NAVY NUMBER

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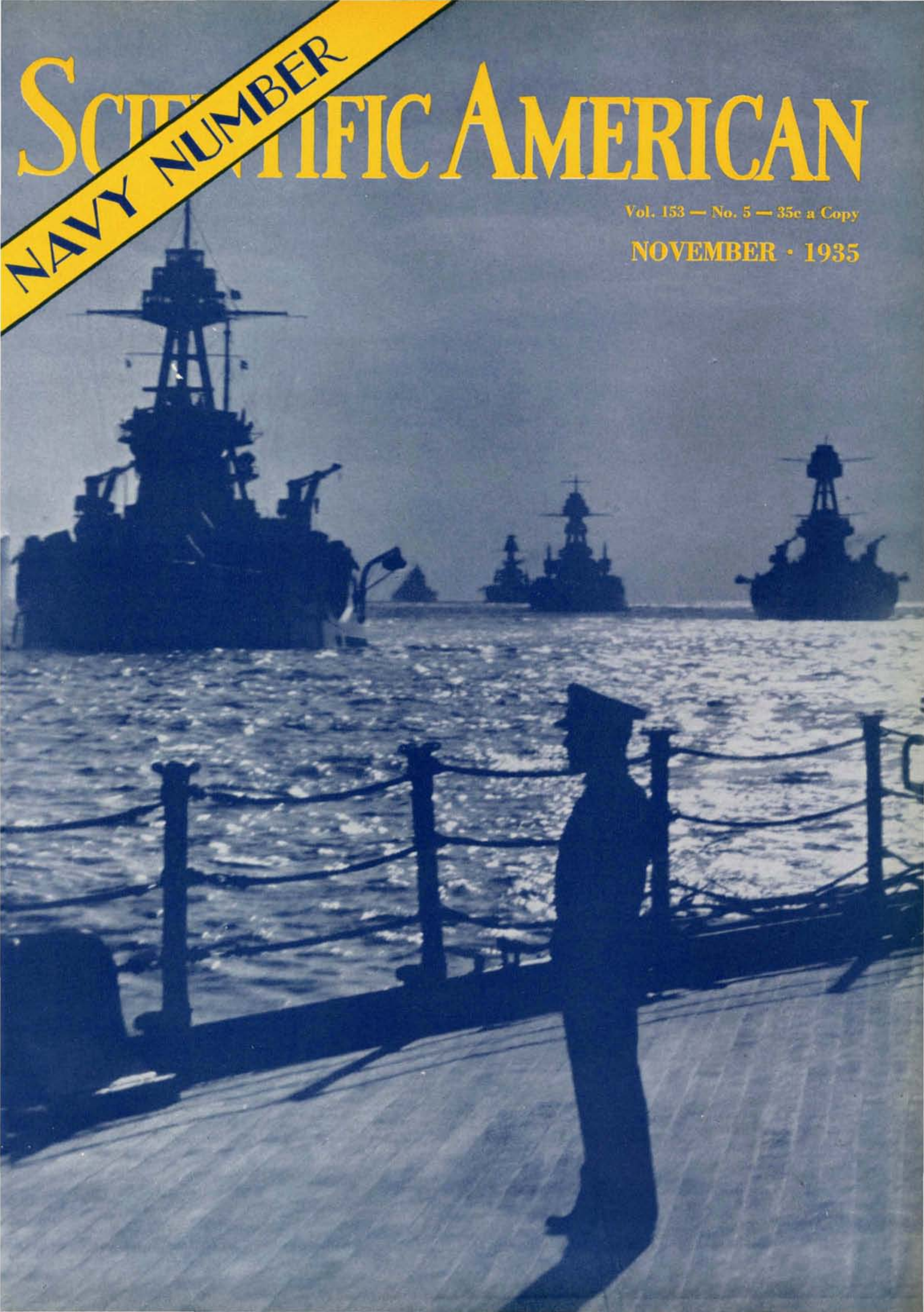

IMMEDIATELY AVAILABLE ON LAND AND SEA

WILKINS, R. A.: Born September 12, 1896. Graduate in Chemical Engineering Massachusetts Institute of Technology 1918. Served in the Development Division of the Chemical Warfare Service—in command of Research Laboratory Offense Section. Chemical Engineer Lynite Laboratories, Cleveland, Ohio. Instructor in Mathematics and Chemistry, Chauncey Hall School, Boston, Mass. Assistant Professor of Chemical Engineering, Massachusetts Institute of Technology. Vice President and Research Director, Industrial Development Corporation. Vice President and Director of Research, Revere Copper and Brass Incorporated. Professional Societies: American Society for Testing Materials; American Institute of Mining and Metallurgical Engineers; American Chemical Society; British Institute of Metals.

SCIENTIFIC AMERICAN has proved so valuable for reference use that, afloat or ashore, a copy of the magazine is always available to those who have authority in the various branches of the Navy Department—Research, Purchasing, Policy, and Strategy. Investigation will immediately establish the influence and good will that SCIENTIFIC AMERICAN enjoys in this branch of Government Service.

RESEARCH LEADERS HELP US EDIT

The Editorial Staff of SCIENTIFIC AMERICAN has always had the co-operation of distinguished leaders in all fields of Science. They serve as contributing editors.

It is our privilege to announce that beginning with this issue, the readers of SCIENTIFIC AMERICAN have the benefit of the counsel of R. A. WILKINS, Vice President and Director of Research, Revere Copper and Brass Incorporated.

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EVERY significant scientific discovery or laboratory development is immediately recorded and evaluated. This editorial service is not for the specialist in a particular field, but for all research men in industry, for research students in school, college, or university, and for that select group of science-minded individuals who cherish accurate scientific knowledge for its own sake.

Measured in numbers, the readership of SCIENTIFIC AMERICAN is not large, and never will be large. Its editorial standard is too high either to appeal to or to be appreciated and understood by the mass mind, yet the SCIENTIFIC AMERICAN readership, in its influence and purchasing power, is an unexploited and unused market for many advertisers desiring to reach those who pioneer in Commerce, Industry, School, and Government.

Constantly used as a reference, every issue has a circulation at least ten times greater than the numerical count of 31,602, credited it by the Audit Bureau of Circulations, of which it is a member.

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SCIENTIFIC AMERICAN

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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COVER

THE illustration on our front cover this month, taken during practice maneuvers, was supplied through the courtesy of the United States Navy. All photographs of naval vessels, equipment, planes, and so on, used in connection with articles in this issue are, unless otherwise credited, United States Navy, Official.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, November, 1935. Vol. No. 153, No. 5, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

Books SELECTED BY THE EDITORS

THE SOLAR SYSTEM AND ITS ORIGIN

By Henry Norris Russell, Professor of Astronomy, Princeton University

"IN clear, informal style, Dr. Russell sums up the present state of knowledge and theory concerning the solar system. He tells first of the dynamical properties of the system—its tremendous isolation in space, the probable age of the planets, and of how, probably about two billion years ago, the earth began an independent existence. He describes the comets and their strange tails—comets which are probably steadily wasting away, though Halley's Comet has been seen to grow 27 successive tails and shows no signs of exhaustion.

"He then takes up the physical and chemical properties of the system, and describes important work done here and abroad during the past few years, which, despite its general interest, is not yet widely known. The temperatures and atmospheres of the planets are next discussed—with incidental bearing on the possibility of life upon them. Finally, he considers the various theories of the origin of the solar system—the theories of Chamberlin and Moulton, of Jeans and Jeffreys."

This is the publisher's blurb, from the jacket of the book, and it accurately describes it. The many SCIENTIFIC AMERICAN readers who tell us by letter that they "can never get enough of Russell" may now slip in some extra Russell by reading it.—$2.15 postpaid. —*A. G. I.*

PARADE OF THE ANIMAL KINGDOM

By Robert Hegner, Ph. D., Assisted by Jane Z. Hegner

A TOTAL of 743 clear illustrations would by themselves make this book what it purports to be, but in addition, 664 pages of carefully compiled text, descriptive of animals, birds, and reptiles, make of it an excellent reference work. This is an unusual natural history of animals written for all those who wish to know something about the modes of life and activities of the animals they see or read about. The authors have chosen representatives of each large group of the animal kingdom arranged in the order of their complexity from amoeba to man. We recommend it to all who are interested in animals to the slightest degree because the authors have taken pains to tell what most people want to know about animals —where they live, how they protect themselves, where and how they obtain their food, how they reproduce themselves, how they pass the winters. This is a splendidly made book 7 by 10¼ inches and weighing five pounds.—$5.50 postpaid.—*F. D. M.*

THE LEICA MANUAL

By Willard D. Morgan and Henry M. Lester

ALTHOUGH this beautifully produced book is directed mostly to users of Leica cameras, it is full of information that will be of great benefit to any photographer. In fact, only one or two chapters are so specifically concerned with the Leica as to hold little interest to users of other miniature cameras. Some of the subjects covered include the making of positives, stereoscopic photography, panoramas, miniature monsters, photomicrography, infra-red photography, astronomical and candid photography, photo-murals, and so on. This is a beautifully produced book of 502 pages, thoroughly illustrated with excellent photographs, and printed on fine coated stock.—$4.00 postpaid.—*A. P. P.*

THE STRUCTURE OF CRYSTALS

By Ralph W. G. Wyckoff

THIS is a supplement to Part II of the second edition of the author's well-known book on the X-ray diffraction method for the determination of the structure of matter. It is a technical book that is recommended to those who are already on familiar terms with the original book.—$6.20 postpaid.—*A. G. I.*

ADVERTISING LAYOUT AND TYPOGRAPHY

By Eugene de Lopatecki

FACED with the necessity of preparing advertising copy, suggesting ideas for advertising campaigns, or presenting in an understandable manner a layout for any kind of printed matter, the average business man is likely to throw up his hands and cry quits. Yet the ability to meet such a situation is frequently desirable in many businesses, and the man who is equipped to do so will often find himself in an advantageous position. This book literally takes the reader by the hand and leads him, step by step, through the whole art, making every step as simple and easy as possible. It was written by an experienced art director who himself makes use of the exact methods which he so lucidly explains, and is illustrated with numerous drawings. Each chapter is set in a different font of type, so that the reader is able to judge for himself the effectiveness of the various styles.—$3.15 postpaid.—*A. P. P.*

THE NEW SCIENCE AND THE OLD RELIGION

By Thornwell Jacobs, Litt. D., LL. D.

THE president of Oglethorpe University, of Atlanta, presents in this work a 517-page, illustrated survey of cosmology, evolution, human origins and an orientation regarding the meaning and nature of life, in an attempt to find a formula that will make it possible for the reader "to keep his faith without stultifying his judgment." The author regrets the fact that, as he says, "the majority of our religious leaders are, most unhappily, arrayed in fierce opposition to the evolutionary and revolutionary teachings of modern science," a fact which "is proving fatal to the churches, driving from their doors those whom they can least afford to lose." The book leans heavily in the direction of religion but not fundamentalism, and should be acceptable to those who believe there is no opposition between religion and science, and who cherish religion.—$3.95 postpaid.—*A. G. I.*

SAHARA, THE GREAT DESERT

By E. F. Gautier

THIS is a scientific treatise covering every aspect of the Sahara—its climate, desert life, geology, history, and its individual regions—in fascinating style of language. The author is professor in the University of Algiers and he knows his Sahara. The book is illustrated and has a folding map of the desert. The mystery of the Sahara exists only for those who have *not* read this book.—$3.90 postpaid.—*A. G. I.*

ACROSS THE EDITOR'S DESK

THE year 1935 rounds out 90 years of service for the United States Naval Academy, at Annapolis, and for SCIENTIFIC AMERICAN—the birthday of the one having fallen in September and of the other in August. Both have reflected the genius of the American people, the pioneering, progressive, and peaceful spirit of the founders of the country; and, in their seemingly separate and distinct rôles, have often found their interests intertwined, identical. Both have always stood firmly for peace—for peace with honor; have striven for adequate means to meet any menace from within or without; and have fought all manner of ideologies that would undermine the very foundations of our scheme of government and substitute, instead, a system, or systems, tainted with foreign beliefs or hatreds. When radical thought has reared its ugly Gorgon's head, staunch American ideals have been maintained in the United States Naval Academy (in which our Navy finds constant renascence) and in SCIENTIFIC AMERICAN.

It is primarily because of this linkage and of the old naval tradition of this journal that this November, 1935, issue is devoted largely to a study of navies, our own in particular. (Odd how little the average American citizen knows about his Navy, and how little he cares! Odd, and tragic, too, if the United States should be attacked!) By virtue of our peculiar situation, as regards the world of science and industry—in both of which the Navy stands as preceptor and collaborator—it is the aim of this issue to present a many-sided picture of this vital arm of the National Defense in such a way as to show that it is not an abstract idea but, rather, a defender of the soil. From the wide variety of articles here collected, it is hoped that those inlanders who have never seen the oceans that surround us and to whom a battleship is but a pretty and expensive toy may gain a new understanding of the Navy's worth to them.

Japan, having built her navy nearest to Treaty strength—of all signatory nations—has abrogated all naval treaties. Britain later discarded them. First, however, she signed with Germany, without consultation with other powers, a treaty giving Germany the right to build up to 35 percent of Britain's strength. From this there follows a concatenation that seems destined to lead to disaster. France, angered at Britain's concession to Germany and, too, fearing her old enemy, determines to build a stronger navy. To counter France, Italy, already on the verge of an African war, will build a more powerful navy—is already building two 35,000-ton battleships! Soviet Russia, finding Germany again a menace to her security in the Baltic, embarks upon a larger building program on her western shores. She is able thus to pay less attention than formerly to Japan, with whom she has always been at loggerheads, in the east. The increasing navies of Europe bring home to Britain the hard fact that she must hold the bulk of her navy near home.

The sum of all this, so far as the United States is concerned, is that two important checks—Britain and Soviet Russia—on the imperialism of the Japanese militarists in Asia have been greatly weakened. This leaves for the United States a very touchy situation, the outcome of which is hard to predict. Delicate handling is indicated. But unless our diplomats are careful, all of our conciliation will be construed as weakness—as it has been often in the past. Our rôle must be one of friendliness but rigid firmness. Other nations do not understand our sophomoric idealism, and so long as we are governed in international affairs by the acts of misguided zealots, foreign peoples will continue to tease our complacency while continuing to do things their own way—witness the disastrous effects of our "disarmament by example."

This country has declared itself for a Treaty Navy. Not by the wildest flight of fancy does this mean a naval building competition; it simply means obtaining for ourselves the strength agreed upon by the naval powers, in solemn conference assembled, long after these others have attained Treaty strength—or most of it.

Let us, then, look upon our Navy in a new light and try to understand its mission to preserve peace and to command the respect of the world for our peaceful policies. We are not an aggressor nation, but we do have huge interests throughout the world; our Navy is our main assurance that these will not be burglarized.

COMING

"In Quest of the Perfect War Gas," by Captain Alden H. Waitt, U. S. Army

Dr. Charles Bache, on Some Prehistoric Burials

"Clues for the Color Blind," by Dr. Clennie Bailey

Developments in the Glass Industry, by Philip H. Smith

S. F. Aaron, on Misinterpreted Animal Observations

"The Mists of Madness," by Prof. George H. Estabrooks

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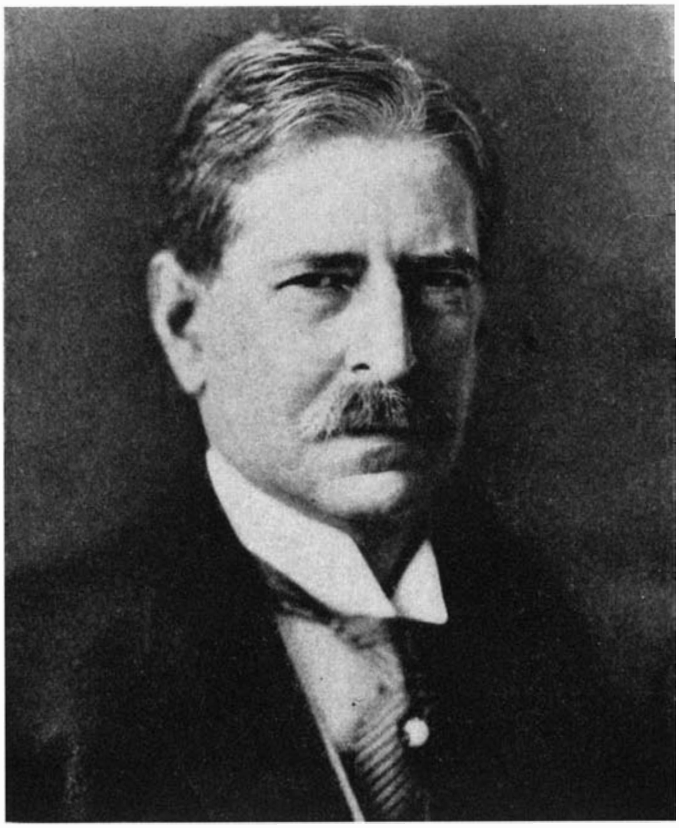
IN dedicating this issue to the Navy, we wish to express our appreciation for the splendid co-operation of the following who have helped make it a success: Secretary of the Navy Claude A. Swanson; Assistant Secretary of the Navy Henry L. Roosevelt; Admiral W. H. Standley; Captain W. D. Puleston, U.S.N. (our contributing editor); Captain Jonas H. Ingram, U.S.N.; Captain P. N. L. Bellinger, U.S.N.; Lieutenant W. B. Ammon, U.S.N.; and Dr. Oscar Parkes, London.

Editor and Publisher

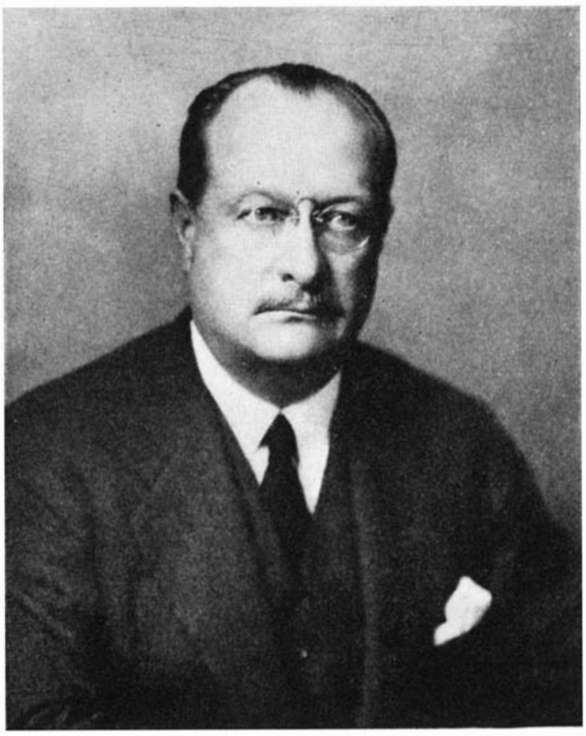


The U. S. Naval Academy

90 YEARS OF SERVICE

Scientific American

SECRETARY of the Navy Claude A. Swanson: To celebrate jointly the 90th anniversary of two American institutions that have contributed so much to the scientific development of our country is peculiarly appropriate. As Secretary of the Navy I am privileged, on behalf of the Navy, to felicitate our civilian scientific colleagues, and to express the assured hope that the Navy and their fellow scientists in private life will continue their scientific progress side by side and to the increased benefit of our whole national life.



