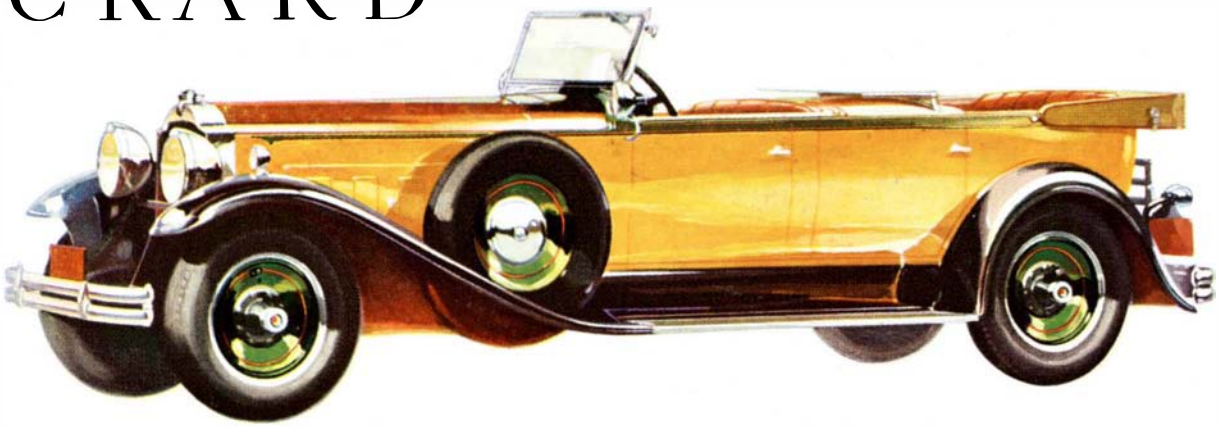

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