ASSISTANT Secretary of the Navy H. L. Roosevelt: It is a pleasing coincidence which couples the career of the United States Naval Academy with the career of SCIENTIFIC AMERICAN. Both emerged, 90 years ago, from small beginnings. The Naval Academy has become the repository of 160 years of naval experience and tradition, in the light of which we train our successive generations of sea officers. SCIENTIFIC AMERICAN contributes to a similar, and in a sense, a more catholic function. In these days of precise machinery. the SCIENTIFIC AMERICAN is a kindred medium for the advancement of knowledge, as this navy issue most amply demonstrates.

ADMIRAL W. H. Standley, Chief of Naval Operations: That science has been the hand-maiden of the Navy during the past 90 years is largely due to the wise foresight of Secretary of the Navy George Bancroft in founding the United States Naval Academy in 1845. Then we had but two reliable sea-going steamers which were considered as merely auxiliary to a Navy of sailing ships. The advances which have meantime transposed our floating forces into marvels of applied science are in great part a product of Naval Academy education combined with practical experience afloat.

THE "CRADLE OF THE NAVY" ON THE SEVERN RIVER

"HE should be the soul of tact, patience, justice, firmness, and charity." John Paul Jones pronounced this dictum as his opinion of the necessary attainments of the naval officer. To this, and others equally sententious by our naval hero, the United States Naval Academy has rigidly adhered for 90 years. From a small beginning in 1845, this institution has grown into this splendid group.

15 YEARS OF NAVAL DEVELOPMENT

Momentous Post-War, Post-Treaty Period . . . Great Advances in Design, Construction, and Personnel Training . . . Science in the Navy

By CAPTAIN JONAS H. INGRAM, U. S. N.

NO similar period in our history, since the advent of steam, has contributed more to the scientific and technical development of our Navy than the past 15 years.

The lessons learned from the World War provided the basis for new ideas and experimentation along varied lines. The composition of our fleet itself was influenced by the practical experiences of war and later by the terms of the Washington Naval Limitation of Arms Treaty in 1921.

Prior to the World War our Navy consisted chiefly of capital ships, some antiquated cruisers, a few destroyers and submarines, and a handful of naval auxiliaries. Naval aviation was in its infancy.

War, with its inevitable increase of naval appropriations, enabled the Navy Department to plan for a balanced fleet of all types as had been the urgent recommendations of the General Board of the Navy for several years.

The organization of the Naval Establishment provides for technical experts, in design and practice, to work out the many scientific details necessary for the development, experimentation, and construction of effective men-of-war,

The officer personnel of the Navy is made up of men who have dedicated their lives to the naval service, the great percentage of whom are graduates of the United States Naval Academy at Annapolis. Many of these graduates are later recalled for a post-graduate course at the Academy and still later sent to such technical schools as Massachusetts Institute of Technology, Columbia, Harvard, for further instruction.

These men have had the advantage of advanced education, travel, contacts abroad, opportunity to see what other nations have, and above all, the deep interest instilled by love of a profession that demands going to sea and operating the ships they may be called upon to fight. In this manner the opportunity is afforded to observe at close range the need for improved methods and the live desire not merely to keep abreast of the times but to set the pace.

The very best example of the professional alertness of the naval officer is his interest in naval aviation. The whole Navy is emphatically air-minded. While only a small percentage of the total number are pilots, every target practice, scouting problem, or grand fleet maneuver has brought home to everyone the possibilities and advantages of a su-

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These are the personal views of the writer and in no way express the official views of the Navy Department.

perior air force. As a consequence, the whole Navy is deeply interested in the design, operation, and tactics of aircraft.

The same interest is apparent in all branches of the profession. While the naval constructor is the designer of ships and responsible for their plans and construction, the line officer is keenly interested and always ready to give practical suggestions for the best possible product. The same interest is evidenced in the engineering, ordnance, navigation, communication, supply, and medical branches. This interest and co-operation between the technical and operative branches of the Navy have been conducive to intelligent co-ordination and productive of most gratifying results.

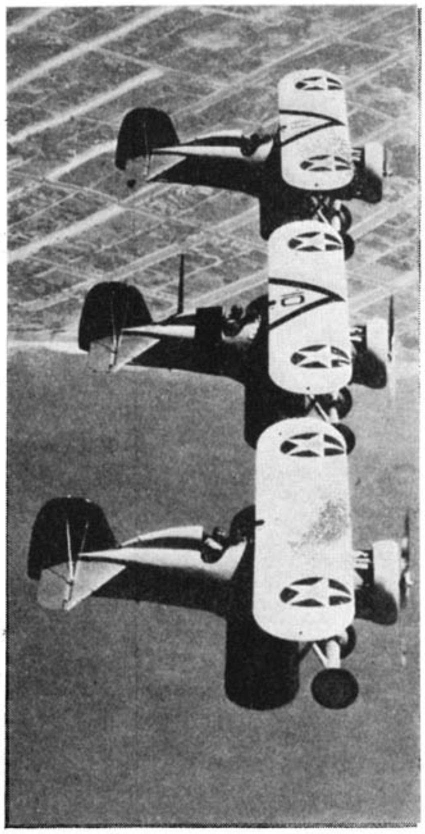
The Navy is not a Federal bureaucracy inhibited by red tape and lacking in initiative, but, on the contrary, is a live and going organization. It is the result of a gradual evolution of a system over a long period of years, imbued with ideals and traditions of public service, and inspired by the stimulus of selection and promotion on merit.

IN reviewing naval development over a specified period, one naturally turns to the evolution in design, the reasons for types, and the causes for subsequent changes.

The German submarine menace was responsible for the design and rapid building of our "flush deck" destroyers, a seaworthy and effective type, superior in fighting characteristics to their "opposite members" in foreign navies. While this gave us a preponderance of destroyer tonnage at the time, it presented later a serious disadvantage in that they all became over-age by 1933, and in the meantime this important category had been completely neglected in new construction. The recent building program has, however, brought forth a new type that merits much praise. These new craft embody many new features of unusual construction. Armed with five 5-inch double-duty guns, mounted on the center line, that can be used either as anti-aircraft batteries or for horizontal firing against surface vessels, and having two quadruple torpedo tubes on a center line capable of firing to either side, this type of vessel represents a formidable fighting unit. Together with their high speed and efficient depth charge firing device, these new destroyers will command a wholesome respect from enemy submarine craft. (See SCIENTIFIC AMERICAN, September, 1935.—*Ed.*)

The greatest improvement in design has been evidenced in the new ideas incorporated in the capital ships and in the development of the new 10,000-ton, so-called "treaty cruisers."

The war accentuated the dangers of the submarine and mine menace and



"The whole Navy is air-minded"

much experimentation was made on the effect and scope of torpedo and mine explosions. This was accomplished by noting the effect of high explosives on caissons built similar to under-water sections of large ships. As a result of these experiments came intricate underwater compartmentation, air spaces, and double bottoms filled with oil. The combination is as nearly impervious to severe shocks as possible, and tends to localize injury. With the advent of the aerial bomb came the "blister," which is an additional compartmentation outside the outer skin of a vessel and capable of being flooded with sea-water and then pumped dry, giving the additional advantage of keeping a ship on an even keel after sustaining damage. It thus insures an even platform for continued gun fire and prevents loss of stability.

High-angle gun fire and aerial bombs necessitated heavily armored decks in addition to side armor.

The new menace from the air demanded additional defensive strength in anti-aircraft batteries of intermediate caliber and high-angle guns and new, heavy caliber machine guns. The necessity for planes on ships other than plane carriers was responsible for the catapult which literally fires a plane off a ship, giving it a momentum of 60 miles an hour over a space of 60 feet. Stowage space for from three to four planes had to be provided on each ship with efficient means for picking them up at sea under normal conditions or in considerable seaway.

This ready adaptation to new offensive measures was so effective that the battleship continues to be the backbone of the fleet—the toughest ship made, able to give and take more punishment for a longer period than any other type yet projected. (See "Why the Battleship?" by Commander Jonas H. Ingram, July and August, 1934, SCIENTIFIC AMERICAN.—*Ed.*)

The prestige of the battleship has been maintained, not by building new ships—this being contrary to Treaty provisions—but by the modernization of our ships. This work has, in some cases, been so extensive as to include new engines, new boilers, increased elevation of main battery guns, additional deck armor, blisters, re-compartmentation, anti-aircraft batteries, and substitution of the tripod mast for the conventional cage mast, characteristic until recently of American battleships. This last modification was necessitated by the added weight of fire control installation and equipment that were added to the fighting tops. Oil burning and stowage of fuel oil made a major problem in the conversion of some of the older ships. (See also "Modernizing the U. S. S. *Mississippi*," by Captain W. D. Puleston, June, 1934, SCIENTIFIC AMERICAN.—*Ed.*)

The Cruiser. The new 8-inch, 10,000-ton cruisers gave the naval constructor a new field to exploit and a fast, moderately armored, heavily armed ship resulted. In it are embodied all the latest modes of offensive and defensive characteristics. These ships are really the last word in American warship construction and have probably attained the limit of combat strength that their restricted tonnage will permit.

T*HE Plane Carriers*. A plane carrier is essentially a portable aviation field with the attending stowage and repair facilities. It must be capable of high speeds and long cruising radius and, at the same time, have deck space ample to provide take-off and landing area for her planes. It must be large enough to accomplish this under trying weather conditions at sea, and, of course, be capable of carrying a number of planes, fuel, equipment, and spare parts.

Our first two large carriers, the *Lexington* and *Saratoga*, were originally laid down as battle cruisers but due to the Treaty of 1921 were converted into plane carriers. The limited total tonnage for plane carriers made it imperative to spread the allowance over more ships and the recent policy has restricted the size of carriers to 20,000 tons.

The constructor has kept apace of the time not only in ship design but also in the advancement of scientific construction. Extensive experimentation was made in the structural strength of materials and in details of construction to insure stronger and more efficient structures.

In ship design, from the time the first line is drawn, it is largely a question of compromise as to weight, which includes not only the hull itself, but armor, machinery, armament, fuel capacity, equipage, and the necessary quarters for the accommodation and contentment of personnel.

Research work and experiments have been made in metallurgy with astounding results. Lighter metals have been used as a substitute for steel in many places with a corresponding saving in weights. Considerable improvement has been made in steel and in armor plate. Outstanding, however, have been the results attained from the exhaustive tests on the many phases of electric welding. This scientific development of metal working has practically made the use of rivets obsolete in warship construction, with many attendant advantages.

Some other interesting products of research and tests are: Strength of hull plating in compression; Strength of submarine hulls; Studies of ship vibration; Behavior of corrosion resisting steel in gasoline tanks and in salt-water piping; Extensive revisions of specifications for various types of steel in order that air hardening and resultant brittleness, following welding, might be kept within acceptable limits for ship construction; Development of insulating materials; Perfection of effective anti-fouling paint for ships' bottoms; Development of special type of glass for airport lenses, resulting in marked savings in weight; Completion with refinements in the design of submarine escape apparatus, the "lung"; The progressive development of the underwater design of hulls to avoid resistance by exhaustive tests of models in the model tank at the Washington Navy Yard.

NAVAL aviation first received official recognition in September, 1908. The following 13 years were largely experimental in character though great strides were made during the period of the war and immediately afterwards. It was not until September, 1921, that the formation of the Bureau of Aeronautics was authorized by the President of the United States and Rear Admiral W. A. Moffett, U.S.N., was appointed Chief of that Bureau.

The first turn-table catapult was constructed and installed on the U. S. S. *Maryland* in 1921. Three additional catapults of this type were ordered after the *Maryland* tests, and before these were completed an order for 20 more was placed. Today each battleship and cruiser in the United States Navy carries its complement of aircraft, with planes always ready to be launched from modern, efficient catapults.

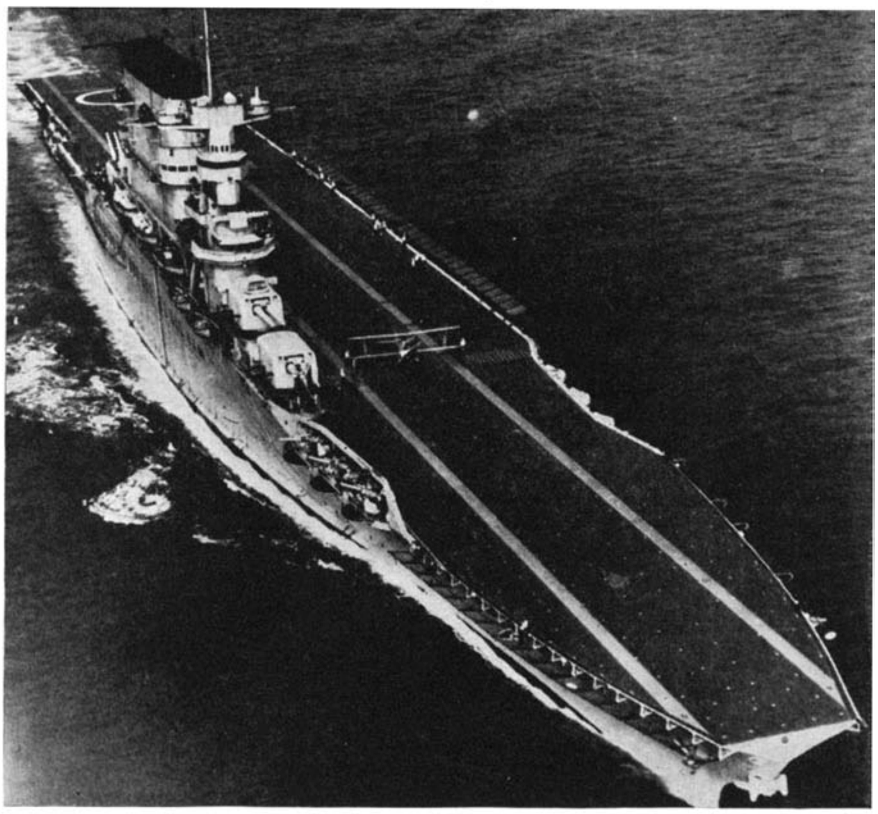
One of the most important post-war achievements was the development of the air-cooled airplane engine. (See "Industry and the Navy," in this issue. —*Ed.*) This power plant, lighter than the water-cooled type, gives much better performance and eliminates the possibility of forced landings due to broken water connections, radiator leaks, and defective water pumps. Air-cooled power plants ranging from 200 to 500 horsepower are now standard in the Navy and are installed in every service type of plane in operation. Another noteworthy advance was the substitution of metal alloys for wood construction. Metal is lighter, stronger, and does not deteriorate so quickly.

During 1928, there were five types of planes in use in the Navy, namely; fighting, observation, torpedo, patrol, and training. Each had its specific duty to perform and was designed especially for that duty. In this connection it should be borne in mind that features of design for Navy planes differ radically from those applied to military and commercial aircraft. Large patrol flying boats are often called upon to land and take off in heavy seas, hence they must be of very rigid construction. Fighting, observation, and torpedo planes are carried aboard ships and are subject to the additional strains of being catapulted and landing into arresting gear. Consequently, they must be of sufficiently rigid construction to withstand being operated in this manner.

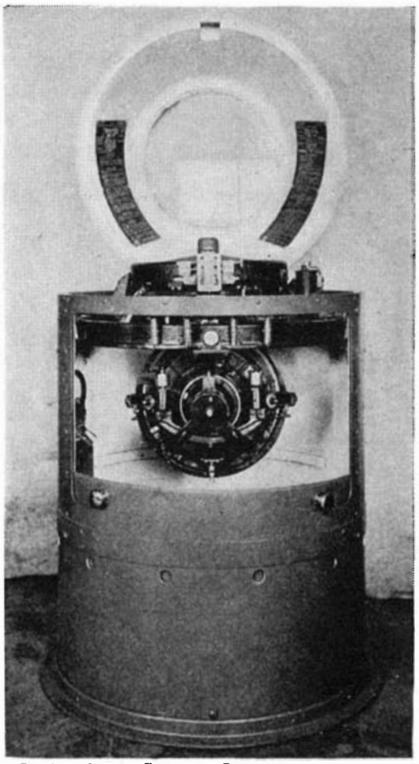
The year 1929 saw the Navy's Five-Year Building Program, as authorized by Act of Congress and approved June 24, 1926, well under way. The progress made during the year in naval aviation continued to demonstrate the wisdom and soundness of the program, since the Navy had on hand or in production aircraft suitable for carrying out any mission which the forces afloat might be called on to accomplish.

THE year 1929 opened with the Fleet's annual cruise in southern waters, participated in for the first time by the two carriers, *Saratoga* and *Lexington.* Together with the battleship and cruiser planes, the carrier planes demonstrated every possible form of offense against surface craft and shore bases. Torpedo planes delivered attacks through smoke screens; fighting planes delivered attacks on surface vessels and shore stations; while radio-equipped observation planes kept the ships constantly informed of all phases of the "war." A night air raid, sent out by one of the carriers while she was yet 150 miles off the coast of Panama, theoretically destroyed the locks. A total of 247 planes took part in the maneuvers and flew 4397 hours over nearly half a million miles in every kind of weather and under varying conditions, without a single serious accident.

Operations during the year showed conclusively the immense value of aircraft carriers, and the authorization of an additional carrier by Congress showed clearly their appreciation of this fact.



U. S. S. *Lexington*—one of the nests of the sea hawks



Courtesy Sperry Gyroscope Company

The Gyro-Compass has successfully passed severe tests by the Navy

Due to the increased reliability and length of life of the American aircraft engine and its marked advancement, the Navy Department was enabled to limit its purchase of spare engines to 50 percent—a distinct economy.

Fast two-seater fighters with retractable landing gears were developed and assigned to the Fleet, and the development of tactics for this type of combat plane was vigorously carried out.

The two-row radial air-cooled engine reached the stage where it could be relied upon as a satisfactory service type power plant.

Fourteen Navy and Marine Corps flyers were saved by emergency parachute jumps during the year, continuing the record of naval aviation of no one having lost his life due to failure of the parachute to function.

The most important event of the fiscal year 1934, looking toward the continued operating efficiency and future expansion of naval aviation, was the passage of the Vinson-Trammell Naval Bill. This legislation authorized the construction of the Navy to Treaty strength in surface ships and the necessary number of aircraft commensurate therewith. The previous aircraft building program, which was enacted in 1926, provided airplanes (1000) only for a Navy of the strength existing in that year. Hence, since 1926 until the passage of the Vinson-Trammell Bill the Navy operated under that 1000-plane limitation.

It was estimated by the Navy Department that a total of approximately 2000 airplanes would be required to equip the existing Navy, the six cruisers, and two aircraft carriers in 1934, and the ships to be built under the Vinson-Trammell Bill, together with necessary tender-based, long-range patrol, bombing squadrons, and other activities. In order to insure the proper and timely supply of airplanes, a five- to seven-year Aircraft Building Program was laid down which provided for the completion of a certain percentage of planes each year.

In September, 1933, a squadron of patrol planes (P2Y-1) flew from Norfolk, Virginia, to Coco Solo, Canal Zone, a distance of over 2059 statute miles—the longest formation flight on record at that time.

Another incident which clearly exemplified the high state of efficiency which had been attained was the flight of a squadron of patrol planes (P2Y-1) from Norfolk to Coco Solo, thence to Acapulco, Mexico, San Diego, California, San Francisco, California, and thence to Pearl Harbor, Hawaii. The last leg of the flight, made in January, 1934, was 2309 statute miles and was flown non-stop and in formation in 24 hours, 45 minutes, thus setting a new record.

On April 9, 1934, the Fleet, consisting of 110 ships, left the West Coast for the East Coast via the Panama Canal, the transit of which was commenced on April 23 and was completed in 47 hours. During the trip between coasts, and while engaging in maneuvers, the airplanes of the *Saratoga*, *Lexington*, and *Langley* flew approximately 1,500,000 miles without a single actual casualty.

IN engineering, the American Navy has long been a pioneer, having contributed extensively to this field in design, efficient operation, upkeep, and scientific development. The work of the naval engineer is well known to the profession as he has been closely identified with engineering development since the days of the single-cylinder, simple horizontal engine, operating on 40 pounds of steam pressure supplied from the rectangular type of boiler, to the formidable, high-powered plants of today. The engineering plants of our modern capital ships are illustrative and typical of the remarkable program of the past 15 years in Naval engineering development.

Since 1920, the following battleships have been completed:

Tennessee	(1920)
Maryland	(1921)
California	(1921)
Colorado	(1923)
West Virginia	(1923)

All of these were of the so-called "electric drive" type having electric reduction between turbines and propeller shafts. All of these had steam pressures

IMPORTANT NAVY ACHIEVEMENTS

Centrifugal condensate pumps and air ejectors have replaced main air pumps.

Centrifugal pumps have been adopted for water service having submerged suction.

Positive displacement rotary pumps are used for fuel oil.

Direct-drive centrifugal blowers have been superseded by direct-drive propeller type and geared centrifugal type.

Service air compressors have been changed to the geared turbine or motor-driven two-stage types. High pressure air compressors have been changed from reciprocating to turbine drive.

Whistles have been changed from the bell to the diaphragm type.

Improvement has been made in condensers which now operate at higher rates of heat transfer with better disposition of transfer surface and lower condensate pressure.

Evaporators have increased in capacity and simplicity; the high pressure type has disappeared from service.

Mechanical pressure atomization of fuel oil has remained in use. The capacity and overall efficiency of burning oil have been increased through refinements in the atomizer and register design.

Lubricating oils have been reclassified and a work factor method of evaluation adopted. The work factor and other tests have been revised upward to more than double the quality.

Packings have been improved and developed to increase their endurance life from 1500 hours to about 6000 hours.

The tests for refractories have been revised to eliminate all but the highest quality commercial No. 1.

Until 1925, magnesia was used for heat insulation for practically all purposes. Since then, improved high-temperature insulations have been developed and adopted.

Chromium-steel for turbine blading has given a material highly resistant to steam erosion, shock, and fatigue.

Steels containing molybdenum have been adopted for high temperature use up to 850 degrees Fahrenheit.

High chromium-steel alloys have been used to resist scaling at high temperatures in boilers and superheaters.

Silicon-bronzes have been developed as substitutes for bronzes containing tin and zinc. These are weldable.

The development of new silver solder has permitted the adoption of new designs of streamline fittings and the use of thinner tubing.

The quality of Monel metal has been improved, resulting in the production of better castings and permit-

OF INDUSTRIAL SIGNIFICANCE

ting its fabrication by electric welding.

The use of the 18-8 type of corrosion-resisting steel for boiler burner sprayer plates has resulted in elimination of breakage and reduction of erosion.

The use of metal spray has been found satisfactory for restoring worn parts in certain applications.

A cobalt-chromium-tungsten alloy has been developed for application by gas welding to surfaces of valve disks, valve seats, and other surfaces subjected to steam erosion and frictional wear.

Aluminum alloys resistant to corrosion, especially of the inter-granular type, have permitted their substitution for heavier metals both in cast and wrought forms.

Improved methods of fabricating copper-nickel tubing have resulted in tubes more free from mechanical defects and permitting their use as condenser tubing. Tests indicate the copper-nickel tube to have a service life at least twice that expected from admiralty tubing and to permit higher water velocities without injury.

Free machining, corrosion-resisting steel is suitable for threaded parts such as valve stems, bolts, and nuts.

The use of beryllium as a hardening agent has been found an improvement where the metal so hardened is subjected to vibration such as in diaphragms of signal horns.

The use of seamless, forged, boiler drums has permitted the adoption of higher steam pressures. Since the development of electric welding and the non-destructive examinations by X-ray and gamma ray, the welded boiler drums have superseded the seamless forged drums.

The use of X-ray and gamma-ray examination for important steel castings has increased the reliability of these castings.

Turbine efficiencies have been increased by use of higher speeds permitted by the development of double reduction gears.

The development and adoption of economizers, air pre-heaters, and enclosed feed systems have improved boiler efficiency and life.

Ball bearings have been more generally used in restricted applications to reduce friction.

The development of welded union end pipe fittings in small sizes and the extension of welded pipe joints have served to reduce weight.

The above items will serve to give a general idea of the progress that has been made to date in marine engineering. Needless to say, such a summary must be very incomplete and sketchy for the reason that practically every part of the engineering plant and the materials used therein are constantly undergoing changes and improvements that would be impossible to cover fully in a brief listing such as this.

of 300 pounds or over and a superheat not exceeding 75°, Fahrenheit. Large tube, B.&W. oil-burning boilers were used. The modernization of the *Texas* and *New York* did not change the main engines but changed the boilers to the Dyson type with superheater. The modernization of the *New Mexico* changed the main engines to turbine drive and changed the boilers to the small tube, express type.

In 1922, the *Langley* was commissioned as the first airplane carrier. This ship was originally the *Jupiter* on which the first electric reduction was installed experimentally and retained. The airplane carriers *Lexington* and *Saratoga* were converted from the partially built battle cruisers. These vessels are electrically driven and each has 180,000 designed engine horsepower. The development of electric drive probably reached its peak in these vessels.

All recent heavy and light cruisers and destroyers have geared turbine drive.

The Diesel engines on submarines have been constantly improved to obtain increased power, ruggedness, reliability, and efficiency. Airless (solid) injection engines are the latest type developed for these vessels.

Refinement in turbine design has resulted in safe operation at high speeds with a consequent reduction in weight. Illustrative of this are the ship's service generators. A 300 kilowatt turbo-generator purchased in 1920 weighed 23,000 pounds. During 1933 a 400 kilowatt set was purchased which weighed 24,075 pounds.

During the last few years, the use of alternating current instead of direct current for ship's lighting and power has been generally adopted. This has resulted in greater reliability due to the squirrel cage induction motors and consequent freedom from commutator troubles; simplification of motor control equipment; and greater flexibility in a system which permits the generation and distribution of current at a higher voltage, thus saving considerable copper and yet permitting utilization of the energy at different voltages (through transformers) for the various power applications.

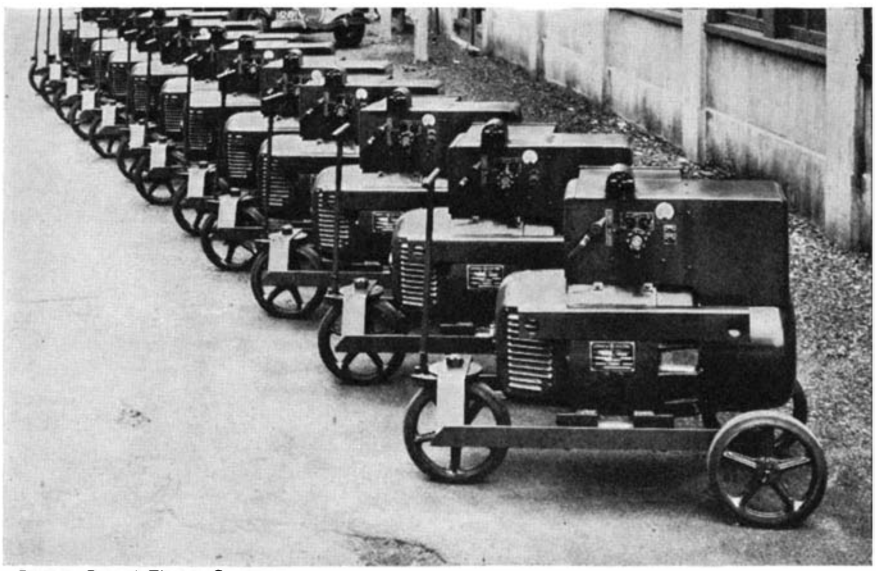
Saving of weight has been an important accomplishment in marine engineering without sacrificing reliability and ruggedness. Many parts, such as electrical fittings, instruments, gage cases, and thermometers, which were formerly made of heavier metals, were first changed to an aluminum alloy of about one third the weight. Later these parts were changed to molded phenolic material with a weight only half that of aluminum. Development has also decreased the weight without loss and, in some cases, made a gain in efficiency in structural parts, refractories, and heat insulation.

The first heat- and flame-resistant electric cables were installed in 1929. The development of these cables has been continuous. Aside from the greater reliability of these cables in abnormally heated spaces, the higher load ratings permitted result in a further saving of weight by the saving in copper.

During the last 15 years the developments listed in the accompanying tabulation, among others, have been made in the auxiliary machinery.

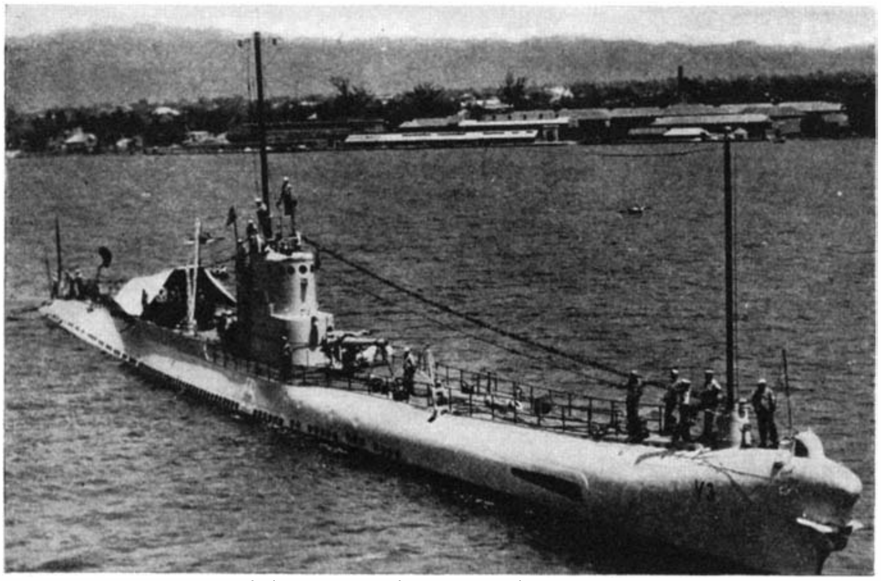
DURING this same period, the Navy has been constantly in the forefront of communication development. It has contributed to the development in many ways, but principally through the drawing of specifications and the purchase of material which have made practicable the production of improved devices.

Within 15 years, obsolete spark and



Courtesy General Electric Company

A group of electric arc-welding units developed for the Navy



One of the Navy's submarines—the U. S. S. *Bonita*

arc radio transmitters have been replaced with vacuum tube transmitters. Radio receivers have been developed to provide the greatest practicable sensitivity and selectivity. The behavior of high frequencies (short waves) has been thoroughly explored, the laws have been derived, and a whole new section of the radio spectrum has been opened to practical use. The Navy has applied these frequencies to long-distance communication. Stabilization of frequency adjustment of radio transmitters has been achieved through development of quartz crystals. Radio direction finders have been developed from the crude devices of the war period to reliable instruments and they have been applied to navigational purposes as well as to the recording of electrical disturbances for tracing the path of storms. Automatic high-speed radio transmission and reception have been developed on a practical basis. Radio photography has been developed and put to practical use, as, for example, in sending weather maps. Multiplexing, or simultaneous transmission and reception, on several radio circuits has been perfected and has been applied, not only on shore, but in vessels. Depth finders or indicators have been perfected and ocean bottom contours are being determined by soundings taken from rapidly moving vessels.

The time signal service has been improved and expanded. Six standard time signals are broadcast daily from the Naval Observatory in Washington through Arlington and Annapolis and are re-broadcast by Mare Island, California, and Honolulu, T. H., with an extremely low average error. The service of weather and hydrographic broadcasts has been improved and extended. Eighty-eight bulletins are broadcast through 39 stations. The direction-finder service along the coasts and at harbor entrances furnishes a quarter of a million bearings annually to ships and aircraft. The naval communication service handles messages for all departments and agencies of the government, effecting savings in commercial charges of over three quarters of a million dollars annually.

Naval officers have played a leading part in all national and international communication affairs. The first chairman of the Federal Radio Commission was a naval officer and a naval officer was furnished as their first technical advisor. The Navy has assisted in representing the nation at each of the dozen or more international conferences held on communications since the World War. The Navy has assisted at all national conferences on communications and has materially assisted in formulating the present frequency allocation.

A volunteer naval communication reserve has been organized, with a membership of 700 officers and 3900 men, throughout the country. About two hours per week are devoted to drills from 32 Navy-owned control stations and about 2000 privately-owned amateur stations. A very complete organization for communication in emergencies and disasters is maintained and has been used most effectively on several occasions.

FLEET Tactics should be so designed as to take the maximum advantage of every naval characteristic of the Fleet as a whole and of its separate units in order that the Fleet may be able to utilize its every ounce of offensive or defensive power to advantage when it is called upon to use force.

Up to the time of the World War, our Fleet was making a slow but steady growth. The major effort was to build battleships and to train personnel. The growth of the Fleet and resulting expansion in the allowed personnel required that the maximum training effort be in fundamentals. The result was that training in Fleet Tactics was limited in scope.

The mission of our Navy during the World War was to provide troops and supplies with safe conduct through "submarine zones," to combat the submarine menace, and to augment the British Grand Fleet with battleships.

The close of the World War found our Navy with a large number of battleships (some being beyond a useful age) and destroyers, and with a building program under way which, had it been completed, would have made our Navy the strongest in the world, especially in battleships and destroyers. Our officers were rapidly digesting the naval lessons of the war and applying these lessons to our Fleet. One of these lessons was that aircraft had come to stay and was a very important auxiliary to any Fleet. Fleet Tactics, designed to fit our existing Fleet and ships building, were beginning to take shape. Demobilization was under way, and the importance of training the individual and the single unit of the Fleet gave way to training the Fleet as a Fleet.

Then came the Washington Disarmament Conference and our actual superiority in battleships over other World Powers gave way to equality. This brought our naval tacticians face to face with a new problem. The battleship is, and has been, the backbone of the Fleet. In this type of ship we were at maximum strength allowed by the Treaty; we had a large number of destroyers, many of them being of wartime construction; experimentation had demonstrated the importance of having aircraft with the Fleet and airplane carriers to carry them there; we had few cruisers and no one knew just what kind of vessel the newly proposed 10,000-ton 8-inch-gun cruiser would be. The problem was to revise our tactics to meet the situation and to look forward to applying our tactics to a well-balanced Fleet, when we might get one.

The fundamental historical principles of Naval Tactics are still sound, but the application of these principles to the Fleet of the present day is a task which is unending. Therefore, the development of our Fleet Tactics to meet existing conditions and to meet probable new naval developments is one of the major naval achievements since the World War.

As long as we are not a seafaring nation, we must continue the individual training of raw personnel. This training is for the most part to produce a highly skilled personnel. Scientific naval developments demand this, but along with the training of new personnel the advanced training of the older personnel must go forward in order that our Fleet as a whole may be ready to carry out its mission.

OUR POINT OF VIEW

A Worker is Worthy . . .

"I AM not so sure I shall bother to submit a bid for any more Navy business. Why should I? After doing the research necessary to meet their rigid specifications, all I can get out of it is a 10 percent profit. I stand the great cost of the research and show a net loss on the deal. It's not even a good gamble for companies such as ours that most often must develop each product sold to the Navy under each new contract."

Thus spoke the president of one firm that for years had been making an outstanding and vital product for naval vessels. In many other firms the editors found the same feeling existing in regard to section 3b of the Vinson Act which was approved March 27, 1934. Under it, as the statement of the manufacturer mentioned above indicates, the contracting company is required "To pay into the Treasury profit . . . in excess of 10 per centum of the total contract price, such amount to become the property of the United States . . ."

Why both the Navy and private industry should have been saddled with this handicap we do not know. The Army has no such provision, nor has the Coast Guard or any other Government service. Thus, in the first place, it is discriminatory. More important is the fact that it discourages simplification of existing equipment and materials and the development of new devices to make the Navy a more efficient unit. Initiative has no incentive when hope of a possible reward is so small. We say *possible* because it is public knowledge that not all development work—sometimes costing hundreds of thousands—results in a product that is satisfactory. Indeed, there is too often a net loss in companies having one success and several failures. Yet purveyors to the Navy must take that chance if they expect to meet the very rigid demands of the Navy specifications. The profit limitation, therefore, can not but retard naval progress at a time when, because of naval treaties, we must pack every possible ounce of power and efficiency in the tonnage we can build under those treaties.

For special equipment, and instruments in particular, the Navy is often the sole or main customer. Consideration of these facts has prompted proposal of an amendment to the Act to exclude instrument makers from the 10 percent limitation of Section 3b. A prominent executive, president of a company whose instruments are vital to the Navy, who was questioned at great length before the House committee on Naval Affairs regarding this proposed amendment, reports that the Committee gave him a fair hearing and reported favorably on the amendment. "My experience before the Committee," he says, "shows me how responsive the legislative branch of our Government is to the needs of business provided business has the intelligence to present its views intelligently." The bill has passed the House and will be taken up by the Senate early in the next session of Congress.

It should be passed by all means; otherwise the Navy's efficiency will suffer sorely. "This pursuit of every possible opportunity for adding to the effectiveness of the national defense as well as other scientific applications," the executive told the Committee, "cannot continue unless the inventors, the engineers, and the organizations engaged in this kind of work have the hope, at least, of a sufficient compensation for their successful inventions to outweigh the losses on their inevitable and unavoidable failures." Progress depends on the creative mind. The man of creative mind is adventurous. To the adventurous, the offer of a doubtful reward, such as the 10 percent on an unknown cost allowance, is really no reward and amounts to a complete withdrawal of all incentive.

Conservation Gains

ONE of the main reasons for the alarming decline of wildlife in the United States—a subject frequently discussed in these pages—is the lack of organization on the part of sportsmen. There are millions of individuals interested in fish and game, yet there is no articulate voice to speak for them. There is ample material for the building of a powerful machine, but no guiding spirit for its assembly and subsequent operation.

Now, however, there appears a light in the cloudy picture of conservation. Jay N. ("Ding") Darling, well known for his two years of work as the Chief of the Bureau of Biological Survey, appears as one of the guiding spirits of the American Wildlife Institute. Associated with the group are such nationally known figures as Walter P. Chrysler, Thomas H. Beck, Powel Crosley, Jr., and others. The function of this organization is to influence and guide the existing but inarticulate sentiment for the preservation of wildlife, to the end that the sportsmen and other interested parties may coordinate their efforts and bring to bear their massed force to carry out well-considered programs of conservation. An auspicious start has been made: There is every indication of well-merited success.

The Unforeseen

BRITAIN awoke to the fact, one day quite recently, that she had been checkmated in the Mediterranean. As part of Italy's long-view strategy, that country's military chiefs had worked out in 1930 a plan for nullifying the military value of Malta, a British island base situated between Sicily and the African coast. Apparently Britain had not suspected such a plan until it came to light in the Anglo-Italian crisis over the Ethiopian problem. In England, the news of this plan, coupled with the antagonism of the Italian press, caused consternation. "Why haven't we built enough ships to command such a situation?" the people wanted to know. "What is wrong with our Navy?" "Can Gibraltar and Suez maintain our hold on the Mediterranean?" "Why has the Admiralty been so short-sighted?"

Here was an unforeseen situation calling for a great deal of diplomatic squirming and military maneuvering. As this is being written, no untoward incident has resulted, but it is conceivable now that some slight spark may yet start the flames of war in the Mediterranean. That would, indeed, be no less regrettable than disastrous; and it is earnestly hoped that the whole matter may be settled on a friendly basis to the entire satisfaction of all.

Nevertheless, there is a moral. Had Britain been unquestionably supreme on the seas, there may have been no threat, and her admonitions may have assured peace. But, according to Britishers, she has permitted her navy to become weakened, and the voice she raises in the cause of international peace correspondingly puny.

Often in human affairs it is the unforeseen that must be guarded against; *always* is this so in international jockeying for military position. "In times of peace prepare for war" is a truism to which, in urging continued support of our American naval building program, this journal conditionally subscribes. We would modify it to read: "In time of peace: prepare to keep out of war!"

THE PROBLEM OF THE

Pacific Naval Problems Have Their Foundations in the History of International Meddling and Muddling . . . A Way Out

By ORSON D. MUNN

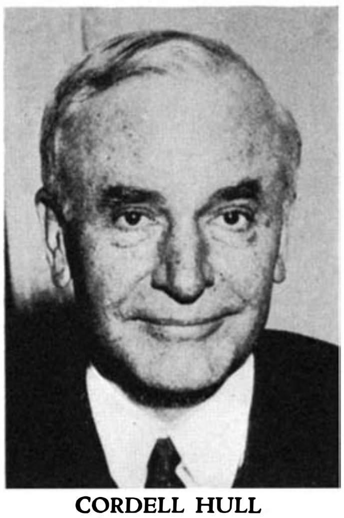
CHINA'S WEAKNESS. The military weakness of China is the basic cause of the present chaotic situation in the Far East. The helplessness of China is no new condition. Throughout the 19th Century, China was bullied in turn by all the great European powers. Unable to offer any effective military resistance, China was obliged to engage in the very dangerous policy of playing off one European power against another, and when this policy failed she resorted to diplomatic delays and evasions in complying with treaties wrung from her by force. In addition to these peaceful measures, China made one desperate but ineffective resort to arms, the Boxer outbreak of 1900, which was speedily crushed by a foreign coalition. Since that defeat, China has not dared to oppose any Great Power forcibly. She has, however, at various times employed the commercial boycott with extraordinary success.

JAPAN'S STRENGTH. In startling contrast to China's military weakness has been the rapid military development of Japan, who has assimilated the military methods of Europe with almost miraculous swiftness. Japan had military traditions to build upon, and her leaders were wise enough to secure German officers to instruct her army and British officers to train her navy in the modern military science and art.

By this rapid transformation of her military system, Japan alone of all the Asiatic powers succeeded in preserving her entire independence and the freedom to develop her national life without foreign interference. Probably never in the world's history have two neighboring States presented such a sharp contrast, and those advocates of national disarmament as a possible road to peace should consider the recent and present condition of these two ancient Asiatic peoples.

INTERESTS OF OTHER POWERS—RUSSIA. Russia is at once a powerful European and Asian state. Under the Emperors her slow glacial-like expansion excited the fears of Europe and Asia. The European powers were unable to prevent her expansion in the Far East, but modernized Japan in a series of victories on land and sea in 1904-5 defeated the armies and fleets of the previously dreaded Eurasian colossus and halted the advance of the Czars in the Far East.

GREAT BRITAIN. The interest of Great Britain in the Far East is of long standing. She has established herself at Hong Kong, and spread into the Yangtze valley which in due course was generally recognized in Europe as a British "sphere of influence." In the last quarter of the 19th Century the main British problem was to guard against the rapid advance of Russia. She was able to hold her own with the Czars. But the rapid growth of the German nation and navy forced her to ally herself with Japan in order that she might prepare to hold the North Sea against the German naval menace. Japan freed Great Britain of the Russian menace, but Japan's success against Russia also relieved Germany of the threat to her eastern frontiers by the Russian army. This, in turn, enabled Germany to devote more money to her navy, so that in the end Britain probably lost much more than she gained by the victory of Japan over Russia.


CORDELL HULL


SIR SAMUEL HOARE

The solution is in their hands

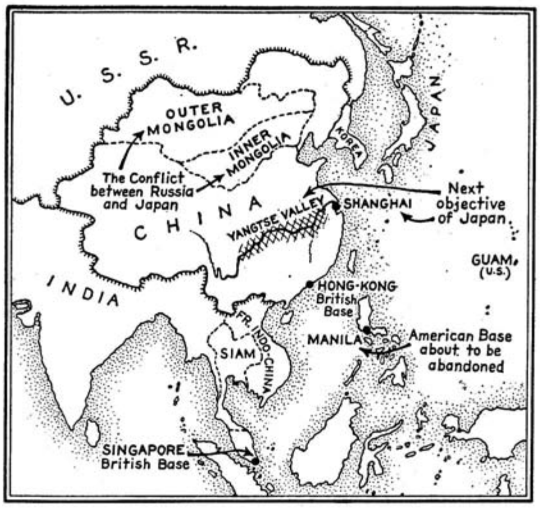
THE UNITED STATES. American interest in China commenced soon after our independence; Yankee tea ships from Marblehead, Salem, and Boston carried our new flag to the Far East. Our infant Navy was called upon to send men-of-war to protect our shipping in the Far East just as it had despatched Preble's squadron to the Mediterranean to protect our merchantmen from the Barbary pirates. In addition, our naval vessels assisted in opening the Chinese and Japanese ports to modern commerce about the middle of the last century.

THE OPEN DOOR. Under McKinley and John Hay we took the lead in formulating the Open Door policy. After much negotiation we gained the reluctant consent of Russia, France, and Germany to this new system; Great Britain was prepared to continue the old European method of delimiting spheres of influence or subscribe to the Open Door proposal. In the end she co-operated with the United States in securing the adherence of the Continental Powers to this new doctrine with the proviso that there would be no interference with already existing spheres of influence.

While Hay was negotiating, Japan was busily preparing her army and fleet to resist the advance of Russia into Korea. She had been robbed of the fruits of her victory over China in 1895 by the joint action of Russia, Germany, and France, and felt keenly a resentment she dared not at that time openly avow.

OPEN DOOR PRESERVES CHINA FOR JAPAN. John Hay's doctrine delayed the dismemberment of China until the consequences of the Japanese victory over Russia entirely changed the Far

FAR EAST*



Eastern situation. Japan took the place of Russia as the most aggressive power in northern China, while the rivalries in western Europe preceding the World War forced them to moderate their activities in the Far East. Thus by a very curious cycle of events, Hay's Open Door policy preserved China from Europe only that it might fall under the control of Japan.

OUR GROWING INTEREST IN THE FAR EAST. Our Asiatic Squadron had for several generations been stationed in Asiatic waters, laying up during the winters in the mud docks of the Pechili before modern port facilities were available. In later years they based on friendly neutral harbors like Hong Kong. And it was from this port in the spring of 1898 that Dewey took our squadron that destroyed the Spanish fleet and captured Manila Bay. We purchased the Philippines from Spain in the treaty that followed this victory. By the acquisition of these islands we gained an American base of operations for commerce or war in the Far East.

KOKI HIROTA

The director of the destinies of Nippon

THE U. S. AND JAPAN IN THE WORLD WAR. Thus the two decades before the World War saw the slow decline of European and the gradual increase of American and Japanese influence in the western Pacific. During the World War the prestige and power of America and Japan increased at the expense of the five great European states that had previously dominated the Far Eastern situation.

LANSING-ISHII AGREEMENT. Japan's contribution to the Allies in the World War, though of great value, cost her little in lives and money; nor did Japan's exertions during that war prevent her putting great pressure on China that culminated in the famous 21 demands of 1915. The provisions of this secret treaty would have definitely established Japanese suzerainty over China. After we entered the war, Japan was able by shrewd bargaining to negotiate the Lansing-Ishii agreement with us in which we almost agreed to recognize her as the dominant nation in the Far East. The language in that document was vague but it is probably true that the Japanese government at that time sincerely believed we had recognized their predominant position in the Far East. Nevertheless, at the Versailles treaty making, we supported China against these Japanese demands.

AFTER THE WORLD WAR. In 1921-2 the Washington Arms Conference substituted the Four Party Treaty for the Anglo-Japanese alliance, restricted the fortifications in the Far East, and established the 5-5-3 naval ratio in capital ships and aircraft carriers. These limitations were extended in the London conference of 1930 to all classes of ships.

THE PRESENT SITUATION. In spite of the efforts of the three naval powers — Britain, Japan, and the United States—to settle the Far Eastern question by treaties and naval limitations, the problem has continued to vex the chancellories of the world. Today it is probably further from a settlement than at any time since 1900.

RUSSIA AND JAPAN IN THE MONGOLIAS. Amid all the domestic upheavals that followed from the World War, Soviet Russia has retained a large interest in the Far East. Only recently the Soviet government has announced her intention to preserve every inch of her own soil. In addition to her own territory the Soviets have a benevolent, almost paternal, interest in Outer Mongolia which is the only province outside of Russia proper to establish the Soviet form of government. Adjoining Outer Mongolia is Inner Mongolia that lies on the northwestern flank of northern China through which Japan must pass in her advance from Manchuria (Manchukuo) into China proper. Japanese army officers are too wise to leave a long line of communication exposed to a flank attack from Russia, so they are now engaged in securing Inner Mongolia and establishing outposts in Outer Mongolia. The Soviets are naturally encouraging the Mongols, who are nominally under the Chinese government, to resist the Japanese efforts. Thus we may see a repetition of the situation in the Russo-Japanese war, where Japan and Russia fought to decide which should gain a Chinese province while the helpless Chinese could do nothing but furnish the battlefields and the innocently involved non-combatants.

OTHER COMPLICATIONS. Russia and Japan have several other issues in dispute including the ill-defined frontier between "Manchukuo" and Siberia and the rivalries among their fishermen. Russia is in a poor condition to oppose Japan because her European frontiers are menaced by the secret agreement known to exist between Germany and Poland, and the probable disinclination of France to go to the assistance of Russia in the event of hostilities arising in eastern Europe. The embarrassing situation of Russia has encouraged Japan to take high-handed measures with the Soviet authority in the Far East. Other potential friends of Russia have hesitated to support her claims because of their fears that Russia as an ally would take advantage of her position to propagate the Soviet ideas of government among their people.

GREAT BRITAIN AND THE UNITED STATES. Great Britain has the most to lose by the advance of Japan into China which would be followed by the gradual eclipse of British trade in the Yangtze valley. The succession of crises in Europe has deterred the British government from taking a more positive stand against Japanese encroachments, and it is doubtful if she could do more than lend her bases and some of her light naval forces and aviation for active opposition to Japan in the Far East.

The United States, thanks to its dis-

(*Please turn to page* 283)

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*See: "Naval Adequacy," by Captain N. H. Goss, *Scientific American*, September, October, November, December, 1928 and January, 1929; also "Our Third-Rate Navy Could Not Fight Japan," by F. D. McHugh, *Scientific American*, May, 1933.

The traditions of the Academy and of the Service, and a life-time of devotion to an ideal

ANNAPOLIS–

BECAUSE to us the Academy stands for solid American ideals and patriotism; because it is the foundation stone of our wall of national defense; and, further, because the anniversaries of that noble institution and of this journal coincide almost to the month, we are glad to present the accompanying intimate word picture of the Academy and its mission as a guide to fathers and sons.

Captain Jonas H. Ingram, U. S. N., graduated from the United States Naval Academy in the class of 1907, being a member of one of the greatest athletic families ever attending Annapolis. Since then, Captain Ingram has coached football at the Academy for many years having been, in succession: Field Coach, Head Coach, Director of Football, and Director of Athletics. He has been a discipline officer, instructor and member of the Academic Board at Annapolis and probably has had as much experience with the development of the school as any officer in the Navy, so is well qualified to write on the Naval Academy.—*The Editor.*

NINE decades ago, under the direction of President Polk, Secretary of the Navy George Bancroft established the United States Naval Academy at Annapolis, Maryland, to train naval cadets as future officers of the Navy. On October 10, 1935, was celebrated the Ninetieth Anniversary of the opening of that school in small buildings on the Severn River. That group has been replaced and expanded during the years, and today the Naval Academy is composed of well-planned, commodious buildings of rugged architecture surrounded by beautiful grounds. On every side are reminders of the Navy and its development. Relics of the valiant sailing ships of its early days are flanked by those of early steam vessels whose development necessitated the founding of the Academy. In sharp contrast to them are modern ships and airplanes evidencing the strides the Navy has made as the nation's first line of defense. The halls fairly shout the traditions of the sea. Nothing seems to have been omitted for the welfare, education, and physical development of the young man so fortunate as to be successful in entering these historic grounds.

The mission of the institution is to give the mental and physical groundwork necessary for the development of a naval officer but in doing this, it is not so different from other institutions such as Princeton, Virginia, Michigan, or Stanford. The course is naturally limited in comparison, but there is little given at the Naval Academy that will not be an asset to a man in any walk of life. The Naval Academy graduate leaves Annapolis carrying less than the university graduate along some lines but more along others. It is not believed that, for the equipment to face the stern realities of life, the Naval Academy graduate will suffer any by comparison.

The Naval Academy does not graduate specialists in any particular field. The first two years' course corresponds in general with the course at any college, with the exception that mathematics is stressed. The following two years divert more from the normal and the course goes into navigation, gunnery, steam engineering, electricity, government and economics, and aviation, none of which will be a drawback to a person in civil life but, on the other hand, may prove to be an asset.

It is shown, therefore, that one does not necessarily submerge himself on entering the Naval Academy nor is it necessary for every midshipman to consecrate his future to the Navy.

The normal capacity of the Institution is about 2400 and the present law provides for the strength each year being in the neighborhood of 1700. However, it is expected that in the near future the Congress will increase the appointments allocated to fill the institution to its normal capacity of about 2400 midshipmen.

IT is believed that the Naval Academy graduate can not but benefit by the discipline, training, physical care, sea cruises, and character-development that the course offers.

Now consider that those elected to enter are not only given a free scholarship by your government but actually receive pay for going—the pay of a midshipman being 780 dollars a year, plus 80 cents a day for rations, commencing at the date of his admission, and is sufficient to meet all his expenses while at the Naval Academy. Furthermore, the government allows the candidates on entrance five cents a mile for traveling expenses from their home to the Naval Academy.

This looks like something too good to be true and like every other good thing has its jokers. Here they are: 1, Nomination; 2, Methods of admission; 3, Mental requirements; 4, Physical requirements; 5, Entrance. All are hurdles, but none that cannot be surmounted by the boy who has the determination and get-up-and-go (provided, of course, he is physically sound) to achieve the goal.

First, the nomination. The students of the Naval Academy are all midshipmen—this term being passed down to us from the British service and signifying an embryo officer. A midshipman is an officer in a qualified sense. He ranks after a commissioned warrant officer, and ahead of a warrant officer in the Navy. Three midshipmen are allowed for each Senator, Representative, Delegate in Congress, and the Vice-President; five for the District of Columbia; and 15 are appointed each year from the United States at large. The appointments from the District of Columbia and 15 each year at large are made by the President. It is the custom of Presidents to give the appointment

MAKER OF MEN

The Mission of the Naval Academy . . . Opportunity . . . Romance . . . Adventure . . . Future . . . Character-Building and Education

By CAPTAIN JONAS H. INGRAM, U. S. N.

of midshipmen at large to the sons of officers and enlisted men of the Regular Army, Navy, and Marine Corps, for the reason that officers and enlisted men, owing to the nature of their duties, are unable to establish permanent residences and thus be in a position to secure nominations for their sons from Senators and Congressmen. The vacancies from the District of Columbia are filled by a competitive examination of candidates residing in the District.

In addition to this, the law authorizes the appointment of 100 enlisted men of the Navy each year; 25 from the enlisted men of Naval Reserve and Marine Corps Reserve; 40 from sons of deceased officers or men of the World War; four from Puerto Rico; and four from the Philippine Islands, one for each class, but these last-named are not entitled to commissions. All candidates are required to be citizens of the United States and must be not less than 16 years of age nor more than 20 years of age on April 1 of the calendar year in which they enter. Candidates must be unmarried, and remain so before graduation or the penalty is dismissal.

THERE are two dates set for mental examination for entrance under the supervision of the Civil Service Commission at specified points all over the country. The papers are marked at the Naval Academy. Those qualifying mentally are entitled to appointment in order of nomination and will be notified when to report to the Naval Academy for physical examination, and if physically qualified will be appointed and enter.

Each Senator and Congressman may nominate one principal and three alternates for each vacancy he may have.

The Academic Board will consider and may admit without mental examination—under certain rules—a candidate who presents a properly attested certificate that he is or has been a regularly enrolled student in good standing without condition in a university, college, or technical school accredited by the United States Naval Academy.

The average boy, therefore, has the following choice of methods for getting nominated for entrance:

Through his Senator or Congressman. First, ascertain if they have vacancies. These nominations are sometimes political but at other times are open to a competitive examination. Influential men in the community can give much aid. Perseverance and persistence on the part of the boy usually wins out in this case. Never give up. Take alternates nominations. Prepare to pass the examination and, if successful, the same determination in securing the final nomination will be productive of results.

Failing in this, the next best method is to enlist in the Naval Reserve. After being in the reserve for a year, one is entitled to take a competitive examination for nomination, the first 25 contestants passing in order of examination merit getting the call.

The last method is to enlist in the Navy and serve for one year on a seagoing ship. Men of the Navy who meet the qualifications are then sent to school to prepare for the examinations, and the first hundred to pass in order of merit win the appointments.

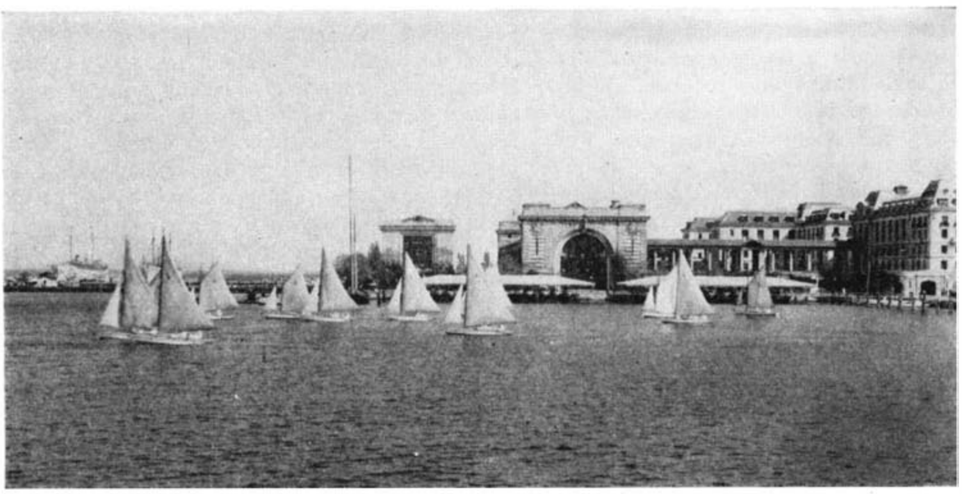
With these three avenues of entrance open to the American youth it is believed that any boy with the courage and grit to follow up and keep plugging can win for himself the right to be appointed a midshipman at Annapolis.

Preparation in fundamentals is essential and a good school education is necessary to pass the examinations with a high average. An average boy can accomplish this if he is diligent, applies himself, and keeps his eye open to every opportunity.

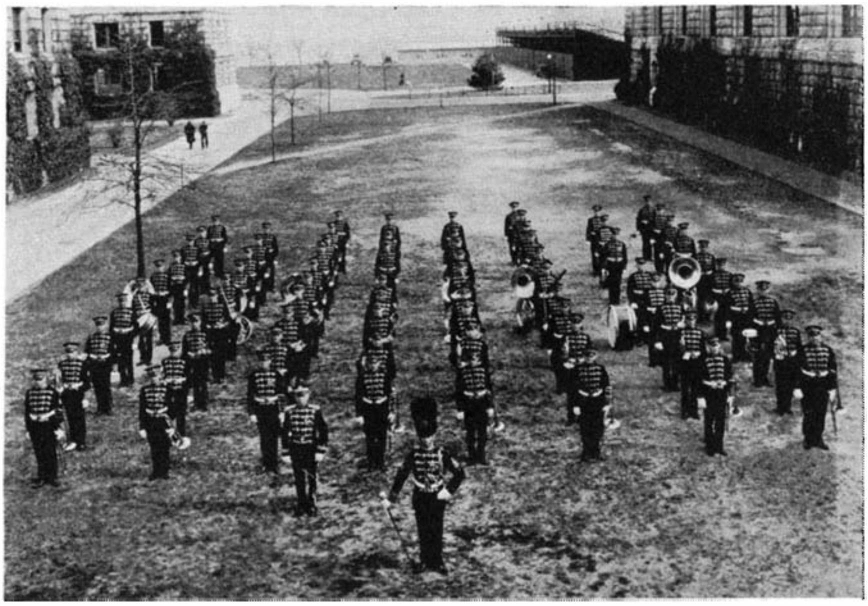
The physical examination for entrance is rigid and any youth who contemplates entrance should apply to the nearest Navy Recruiting Station for a physical examination. Much trouble will be eliminated if one's true physical status is first determined, failure to pass the color test or some minor organic defect being sufficient for rejection.

CANDIDATES who meet the mental, moral, and physical requirements will receive appointments as midshipmen and be admitted as such to the Naval Academy. Each candidate for midshipman will be required to sign articles (with consent of parent or guardian) by which he binds himself to serve in the United States Navy during the pleasure of the President of the United States (including his time of probation at the Naval Academy), unless sooner discharged. The candidate makes a cash entrance deposit of 100 dollars and then takes his oath of allegiance, given by the Superintendent of the Academy. This amount of money goes for the partial payment on the initial outfit of the midshipman. The Government advances 250 dollars which is later deducted from his regular pay. This takes the boy into the Academy as a full-fledged midshipman in Uncle Sam's Navy.

The average midshipman undergoes a radical change during the first two



Sailboats used for training midshipmen at the Naval Academy



"Stand, Navy, down the field . . ."

weeks of his plebe, or first, summer. A short hair cut, ungainly sailors' garb, regular hours, routine drills and exercises, good food, and strict discipline all have their effects. After this period, plebes are "shaken down" and the life becomes more normal and regular. Nothing is left undone to prepare the summer plebe to join up and take his place in the regiment by the beginning of the Academic year on about October first. Uniforms are fitted, military precision in drills attained, naval etiquette and phraseology partially mastered, rudiments of drawing and modern languages learned, swimming tests and athletic tryouts given. In fact, the crude material is gone over and polished in three intensive months of training so that by the time the upper classmen return from leave, it is difficult to distinguish the trim plebe from his seniors other than by their service stripes.

WITH the opening of the school year, the plebe is engulfed in the activities of the regular school year. Studies and the curriculum are a maze. Football starts with a bang and lots of enthusiasm. This is a trying period and one where both feet must be kept on the ground and every opportunity taken to study and get the hang of the way things are done. The first month's start in academics is important. A good start is good for morale and confidence, and usually spells success, or certainly argues well for the future. Athletics may be indulged in without detriment to class standing but if class standing is impaired to the danger point everything should be sacrificed for study.

A good football season, the Army game, Christmas leave, all come quickly. Then the mid-year examinations and a fine spring in Annapolis, with plenty of spring sports, tennis, sailing, golf, and week-end liberties in quaint and quiet old Annapolis. Then comes the end of the school year late in May, June week with its social festivities, graduation of the first class, and no more plebe year. The June ball and then embarkation on the battleships *Arkansas* and *Wyoming* for the practice cruise to foreign ports, are followed by a month's leave at home.

Returning from leave, the youngster year starts. A big rise in position—no more plebe year, no more plebe rates, no sharp cutting of corners or sitting on the edge of chairs and many other humiliating customs that the plebe is supposed to carry out. Studies become harder but the youngster now knows the system and is more experienced in naval life. Another football season, holidays, and the spring season. Another June week and graduation, but this summer no cruise. The new second classmen remain at the Academy all summer and concentrate on aviation: ground aviation, radio, navigation, and gunnery. A squadron of seaplanes is available and much flying instruction is given; then September leave, and back as a dignified second classman, going more into the professional subjects that give the groundwork for the naval officer. A year of hard academic effort, a year in which the life at the Academy is beginning to pay dividends. Physical development has probably come along now so that the midshipman second classman may be a member of a varsity team in some athletic sport. Every midshipman from plebe year on has to participate in some form of organized sport. Strength tests and swimming tests come each year with new standards and intensive work to overcome any deficiencies.

Another June week and graduation and now to the exalted position of first classman—the cock of the walk and lord of all. A fine cruise, taking junior officer's duty on the bridge, quarterdeck, and engine rooms; much navigation and gunnery, signals, and practical gun drills with the big guns. An interesting and highly instructive cruise planned to fit the midshipman for his regular duties at sea after graduation. After returning from the cruise, comes first class leave, a bully leave, then a return for the final year: cadet officers, high rank, and senior class—a fine year —enjoying many privileges and each day bringing him nearer to graduation. Final exams, no more rivers to cross, June week, graduation, and Auld Lang Syne. The paymaster has deducted enough each month to have about 800 dollars available at graduation. If commissioned, this amount is sufficient to buy the uniforms and equipment necessary to go to sea as a commissioned officer in the Navy. If he elects not to follow the Navy or is not commissioned, he has this much in his pocket as a nest egg when he leaves the Academy with a good education and a sound and trained body. Henceforth it is very probable that all classes graduating will be given commissions either in the line of the Navy, Marine, or Supply Corps; and while the entering midshipmen signs to serve at the pleasure of the President, it is customary to accept resignations when submitted. This is now a fairly well established custom.

TO sum up, the young American has had four splendid years of college training, two magnificent summer cruises in big ships to attractive ports overseas, one summer of practical aviation training, all expenses paid in school, books, clothing, food, laundry, hospitalization; spending money on leave; athletic equipment furnished—in fact, he has had no expenses whatever for four years and graduates with a savings account estimated at about 800 dollars. Where can the American boy find another such attractive proposition?

On the whole, the Naval Academy accomplishes more in four years than any other college in the country. Many great educators have, after a cursory glance at the system of the Naval Academy, suggested radical changes. In most cases it can be shown that these changes have been tried in the past and found undesirable, but it is encouraging to realize that the Naval Academy does not stand still, that it is willing to take up new suggestions to keep abreast of the times. It is this spirit which will make its work effective in the years to come, and will progress with the times.

The Naval Academy requires for graduation 130 semester hours of credit for recitations attended during the four academic years. This does not include the amount of time devoted to drills and practical instructions. It is also exclusive of the six months spent at sea—

three months of each of two summers—in the practice cruises. The courses of study are distributed among nine different departments, namely: Seamanship and navigation; ordnance and gunnery; engineering; mathematics; chemistry, physics and electricity; English and history; languages; economics and government; and hygiene. Of these various subjects, 37.2 percent are considered to be purely professional; 31.2 percent relate to mathematics and the sciences, pure and applied; while the remaining 31.5 percent belong to the so-called cultural studies.

The Naval Academy, as these proportions indicate, has a policy, similar to that of other purely engineering colleges which have followed the recent trend, to stress the fundamentals in the sciences in an effort to lay down correct educational foundations even if the specialties, wherein there is constant change in facts and in their applications, are not so fully covered. This policy makes it possible to introduce into the curriculum more cultural subjects, and thus afford a broader education for the midshipmen. A good general education has been given, including travel, practical instructions, and specialization in professional subjects that are an asset in any walk of life; discipline has been instilled; leadership taught; ability to carry out orders and, likewise, initiative have been developed.

AT the time our Navy was created in 1777, John Paul Jones expressed to the Marine Board some of his ideas on the professional attainments of a naval officer. The following paragraph from this letter is posted in the front of the English book of each 4th classman: "None other than a gentleman, as well as a seaman both in theory and practice, is qualified to support the character of a commissioned officer in the Navy; nor is any man fit to command a ship of war who is not also capable of communicating his ideas on paper in language that becomes his rank."

The end sought by this training and discipline may be expressed as follows: "The doctrine is responsibility, and the problem is the formation of character." The Naval Academy spends much time in the formation of character and at an all-important period in the life of every man.

The midshipman is probably cared for better than if he had remained at home. The quarters are light and airy and kept in an immaculate condition. When the temperature falls to a certain level, heavy clothing is prescribed, overshoes and rain clothes are worn in wet weather. Regular sleep and regular hours can not be avoided. The food is the best, well prepared, and the menu selected with care. A physical examination is held once a year. Teeth examined every six months. Sick call held twice daily. An infirmary in quarters for slight ailments and a fully equipped naval hospital with an efficient staff. Care of clothes and person inspected several times daily. Religious life given every opportunity: prayers at breakfast and church on Sunday. Ample time is provided for recreation, sports, reading, movies, sailing, and dancing. Home training and social etiquette are stressed. Public speaking and after-dinner speaking are taught in the English course, and every advantage is given for social attainment.

Particular care is given to physical welfare. Many boys who passed the physical examination as being physically sound show many defects in physique. This is found out by strength tests and a carefully planned system of measurements soon after entrance. The midshipman is photographed in the nude and with a chart as a background to show front, side, and rear views that reveal faulty posture, spinal curvature, length of arms and legs, and general set-up. The corrective measures for all physical faults are prescribed and extra work with experienced instructors put on these faults.

Athletic development is stressed at the Naval Academy. Athletics for all is the motto of the Athletic Department. Coaches, instructors, equipment, and playing fields are provided for all. Teams are maintained in 19 varsity sports for competition with outside institutions.

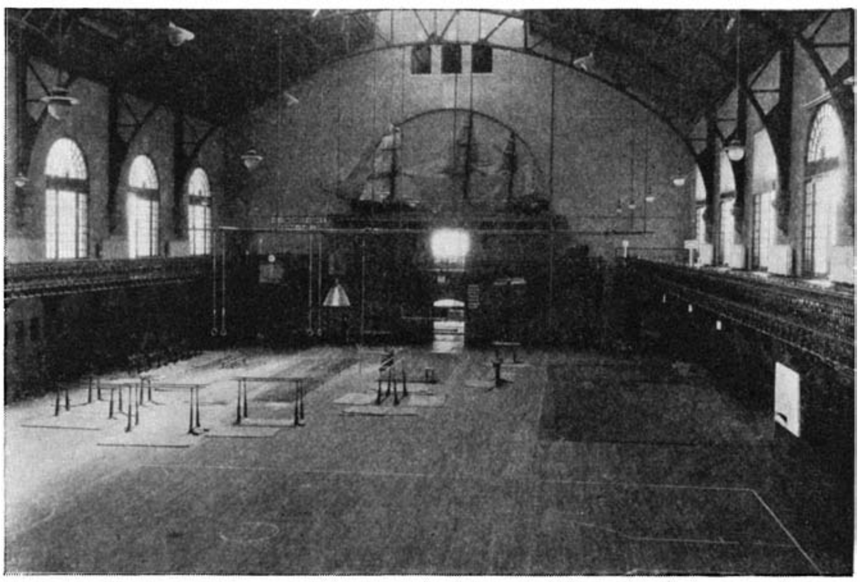
Plebe teams are maintained in all of these sports except small bore rifle and bowling. In addition, class and company teams are maintained in most all sports which gives an outlet to the midshipmen of any size or any degree of ability. Not only does this encourage all the good derived from healthy competitive sport but it develops initiative, leadership, and coaches who will in the future handle athletics not only at the Academy but will be trained to coach enlisted men in all forms of sport.

This mammoth athletic plant is financed by the Navy Athletic Association which derives its funds from its membership and games played, principally football, where admission is charged. It is doubted whether any school in the country gets the 100 percent participation in sports that the Naval Academy demands.

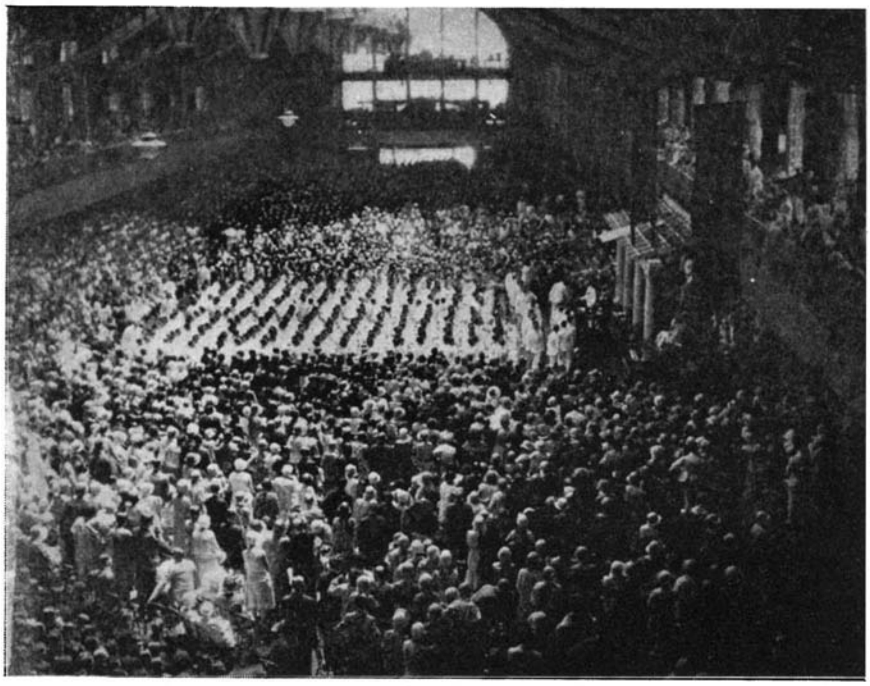
A MIDSHIPMAN'S day, strange as it may seem, begins about 45 minutes before he "turns out" in the morning. This paradox is explained by the fact that the watch squad is "turned out" 45 minutes before reveille. This squad is called by the various masters-at-arms (civilians employed as building watchmen). At 6:20 A.M. the watch squad assumes its duties, and seven minutes later the reveille breaks with bugle and gong, the latter ringing for 30 seconds. Five seconds of silence follows, and then the bell rings again for five seconds. At the second bell, the inspection is begun. All doors are opened, and an occupant of each room stations himself in the doorway and reports "All out, sir" to the reveille inspector as the latter double-times by. The "All out" means that the occupants of the room are "turned out" and that the bedclothes and mattresses are turned back in the prescribed manner.

Twenty-five minutes are allowed after reveille for the morning shower, shaving, and dressing. Then at 6.55 A.M. the call to formation for breakfast is sounded. The midshipmen thereupon fall in by companies on outside or inside parades, according to weather conditions. During breakfast formation, the daily report of the conduct (delinquencies) of midshipmen for each battalion is published by the battalion adjutant.

The battalions then march off by com-



Well-equipped gymnasium at the Academy—McDonough Hall



"Graduation, Auld Lang Syne," and a commission in the Navy

panies and enter the mess hall from four different directions. This great hall is furnished with long narrow tables, at each of which 21 midshipmen are assigned seats. There are about 90 tables, each of which has two Negro or Philippino mess attendants to wait on it. When breakfast is finished, the regimental commander rises and gives the order for the Regiment to "Rise." Then, except on Sunday mornings, he gives the command, "Parade Rest." Morning prayers are then read by the Chaplain. Then follow "Attention!" and "March out."

AFTER breakfast, the midshipmen go to their rooms to sweep, dust, and clean them in general, and to make up their beds. At 8:00 A.M. the march to the class rooms starts. During the week —Monday through Friday—the academic day is divided into five periods of approximately one hour each. The forenoon is divided into four periods, two for study and two for recitations.

At 12:40 P.M. comes lunch formation, at which the adjutant publishes various orders that are later posted on the bulletin boards. After this, the Regiment marches into the mess hall.

Lunch is followed at 1:30 P.M. by the fifth recitation period. The next event is drill, which lasts from 2:49 P.M. until 4:00 or 4:30 P.M. Each midshipman has two "long" drills per week. On Wednesdays, all battalions have the same thing—a drill period assigned to the Executive Department. A dress parade is usually held, if weather permits.

During all of the day until drill, the midshipmen wear "blue service" uniforms. These consist of cuffless trousers of dark blue serge, and a double-breasted, brass-buttoned coat to match. On each lapel of the coat is a gold anchor. On the sleeves of the coat are the marks that distinguish the classes except that the fourth class have no insignia at all. For drill, the uniforms may be blue trousers, leggings, and dark blue flannel shirt, or white "works" (white jumper and trousers), with black or gymnasium shoes.

The interval between 4:00 or 4:30 P.M. and dinner formation at 6:40 P.M. is the time for midshipmen's recreation. A great majority of the midshipmen use this period for athletic exercise of some sort. Others at this time make use of the library, or devote the period to some activity such as the "Lucky Bag" (year book), "Log" (weekly publication), or Masqueraders (amateur theatricals).

On Saturdays, only the first two periods are given to recitations, the third and fourth being devoted to drill. After that, according to the weather, there is either a personal inspection outside or a room inspection.

On Saturday afternoons, all midshipmen, except those having extra duty to perform, are given liberty to visit the city of Annapolis. Saturday evenings are given over to entertainments—hops, motion pictures, and the Masqueraders and Musical Clubs' shows.

On Sunday and holidays, the day begins at 7:15 A.M. On holidays, liberty begins immediately after breakfast. On Sundays, however, the midshipmen must go to church, either at the Naval Academy Chapel or a church of their faith in Annapolis. The uniform for chapel, out-of-town church parties, and Sunday dinner formation is full dress.

A midshipman's day is well occupied during the academic year. He "turns out" at 6:30 A.M. and, aside from the recreation period in the afternoon, the routine carries him up until taps at 10:00 P.M., when the tired middie welcomes rest and sleep.

It takes four years of such a life to prepare the graduate for his duties afloat in the Navy, and once again I quote from John Paul Jones on the attainment of a Naval officer:

"He should be the soul of tact, patience, justice, firmness, and charity. No meritorious act of a subordinate should escape his attention or be left to pass without its reward, if even the reward be only one word of approval. Conversely, he should not be blind to a single fault in any subordinate, though, at the same time he should be quick to distinguish error from malice, thoughtlessness from incompetency, and well meant shortcoming from heedless or stupid blunder. As he should be universal and impartial in his rewards and approval of merit, so should he be judicial and unbending in his punishment or reproof of misconduct."

THE growing boy has many ideas for his future—where he would prefer to go to school and what business or profession he would choose. Then again, he has ideas of adventure, travel, and romance. Many boys have their lives carefully mapped out for them: prep school, college, then on down the groove prepared by Father. Others enter high school with no plans for the future. Yet it is safe to say that the younger generation of today, by the time they have attained high school age, are taking into consideration their future, both as to schooling and occupation, maybe not in a methodical manner but certainly with an eye to grasping the best opportunity presenting itself. They seek independence, contacts, and lucrative positions. Many are doomed to disappointment and drift along with the tide of humanity that simply exists but does not get anywhere in particular.

The writer has been a discipline officer, instructor, coach, and head of a department at the Naval Academy and over a period of 30 years has had the opportunity at first hand to observe the many opportunities extended to the American boy so fortunate as to enter. At the same time I have observed and compared what outside institutions have had to offer. My conclusion has been that many boys scattered over this broad land did not know much about the Academy, its life, and the future it offers.

If I have made the picture clear and extolled the opportunities offered I have done something for American youth and at the same time made more and better material available for the officer personnel of our first line of national defense.

RADIO IN NAVAL TACTICS

By LIEUT. W. B. AMMON, U. S. N.

THE underlying principles of naval tactics are as fixed and unchanging as the theorems of geometry. However, as the type and style of weapons change and technical improvements are made in ship equipment, the application of the principles is varied.

The battle organization of the Fleet is similar to the structure of an athletic team with the Commander-in-Chief as the team's captain. The subordinate unit commanders and ship captains must know not only the doctrines and plan for battle, but the manner of carrying it out so that the Fleet may be a coordinated and effective weapon.

Radio permits the far-flung scouts to give vital information instantaneously to the Commander-in-Chief and his subordinate commanders, whether the scouts be submerged submarines, swift cruisers and destroyers, or speeding aircraft. It facilitates carrying out the principles underlying the dissemination of information. It is the means by which the Commander-in-Chief may disclose his plan simultaneously to a hundred or more scattered but alert ears just before meeting the foe. Hence, he is better able to take advantage of the tactical element of surprise. During action, radio is the invisible means of putting the heavy guns on distant targets. It is the agency used to give information of damage inflicted on the enemy to the team captain and the instrument to enable him to harmonize the actions of his forces and direct their efforts so each contributes the maximum effectiveness to the whole.

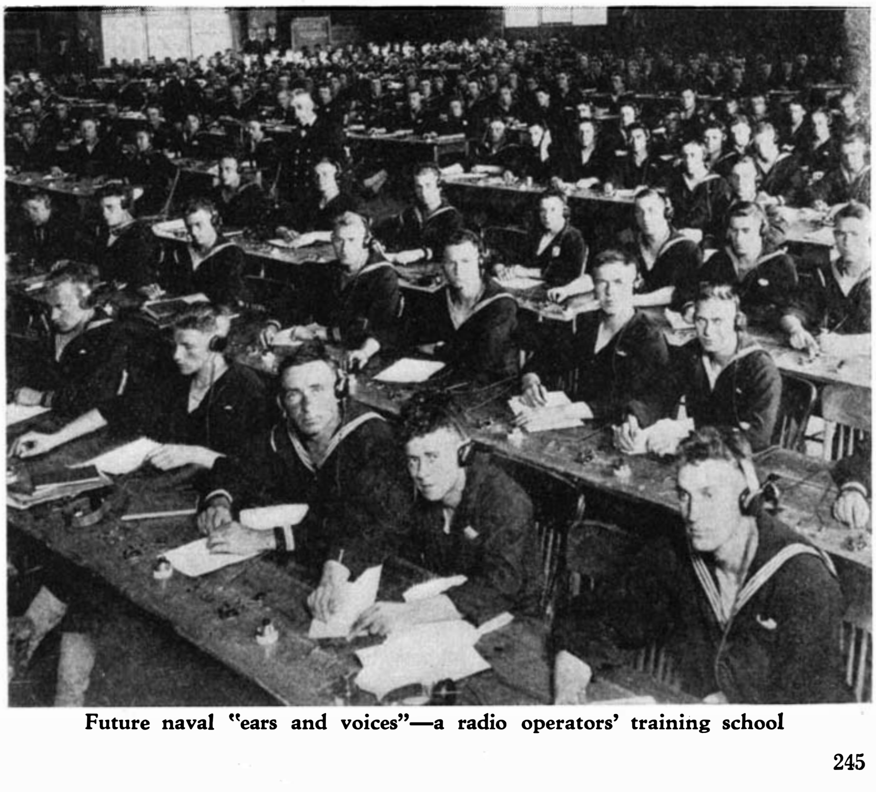
Technical advances in radio since the World War facilitate the maneuvering of the Fleet as a unit under its Commander-in-Chief. Radio serves as the Fleet's voice and ears, making communications as vital to the Navy as gunnery, engineering, and damage control.

The major advance is considered to have been the perfection of the vacuum tube. Some of the earliest types of tubes had a life of about 70 hours and cost approximately 50 dollars each. Today the life is measured in thousands of hours and the cost is only a few dollars. Vacuum tube development made available many types of compact transmitter and receiver circuits which were suited to installation in the confined spaces allotted in a man-of-war. The detection and amplification of signals improved greatly and resulted in longer range receivers. With progress in the technique of vacuum-tube manufacture, transmitter power and sturdiness of tubes was improved and the communication range between ships has increased from a few miles to thousands of miles. The advent of shock-proof tube mounting and the use of non-corrosive and moisture-proof materials in other parts insured equipment against damage from shock of gunfire, rough handling, and the destructive effects of sea spray and air. The evolution of the vacuum tube was the primary step toward fulfilling the Navy's demands for rugged equipment suited for long or short range transmission, simultaneous communication on many channels, and capable of either telegraph or telephone use by submarine, surface ship, airplane, or land station.

Another development increasing radio's value in naval operations was the elimination of much of the interference experienced during the World War. Frequency stability has been perfected and with it the means for rapid shifting of frequencies and accurate calibration of transmitters and receivers. Hence, without mutual interference, frequencies close to each other in the radio spectrum can be assigned within the same body of ships. The receiving operator's problem is simplified; his attention can be devoted wholly to copying a message instead of attempting to receive it while tuning his set to follow the transmitter's vagaries. More accurate receiver tuning has partially overcome static. Scientific shielding has obviated local interference, particularly in aircraft, where electrical noises from the ignition system, motors, and the like, are serious obstacles to good receiving conditions.

A third improvement was the introduction of automatic transmission and reception. Manual transmission rarely exceeds 35 or 40 words a minute even with a high-speed key or "bug," while the use of "automatics" permits speeds above 500 words a minute. Consequently, a circuit's capacity is increased tremendously and the human operator with his inherent errors is eliminated except for punching and copying the tape.

A great many technical advances in the radio art have resulted from the Navy's early and constant demands for better equipment and the tremendous growth in the popularity of radio broadcasting, beginning about 1921.



Future naval "ears and voices"—a radio operators' training school

The opinions or assertions in this article are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

A FORECAST OF WORLD

Design Trends in Naval Ships . . . Eyes Focused on Japan . . . What Ships Powers Will Build; What Types Discard . . . Possible Design Modifications

By OSCAR PARKES
Formerly Editor, "Jane's Fighting Ships."
Specially prepared wash drawings by the author

NOW that Japan has announced her intention of terminating the Washington Treaty in 1936, and Germany has renounced the limitation of the armaments under the Versailles terms, we are faced with the possibility of a return to unrestricted naval construction—unless some sort of agreement is reached next year which will place a check on global tonnage. Ten years ago, world conditions were such that limitations in the design, size, and numbers of the different types of warships permitted to be built were more or less acceptable to the Powers. Today such artificial standards are no longer in favor as experience has shown that they lead to the construction of uneconomical types of ships unsuitable to all concerned.

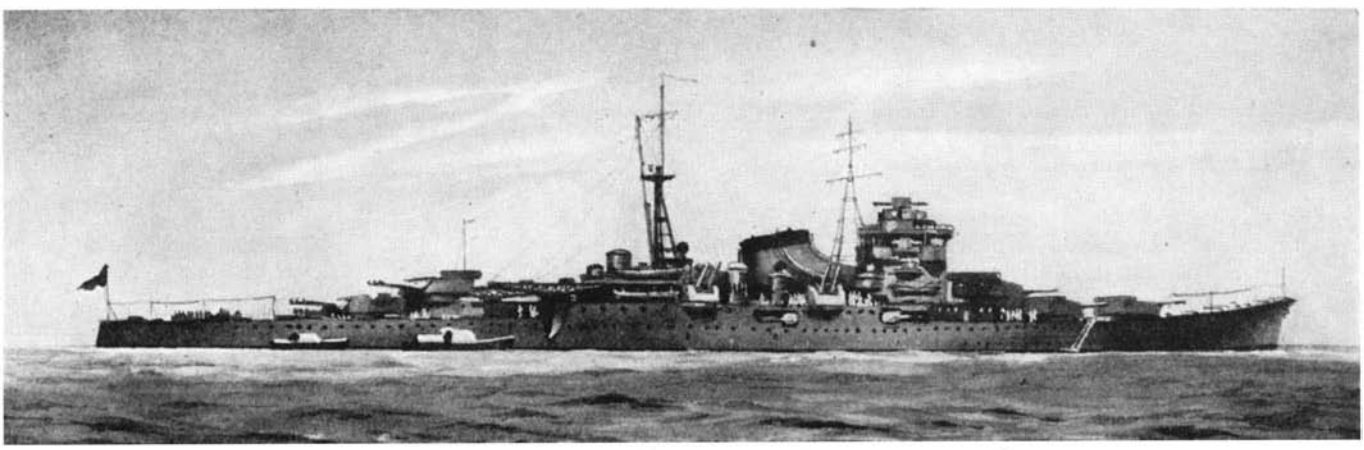
The present attitude of the Powers with regard to their naval requirements is far more difficult to define than it was before the World War. In those days the expansion of the German Navy clearly indicated the quarter from which trouble could be expected and the British Navy was being built expressly for the time when "Der Tag" should dawn. France expected trouble from the same quarter, and the members of the European alliances were anxiously calculating how much would be expected of them in the event of hostilities. Today a very different state of things obtains. On all sides there is a realization that economic and national aspirations in Japan, Russia, Germany, and Italy may lead to trouble sooner or later. The present peace pacts in Europe may do much to restrain nationalism, but between East and West there are rifts which time is not likely to close—territorial and commercial aspirations which already appear as dark clouds on the horizon, especially in the Mediterranean.

Today the German Navy presents no menace, although the designs of the ships provided for in the 1935 Program may be quite as provocative as was that of the *Deutschland*. The two battleships of 26,000 tons—in that program—are to be armed with 12 11-inch guns—which may be taken as indicating that the Marine Admiralty are at one with the British Admiralty in considering such displacement and gun caliber adequate for battleships, or that a big reserve of 11-inch guns has been built up for future 10,000 tonners and it has been thought advisable to get as many afloat as soon as possible, in which case the tonnage would be sufficient for a four-turreted, well-armored ship of the *Deutschland's* speed.

The two cruisers of 10,000 tons with 8-inch guns, on that program, will presumably be smaller editions of the same design, and not likely to be over-burdened with aircraft. Judging by the light type of catapult which has been installed in the battleships and cruisers, the air arm will be employed mainly for scouting and spotting. Bombers over the Baltic will be operated from shore bases with carriers for the wider seas work, and converted liners seem likely to be utilized for this.

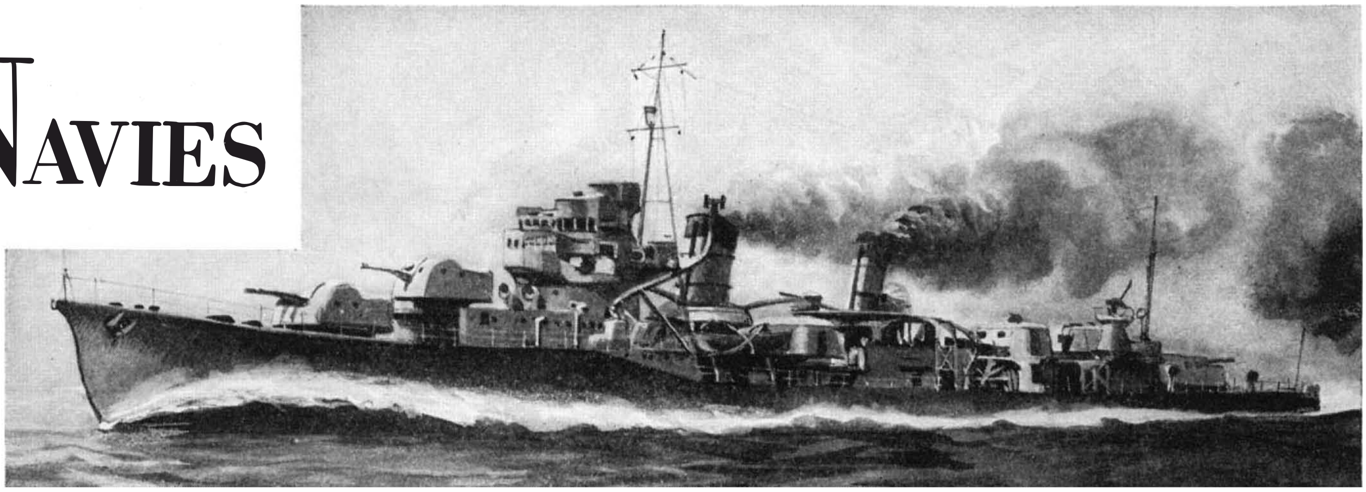
IN raising their destroyer tonnage to 1625, with an armament of 5-inch guns, the Germans are taking a leaf out of the French book and, if anything is likely to make the British break away from the standard type which has served for so many years, it will be these boats. Considering that, before the War, German light cruisers carried only 4.1-inch guns it is high time that some term other than "destroyers" were chosen for these overgrown torpedo craft.

The German menace being negligible, it is on Japan that our attention is sharply focused. No longer satisfied with a 40 percent inferiority to the American and British Navies, she is determined to provide herself with whatever forces she deems necessary, and it is the additions made to her fleet which will dictate the future development in our own. And so, in discussing the possible naval developments the world over it will be as well to take Japan first—and here we are up against the dictating factor in war-



Japanese cruiser *Mogami* of 8500 tons carrying 15 6-inch guns in five triple turrets—three forward, two aft. Her two stacks merge into one; mass of bridgework slightly reduced compared with previous designs. Eight 5-inch anti-aircraft guns in pairs are amidships; the catapults are just forward of number four turret. She makes a speed of 33 knots with 90,000 horsepower

NAVIES



Japanese destroyer *Nenohi* of 1378 tons armed with five 5-inch guns in twin turrets fore and aft and one single raised turret. Originally intended for nine tubes, she now mounts six only in two triple mounts. These have shields and can be seen between the funnels and abaft the second funnel. Her speed is 34 knots with 37,000 horsepower. Later vessels will have eight tubes in quadruple mounts. Note the piled-up bridge and the way the torpedo shields are placed on raised mounts instead of on deck

ship design which bristles with difficulties. Well served by a corps of constructors who have studied in most of the naval schools in Europe, it is not surprising that a very remarkable degree of purposeful originality has been brought to bear upon the design of all types of warships. Ton for ton, Japanese designs show a greater all-round value than those of any other country—to a large extent because they are not hampered by the standards of habitability which obtain, say, in ships of the United States and Britain. As one distinguished Japanese staff officer recently reminded me in discussing the features of their ships "Remember, please, that we have to make up for the 40 percent"—meaning that their ships are designed to embody an individual superiority over their "opposite numbers" in other navies sufficient to neutralize the 5 to 3 ratio of the Washington Treaty. To a large extent this is possible because of their personnel. A six-foot deck is ample for the national stature, and accommodation suitable for their standard of living can be provided without the sacrifice of space considered necessary in our ships. Thus by lowering freeboard and reducing draught, and packing their hulls with turret bases, engine and boiler rooms, and torpedo flats, their designers manage to provide more fighting qualities in a ton of displacement than ever we can.

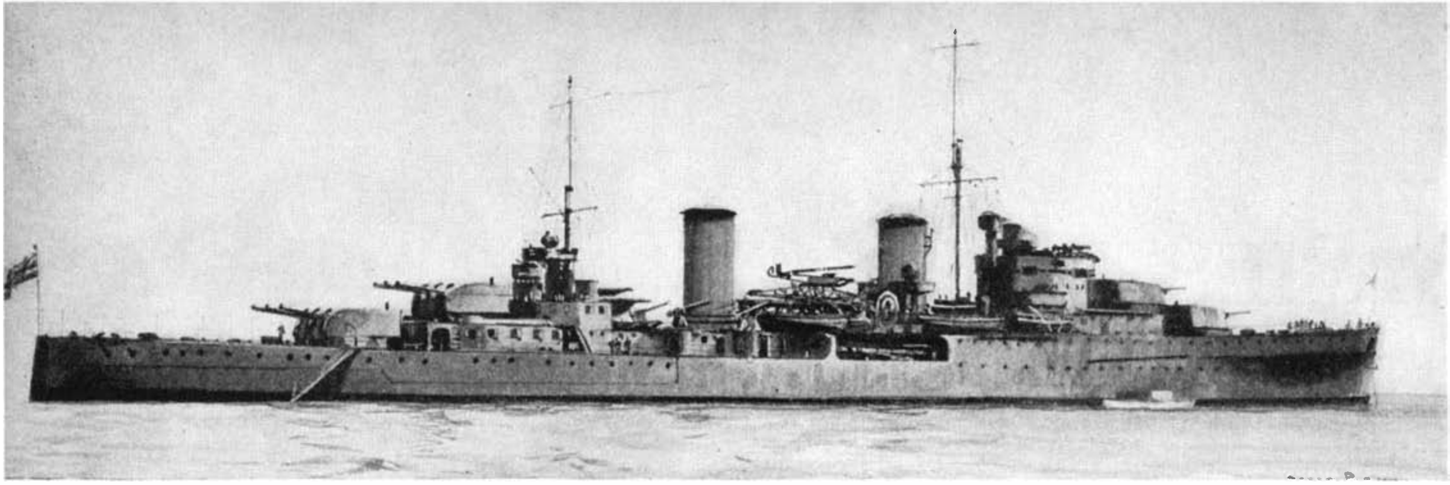
And as their hulls cannot contain cabins and stations which in our ships would be below decks, they have been incorporated in great pagoda-like structures which are replacing the heavy foremast in Japanese ships, around which are hung rangefinders, director towers and searchlights like plums on a tree. Granted that this vast structure may be a wonderful target, it also has the virtue of being exceedingly rigid and free from vibration, which is a very vital advantage in a lightly built and highly powered ship such as they build.

In the past, Japan has leaned towards the monster battleship and is likely to continue to do so. But the claims of the armored cruiser of the *Deutschland* type appeal vastly to the Japanese, judging by my correspondence. Such ships would be ideal wide-radius commerce raiders and their very threat would strain convoy protection to the limits. As soon as the Treaty terminates we may very well expect Japan to try out the *Deutschland* idea along her own lines and produce, say, a "six 12-inch gunned," armored ship with high speed and adequate protection against such ships as she might choose to engage. In the past, Japan has aimed at initiative in the matter of warship types—the *Tsukuba* and *Kurama* classes of prewar days would have settled the hash of any armored cruisers—and it must not be forgotten that she introduced the 8-inch gunned cruiser in her *Kako* and thus forced the other Powers to go in for this unwanted type in which she has always maintained the lead.

At present she is committed to 6-inch guns in her cruisers, and in the *Mogami* class she has certainly produced wonderful ships upon the 8600 tons credited to them. (In a letter to us from Dr. Parkes, after he had forwarded the article, he says: "By the way, you may be interested to know that the *Mogami* came down badly on trials. The high speed and firing of 15 6-inch guns so strained her welded hull that she filled her oil tanks from the sea and finished up drifting about off Kobe. She is the first big welded ship and the Japanese have not been very fortunate in that branch yet." It seems that the Japanese have not mastered the technique of welding, but their work will certainly bear watching.—*Ed.*) The attitude of the Japanese to the 6-inch gun nowadays is difficult to define. Formerly, when such guns were hand-served, they were unpopular as the 100-pound projectiles were too heavy for her personnel to handle and she found the 5.5-inch quite large enough. Now that power-operated 6-inch guns with anti-aircraft mountings have come along, this caliber may be more appreciated but it is an open question whether five sets of triple-mounted 6-inch guns, as in the *Mogami*, would be viewed with as much favor as would the equivalent in 7-inch or 8-inch guns when the Treaty restrictions come to an end.

As regards aircraft carriers, very little is known about the *Soryu*, of 10,000 tons, now building, but I am told that she will be a cross between the *Akagi* and the *Ryujo*—and as likely as not turn out to be something in the way of a cruiser-carrier, with 6-inch guns, instead of 8-inch as in *Akagi*. Such a ship would have to sacrifice a certain amount of carrying capacity in favor of an increased armament and be regarded as an alighting platform for the 'planes of her consorts. There is much to be said for such a type until such time as the autogiro obviates the necessity for an alighting deck.

Developed along Japanese lines, the destroyer has become a miniature cruiser with her guns and torpedo tubes protected by shields, and an extraordinary amount of top hamper. Since the capsizing of the *Tomodzuru*, her torpedo craft have been rather under a cloud and the commission which investigated recent designs called for modifications in the types now building, but the extent and nature of these are not known. The mounting of the tubes on platforms instead of on deck adds greatly to topweight which, in addition to their heavy bridges, must considerably reduce their margin of safety even if it does tend to reduce rolling. British destroyers are said to be able to stand an impossible inclination without cap-



British cruiser *Southampton* of 9000 tons, carrying twelve 6-inch guns in four triple turrets, will steam at 32.5 knots. She has eight tubes and four 4-inch anti-aircraft guns, and is the best the British can do under Treaty tonnage limitations as a reply to the Japanese *Mogami*. Note the absence of top hamper, the two funnels which are pear-shaped in section, and the catapult between the funnels

sizing, but are lively in consequence; the Japanese seem to be aiming at a "stiffer" but more unstable type. According to recent reports the *Ariake* class now carry only six tubes instead of nine and illustrations show her with only two sets of triple tubes.

When the Treaty terminates, it is more than likely that future destroyers will be enlarged into small cruisers in the same way that the French propose. The original metier of "torpedo boat destroyer" has long since passed with the old-fashioned torpedo boat, and there is no reason why they should not develop into sea-going ships and replace the old "third-class cruiser."

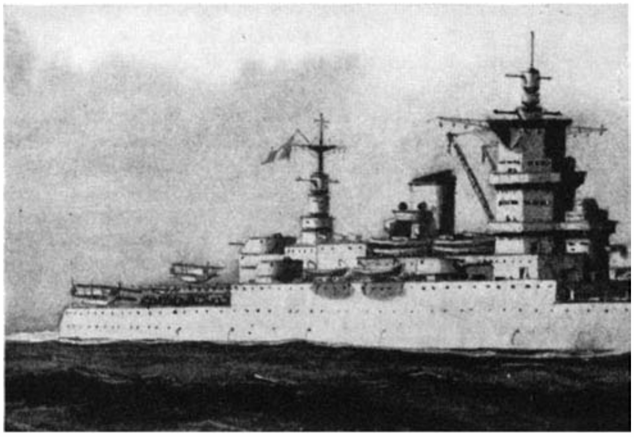
Within recent years, Japan has been experimenting with a variety of small craft which add considerably to her strength although claiming little attention. Her fleet of 400- to 600-ton mine-layers, net-layers, mine-sweepers, and chasers are very efficient little ships and show that she is fully alive to the value of these ancillary craft of specific but interchangeable rôles. None of them is built for "police duties" in peace time with a limited war value for their displacement—as is the case of the British sloops—but of course they have a restricted radius of action and will operate only in home waters.

At the present moment the whole battle fleet is scheduled for drastic reconstruction and the *Fuso* and *Yamashiro* have already undergone modification which have changed them into one-funnel ships with increased protection, catapults, additional anti-aircraft guns, etc. From all accounts, the *Nagato* and *Mutsu* will be also considerably changed; at present both are stripped down with their turrets taken out, the former at Kure and the latter at Yokosuka. *Nagato* will be the first completed and her advent in new guise is awaited with the greatest interest. I understand that she may emerge rather like the *Mississippi* with one funnel and a tower mast forward. That her 16-inch guns will have increased elevation goes without saying, also that her anti-aircraft armament will include 5-inch guns in shields as have been fitted to the *Ise* and *Hyuga*.

Nothing is known about the 5000-ton mine-layer *Okinoshima*, now building at the Harima Works, and it will be interesting to see whether the mine cargo will suffer at the expense of armament —my own view being that she will be a fast layer with a good anti-aircraft battery only. If this should be the case, her mine capacity will be very large—over 500 large-type at least. She will be designed for overseas operations like the British *Adventure* but with a higher speed, I understand.

So much for the anticipated lines of development in the Japanese Navy, and it is upon these that other Admiralties will base their naval programs. So far no vessels of a novel type have been laid down in Japan, and to a great extent future competition will depend upon whether or not this policy is maintained. It is the advent of something new in warships which leads to fresh outbreaks of competition—as was the case with the *Dreadnought*—and it is the departure from conventional type which will most disturb Washington and London.

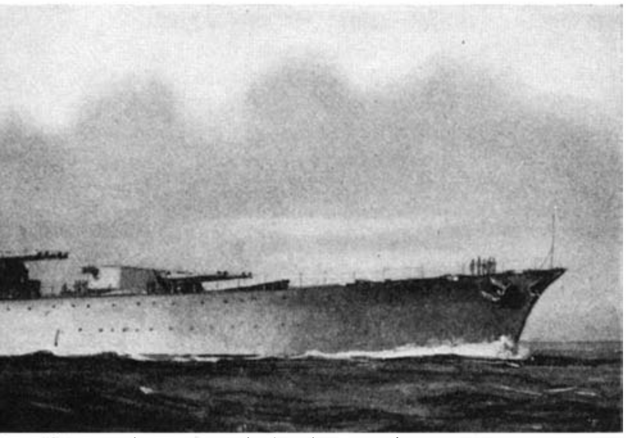
If Japan brings out a battle-cruiser on *Deutschland* lines, then America will have to revise her shipbuilding program; if not, no radical departure from the classes now building may be expected for some time. Reconstruction of the *California* and *Colorado* classes has been postponed and it is not likely that they will be taken in hand until after 1936 when new capital ships will be laid down. The design of these opens a tremendous field for conjecture, but it may be accepted that their displacement will not be below that of the new ships recently laid down in France and Italy and in all probability will exceed 40,000 tons. Upon this displacement they could carry twelve 16-inch guns and steam 23 knots, with the guns either in four triple or three quadruple turrets, and a heavy dual-purpose secondary battery which would probably be mounted in small multiple turrets. At present, anti-aircraft guns in American ships are on open mounts but there is much to be said for the French and Japanese method of protecting their crews from aircraft fire. As visualization of such a ship, I should be inclined to suggest a type carrying three quadruple turrets, two forward and one aft —American constructors do not particularly favor the massing of all the main armament up forward as in the *Nelson*—the multiple dual-purpose, 5-inch guns would be in turrets along the topsides and amidships aft, and no torpedo armament. If the War proved anything, it proved the waste of weight and space in fitting torpedo tubes in battleships.



French battleship *Dunkerque* of 26,500 tons, carrying eig 13.2-inch guns in quadruple turrets. Her secondary armame of 16 5.2-inch guns is in quadruple and twin turrets and t

The American *Savannah* promises to be a very serviceable type of cruiser with her 15 6-inch guns and is likely to be in favor for some time to come. In addition, some sort of flight-deck cruiser will probably be tried out, but the possibilities in the autogiro, when naval types with high power and carrying capacity are built, may obviate a special vessel for alighting purposes. Indeed, this ability to arise and alight on a confined space would seem to presage the end of the catapult which now makes such a call on deck space and weight. At present the only hybrid of this sort is the Swedish *Gotland*, which is a carrier with a cruiser armament, but her 'plane deck is for stowage only and not for alighting. So far as I can gather, the American flight-deck cruiser would serve more as an alighting ship than as a 'plane transport, and such a vessel might be built under the Treaty without delay, if its exact rôle could be economically assured. I say "economically" because the autogiro introduces a new factor when the provision of ships of this type has to be decided upon, and it would be a waste of money to embark on their construction if the development of aircraft made them unnecessary.

For the same reason, it looks as though the giant carrier would have no place in future programs. Twenty thousand tons displacement is big enough for anything in the way of a carrier pure and simple—if not almost too big. Such ships are too vulnerable and their car-



atapult is on the quarter deck. She is said to carry 10,000 tons
[illegible] armor. Note grouping of the three quadruple anti-aircraft
urrets aft. Her speed is 29.5 knots with 100,000 horsepower

goes too precious to risk the concentration of 50 or so 'planes in one hull, and most admirals would be happier to know that their air force was divided into two smaller hulls. The battleship-carrier which was mooted some years ago is an absurdity which will never materialize, and ranks with the submarine carrying big guns such as was tried out for the British Navy in the unfortunate "M" class. Both Japan and America will build large submarines, but practical experience has shown that the British *X.1* and French *Surcouf* types are not a good investment. Already *X.1* has finished her career and is on the suspension list, and the French have never gone any further with the proposed sister to *Surcouf*.

In smaller craft, America is going to the limits, as regards displacement and gun powder, in her *Erie* class, which are reported as being 2000-tonners with four 6-inch guns. If such an armament can be properly fought from a hull of this size, then the design will find favor everywhere. For convoy work, they should prove of all-round value as they carry a hangar and 'plane, and four 6-inch guns will have a word to say to any raiding cruiser. I shall have something to say about such sloops when discussing British ships so will pass on to the possible developments on the other side of the Atlantic now.

Although Herr Hitler has not outlined any features of the new navy he intends to build, his recently consummated naval treaty with Britain has taken the uncertainty out of the Anglo-German naval problem. This menace removed, Britain is faced with the problem of the rapid expansion in the Far East. (And, at the moment, the alarming Mediterranean situation.—*Ed.*) Now, the British Admiralty are no great advocates of large dimensions—they would willingly see battleships restricted to 25,000 tons and 12-inch guns, and cruisers to 7000 tons and 6-inch guns. The reason for this, of course, is that numbers are imperative because so many overseas squadrons have to be maintained and the possession of adequate fleet bases all over the world greatly lessens the fuel provision problem; without bases, ships must carry a vast fuel supply if they are to fight overseas and this means an all-round increase in size. With France and Italy both constructing huge battleships it is hard to see how England can rest content with 25,000-tonners when the opportunity of building them again comes along—public opinion would demand ships equal to those abroad even if the Admiralty had the courage of their convictions—and a reversion to the practice of former days, when first- and second-class battleships were built, would seem to be the possible solution.

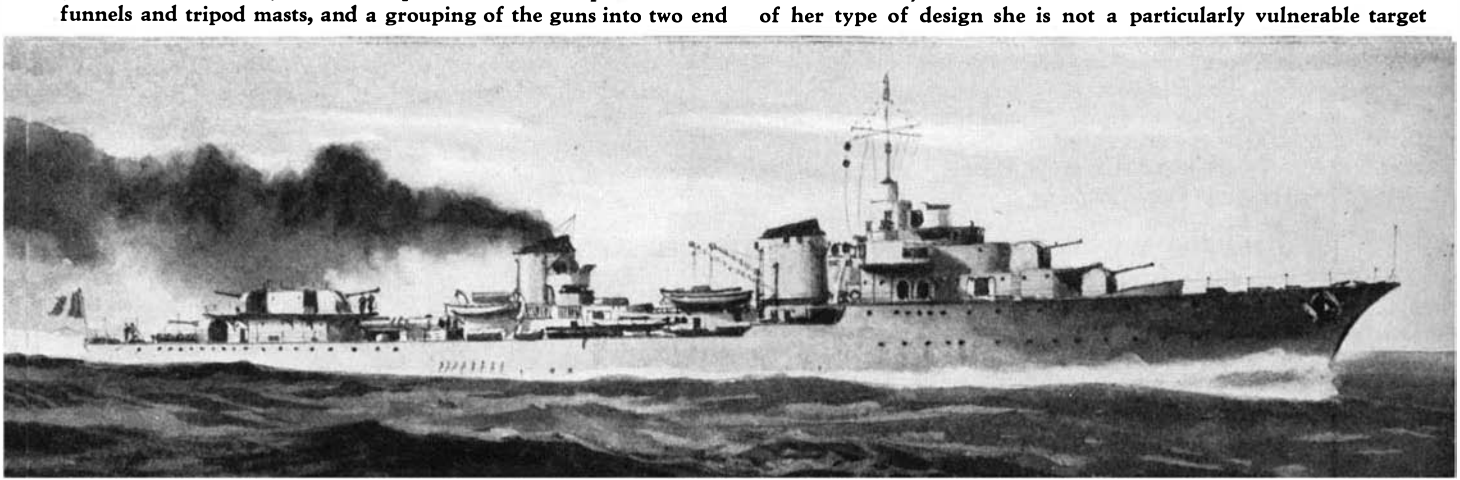
A 40,000-tonner would be pervious to fire from 13.5-inch guns, and a ship half her size carrying six of these, with high speed and thick armor, would be no mean antagonist when built in the ratio of two to one. The same line of argument applies to cruisers. Although the *Arethusa* class, with six 6-inch guns only, is not going to be popular in the Service because of her obvious inferiority to every other ship of her class afloat, yet when numbers are essential and accident or mishap can put a ship of twice her size out of action just as easily, there is much to be said for the minimum of effectiveness.

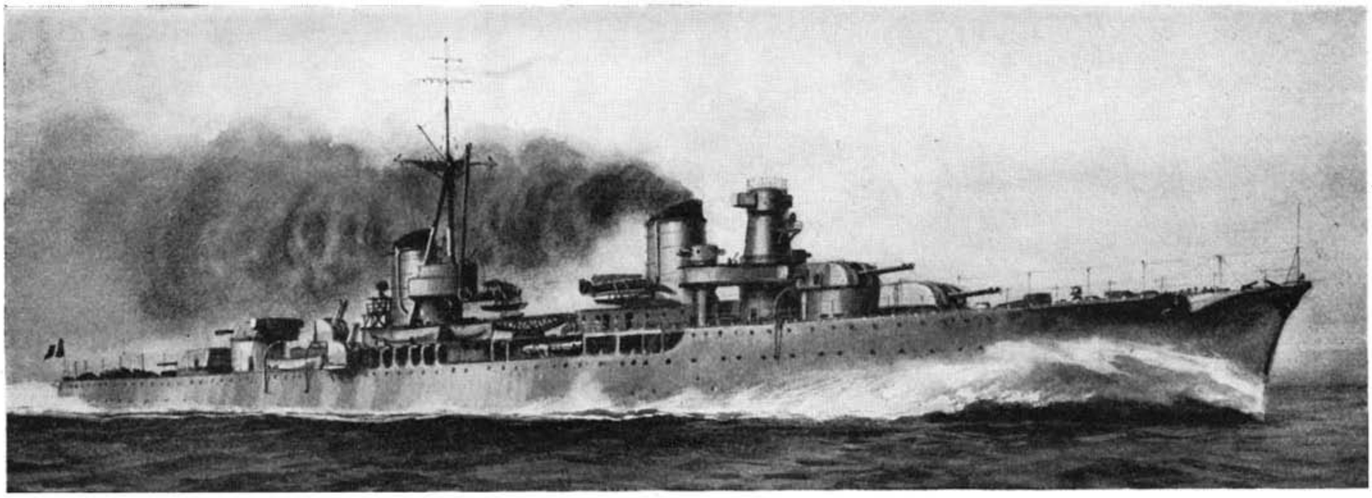
FACED with North Sea and Pacific problems, the solution will probably lie in building a variety of types large and small, of which the smaller units would be assigned to home service. For the protection of her sea trade, England requires cruisers in excess of anything she is ever likely to build, but as convoys may be attacked by every class of warship from battle-cruiser to submarine, and adequate protection cannot be provided to meet every emergency, a compromise must be evolved in the convoy cruiser. As nothing less than 5000 tons would make for steady shooting on the high seas, it seems unlikely that the *Arethusa* will be much improved upon excepting so far as her shortcomings in service may indicate.

No departures from conventional type need be expected in the British Navy. There is no Fisher spirit at the Admiralty and it is realized that the introduction of a new type of ship only nullifies existing superiority and leads to fresh competitive building.

France having renewed battleship construction with the *Dunkerque*, Italy has responded with still larger ships and so set the pace for future com-

French "leader" *Fantasque* of 2569 tons, carrying five 5.5-inch guns and nine tubes, shows a departure from the previous four funnels and tripod masts, and a grouping of the guns into two end sections. With 74,000 horsepower, she was designed for 37 knots but has actually made 42 knots under service conditions. Because of her type of design she is not a particularly vulnerable target





Italian cruiser *Montecuccoli* of 5857 tons, armed with eight 6-inch guns and steaming 37 knots with 110,000 horsepower. She is lightly built and has no armor. The catapult is amidships with stowage for three planes. As an enemy target she has been very much reduced and the former tripod mast and tier of bridges forward have been replaced by a simple turret-like tower

petition. The French favor the quadruple turret which is practically two twin turrets on a single base, the pairs of guns being divided by a thick screen. There is considerable saving in weight, thus allowing for thicker armor over the turret and magazines; and control is simplified. The lay-out of the *Dunkerque* can be seen from the illustration —as in the *Nelson*, there is no stern fire, and it is reported that in the *France* (her third new battleship) there will be three quadruple turrets, one forward and two astern. There is much to be said for tactics which are based on the leading position in an action—call it fighting on the retreat. Gunfire astern leads to better shooting, and the ahead position in battle confers the initiative in smoke screening, torpedo attack, mine dropping, etc. Whatever constructional advantages turret concentration forward may confer, the tactical disadvantages (and especially blast effect on firing abaft the beam) cancel these out. Incidentally, the official model of the *Dunkerque* shows one turret at each end, so the decision to place both forward was a last minute one, influenced by the British practice.

France is building six cruisers of the *La Galissonnière* class with nine 6-inch guns in three triple turrets—two forward and one aft—which are moderately well protected against 6-inch gun fire, and has a leaning towards the quadruple turret in her subsequent ships. In addition, she has a type of large "leader" still building which carries five 5.5-inch guns and can steam over 40 knots. These are overgrown destroyers, expensive and only suitable for destroyer work. There are designs prepared for a 3000-ton vessel carrying 5.5-inch guns which would be a cruiser and fit for high-seas work and endurance. That the large destroyer will merge into the cruiser is becoming obvious on all sides—the Netherlands "leader" of 2000 tons which was designed by Yarrows to carry eight 4.7-inch has been dropped in favor of a German design much larger and more heavily armed, if finances run to her construction, and in other quarters similar ships are under consideration.

Italy is completing her last batch of very fast light cruisers armed with eight 6-inch guns and steaming over 37 knots. This type has grown from 5000 to 6800 tons; and the design, from being rather like a young dreadnought with big superstructures and tripod masts, has become modified to a very reduced target in which the foremast-bridge is now only an armored tower. We are far more likely to be surprised with something fresh in the way of designs from Italy—in the past she has produced ships like the huge *Italia* of 18 knots and carrying four 104-ton guns which appeared in the late 'eighties, the *Reine Elena* which introduced the fast battleship early this century, and Cuniberti's first suggestion for the *Dreadnought*. At present she is re-constructing her older battleships into battle-cruisers; and the *Littorio* class of 35,000 tons and 125,000 horsepower will be tremendously powerful ships of high speed and novel characteristics, from what meager information has leaked out.

To sum up, present indications are that no radical departures from conventional types will appear yet awhile. I think that the flight-deck cruiser will wait upon autogiro developments and that the *Deutschland* will set the fashion for fast battleships in most navies after 1936. Cruisers will multiply in types as national requirements demand, and destroyers will merge on the one hand into fast scouts and drop back again to more moderate tonnage like the British standard type which is big enough for fleet work and well able to hold her own. Submarines have reached a standard which does not offer much scope for improvement—increased speed means a great increase of size as in the British *Thames* type of 22½ knots—and only a few of these can be built at the present cost. Sloops are going to appear in all navies and their characteristics will vary as their duties; and much will depend upon the success of the United States *Erie* class in determining size and armament.

Meanwhile, we can be entertained by the stories of the Japanese one-man submarines, and extraordinary ships which the British are supposed to be building, descriptions of which periodically crop up in the press but which have no foundation except in the minds of the "special correspondents" who thrive on them.

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Dr. Parkes' splendid article is all the more provocative, so far as American readers are concerned, since it stresses the non-competition idea so often reiterated by Americans. "It is the advent of something new in warships which leads to fresh outbreaks in competition," he says at one point. In summing up, he says: ". . . present indications are that no departures from conventional types will appear yet awhile."

The United States will not enter any naval building competition. In fact, it seems that, even in building our Navy up to Treaty strength, we must "follow the leader" in design and development of types. This is due to our lack of experience. Rather than spread our program over a period of years, we practically stopped building anything for years, and our naval constructors have had to start almost "from scratch" in providing vessels under our new program. It is to be hoped that, in the future, the needs of our Navy will be filled through a sane, continuous building program which, while not inviting competitive building, will inspire respect for our policies and permit us to go our way in peace.—*Editor*.

INDUSTRY AND THE NAVY

Tangible, Cash Results to Industry from the Navy's Demands for Superior Products

By F. D. McHUGH

GRACIOUSLY refusing to take all the credit himself for his successful flight, solo, from New York to Paris in 1927, Colonel Lindbergh did something more than achieve a well-earned fame: he called attention to the other half of the team "We." Despite his able piloting, that trip could not have succeeded if that other half, *The Spirit of St. Louis,* and more particularly its air-cooled engine, had not reached a high stage of development. The engine, too, became famous as a result of that flight. Its perfect functioning and absolute reliability called the attention of the world to the strides made by American aviation designers. That reputation has since been sustained and built up to such an extent that, now, American aviation engines find a steady market abroad. But besides assisting in opening a world market for our airplane engines, this one flight stimulated such interest in aviation that it has been possible for the United States to establish the world's greatest system of airways.

This is all history, of course, but we emphasize the facts because the Navy was directly responsible for that air-cooled engine. It was evolved directly from an engine developed for the Navy by the manufacturer's engineers in collaboration with Navy engineers. This development could not have taken place except for the very great assistance of the Navy Department since the excessive design and research costs rendered the engine prohibitive for commercial development, and the Army was not in the market for this type.

Thus we have a key to the situation that has obtained in many industries. Radio, for example, owes much to the Navy, for the Navy was the first large organization to enter the radio telegraph field in America. The present high efficiency and low cost of radio communication equipment are largely due to the Navy's work and its demands on manufacturers for continued improvements. Here, then, is the key, as shown by the air-cooled airplane engine, by radio, and by numerous other products: These have been made available for other services which, without the Navy's assistance, would have been deprived of them.

The Navy is, indeed, a protector of American rights and policies. Yet it is something more, something vital in its influence on American industries. It is a vast marine laboratory, stimulating research and fostering scientific progress and industrial achievement. Seeking always the latest, most improved products of applied science in order to maintain its proficiency, it makes its specifications so rigid that often manufacturers must do considerable research or must re-vamp entire plants to fill the requirements. Knowledge and experience thus gained by the manufacturer has often produced a better commercial product.

STEEL is a case in point. Steel owes its beginning in America as a great industry to the demand of the Navy, in 1881, for better steel than was then available. The Diesel engine is likewise indebted to the Navy. American Diesel engines, before the World War, weren't quite up to snuff. The Navy's work in dissecting and analyzing a German Diesel engine, after the war, put the industry on the right track. Witness, now, Diesel-engined streamlined trains, buses, trucks, stationary installations, and the promise of Diesel automobiles.

When the better steel was demanded, no steel manufacturer was willing to accept the contract to deliver steel on the Navy's specifications, but finally contracts were made. Even then, due to the enormous manufacturing difficulties, pressure was brought to bear on the Navy to force modifications of the requirements. The Department, however, refused to be either coerced or cajoled; the manufacturers finally succeeded; and the net result was the birth of an American steel industry, now grown to be larger than that of any other Nation.

Not content to let its feats stand as the ultimate, the Navy demands constant improvement; and not content to sit idly by after making such demands, makes complete tests of products, suggests methods of improvement, offers the manufacturer the fullest co-operation in the necessary research or reorganization.

The American Navy was the first to develop and use the "electrical reduction gear" for ships, electrical drive being first used in our battleships built during the World War. Since then electrical drive has been found most satisfactory for large liners. The bulbous bow which is now used on many of the large liners (the *Bremen* and *Europa,* for example) with great savings in fuel, is another Navy development. Its principle was discovered by Rear Admiral Taylor in researches in the model testing basin at Washington. The process of welding ship hulls, which holds such promise for commercial ships, is still another application in which the Navy pioneered.

The welding of boiler drums has progressed, under the prodding of the Navy's demands, to the point where one manufacturer (at least) can produce welds equal to, or better than, the plate metal in tensile strength, ductility, impact resistance, grain structure, and ability to withstand repeated stresses.

Some other outstanding developments of far-reaching importance, commercially, brought out or inspired by the Navy are: "slow-motion" movies, developed in collaboration with the Edison Laboratories in 1913; aluminum foil heat insulation; American optical glass for scientific instruments, telescopes, and the like; duralumin for construction of pontoons for flying boats—but, enough of detail.

On page 231, Captain Jonas H. Ingram has given detail enough of Navy progress during the past 15 years. It is a notable fact that most of the developments of which he writes have tremendous significance outside the Navy; some may, in fact, revolutionize their producing industries to the ultimate advantage and profit of civilian users. What Captain Ingram modestly refrained from telling is that only the Navy's actual work, its advice, or suggestions, or a combination of all three made these developments possible. And industry has profited tremendously thereby. It can, therefore, be said without fear of contradiction that the Navy's scientific work has returned more than enough *cash* dividends to the American people to pay back the annual appropriations made to it by Congress for many years!

FLYING IN THE NAVY

Determining Factor in Tactics . . . A Combatant Arm of the Service . . . Three General Classes of Aircraft . . . Will Battleships Become Obsolete?

By CAPTAIN P. N. L. BELLINGER, U. S. N.

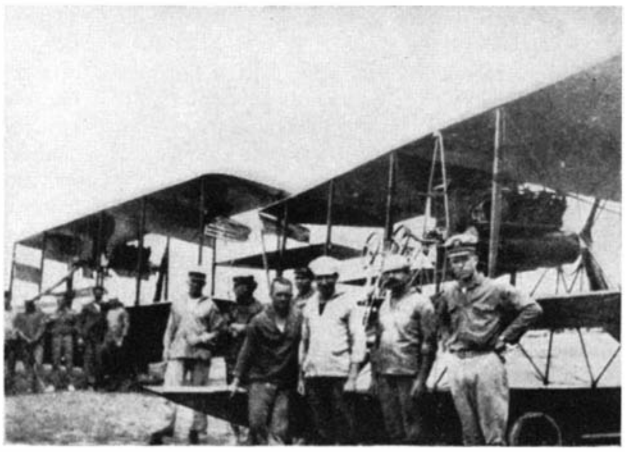
SO long as there is ocean-borne commerce and so long as there are wars between nations, there will always be naval battles, although a major fleet engagement may never again be fought. Some contend that the potentialities of aircraft have offset the effectiveness of such an array of floating fortresses, or that future fleet engagements will take the form of raids. Perhaps it also may be argued that a fleet "in being" is more potent than a fleet in jeopardy. Nevertheless, so long as there are ships on the seas, whether they be merchantmen or combatant vessels, we can expect ships to engage in sea battles in some form or another. Where these engagements will take place will depend largely on the effectiveness of aircraft.

Prior to the advent of aircraft, ships during a state of war could move about on the high seas with ships of the enemy as their only opposition. Now, however, their movements are not only curtailed by enemy ships, but also by the airplanes carried on these ships and by airplanes from shore bases as well. How far away from their shore bases these planes can be effective will be a determining factor in the location of an operation, its type, and the tactics employed.

The modern navy, and the United States Navy rates itself as such, must now have its aircraft as an integral part of its force. All of the capabilities and endeavors of naval aviation further naval interests and are designed to fit the Navy to perform its functions better. In naval aviation, the reliance of ships upon aircraft and aircraft upon ships, the co-operation required between these two fundamentals of the Navy, the necessity for co-ordination of their employment through one high command, the sameness of their objective, require that naval aviation, as it is conceived today and as it may be expanded tomorrow, be an integral part of the Navy.

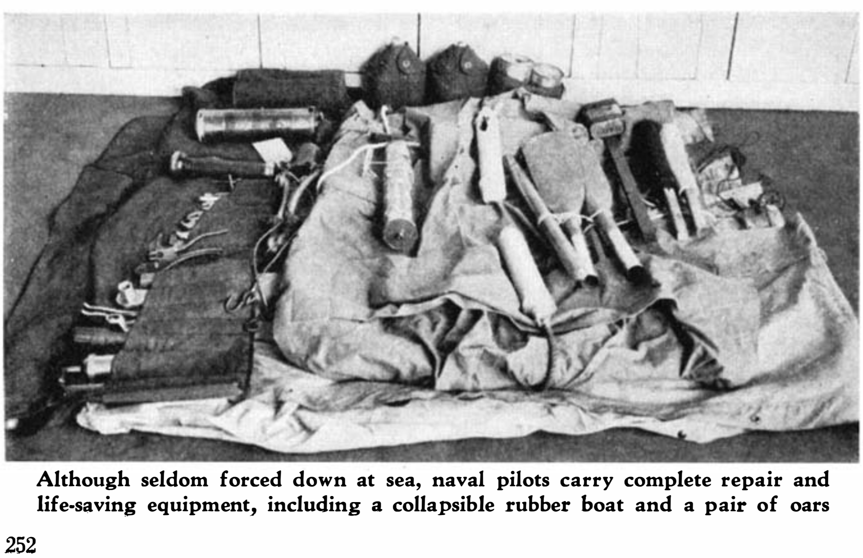
Little did we realize in the early days that aviation would ever play this important part. It was no doubt with the idea of delving into the mysteries of the unknown that in December, 1910, the Navy Department ordered one officer to the Curtiss Flying School for instruction. By the end of 1912 there were exactly seven men in the Navy who knew how to fly, and even in 1917 and later, there were many who had so little faith in the usefulness of naval aviation that they considered that an officer jeopardized his future in the service by continuing in aviation. As the years have gone by and the airplane has developed, its importance in the Navy has steadily grown until now no war plans are considered without due regard to the employment and effect of aircraft.

The old idea was that the only use for planes was to serve the ships on which they were based. Their job was to scout and to spot for gun fire. Aviation was called "The Eyes of the Fleet"; correctly called, too, for at that time it was not capable of playing more than an auxiliary part. But in spite of all this, there were a few individuals with sufficient vision to look forward to the day when aviation would be a potential factor in the Navy.



A study in contrasts: *Above:* The Navy Aircraft Section at Vera Cruz in 1914. *Right:* A flight of modern carrier-based airplanes on maneuvers over Midway Islands

It was not until after the World War that definite steps were taken to put aviation into the Fleet. There had been experimental development aboard two ships prior to 1917 but, due to the stress of war, this work had been discontinued. In 1919, however, a policy was established to put one or more planes on each and every combatant ship capable of carrying them. During the period of execution of the project, all available funds were used for that purpose, to the sacrifice of the various aviation activities on shore. The effect of this policy was to bring aviation in close proximity

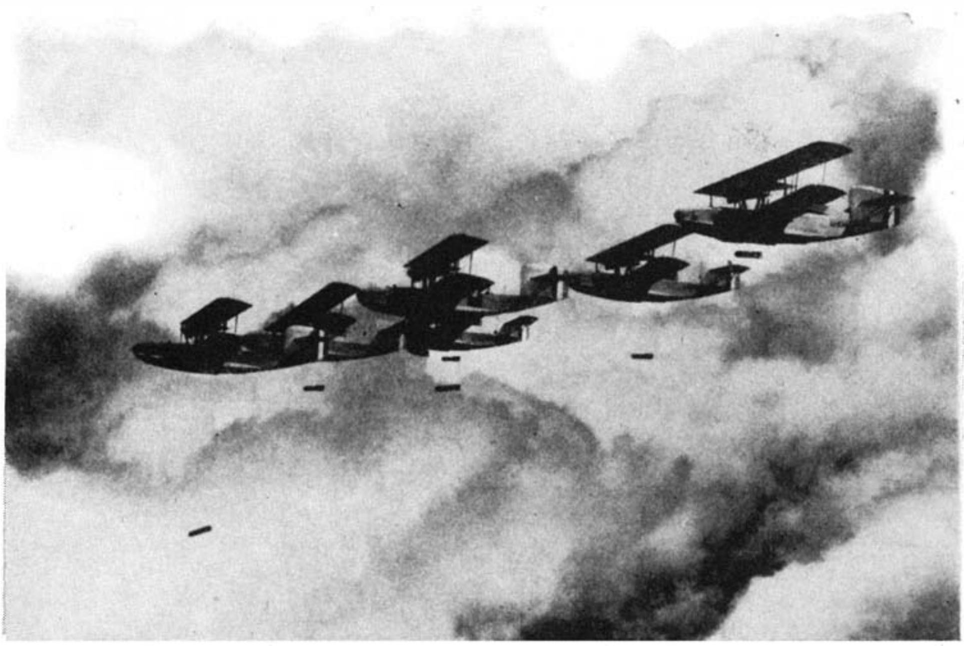


Although seldom forced down at sea, naval pilots carry complete repair and life-saving equipment, including a collapsible rubber boat and a pair of oars

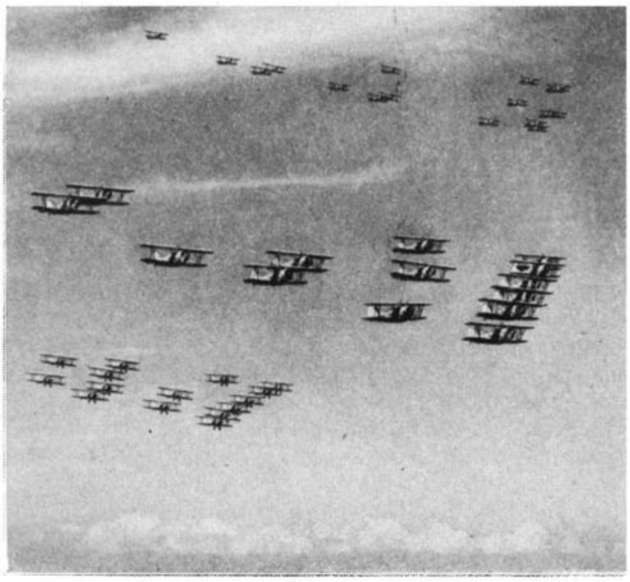
These are the personal views of the writer and in no way express the official views of the Navy Department.

to the rest of the Navy. It educated the aviator to the needs of the Fleet and demonstrated to the Fleet the possibilities of aviation. It promoted the development of aviation in the Fleet as an auxiliary, but on the other hand, it interrupted the development of large flying boats which operate from tenders or shore bases—those big flying boats that are fast becoming one of the most powerful units in the naval aviation of today.

Aviation can no longer be considered only "The Eyes of the Fleet"—it has long since stepped out of that secondary rôle and has become a combatant arm of the Navy. As all of the great powers are admitting, to their intense concern within the last few years, aviation has become an offensive force which must be reckoned with. Moreover, they go further and admit that there is no sure defense against the airplane.



A division of patrol planes launching a salvo of bombs



In Europe today the talk is of air pacts. And the need for air pacts is a tacit admission of the power of destruction that belongs to the airplane and of the inadequacy of defense against it. A chief reason for this inadequate defense is the high speed of all modern planes, both large and small. Theoretically, the big attacking bomber can fly approximately as fast as the small defensive fighter. It can now approach and launch its attack at over 200 miles an hour instead of the hundred miles an hour of not so very long ago. In consequence, its power of evasion, both with reference to anti-aircraft guns and defensive planes in the air, has enormously increased. Its high rate of speed has primarily been brought about by the super-charged motor and the adjustable pitch propeller, which permit a high altitude with a gain of speed instead of a decrease, as was formerly the case.

In the Navy, heavier-than-air aviation is divided into three general classes: planes based on battleships and cruisers; those based on carriers; and the big flying boats which operate from tenders and shore bases.

Our battleships and cruisers carry seaplanes whose main mission is to increase the effectiveness of the ships on which they are based. On the battleships they are called observation planes and their mission is primarily to spot gun fire of the battleships. Aboard the cruisers they are called scouting planes and are used as such.

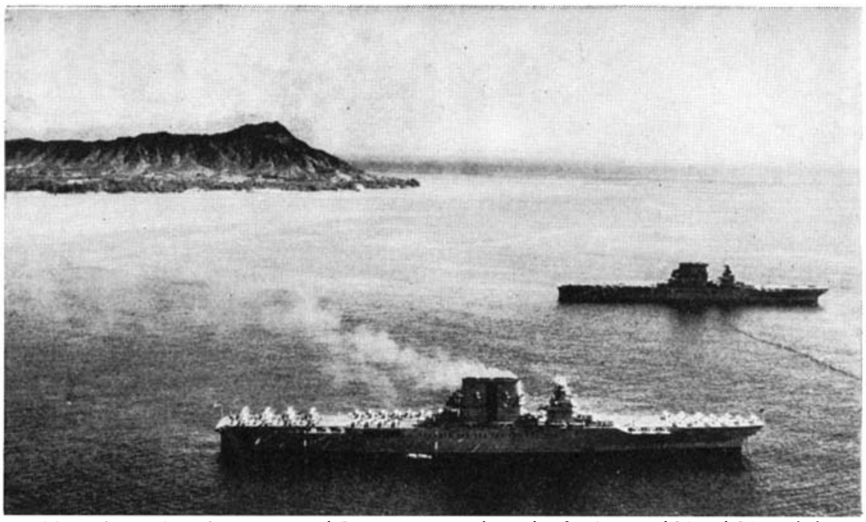
BOTH of these types are launched into the air by catapults from the decks of their ships and, upon returning from their flights, they land alongside and are hoisted on board. Their value to ships may be visualized when we consider that they serve as fast moving observation platforms, capable of taking any position of vantage. Moreover, they cover vast areas and carry with them efficient radio equipment with which to supply information to their ships.

It is an inspiring sight to stand on the bridge of the leading ship in column, to note the hauling down of the signal to launch planes and, looking down the column of ships, to see what appears to be a salvo of planes catapulted into the air.

In the type of plane carried by battleships and cruisers, the prime requisites are strength for catapult shots and open sea operation, a low landing speed, and good vision for observation. Such aircraft must be equipped with hoisting facilities, the total weight must be within the capacity of the hoisting crane, their span must permit satisfactory handling and stowage aboard ship and, with these restrictions, they must be able to carry all necessary equipment, climb to required altitude, travel at high speed and remain in the air the necessary hours to perform their jobs. In themselves, they have little value as a combatant unit in the Fleet but they furnish a very important and indispensable service.

The second class of planes, those based on carriers, are in a group by themselves, both as to mission and as to type. Our great carriers of today do far more than merely carry planes. Each one in itself is a mobile floating airdrome. The carrier is not designed with the idea that as a ship it will seek combat with other ships, although it has guns for defense. Its purpose is to provide a mobile operating base at sea, for the planes which it carries, so that those planes may be available at the scene of action, ready and equipped to perform their functions as an arm of the Fleet.

We now have four aircraft carriers in our Navy and within the next two years two more will be added. Each carrier has been allotted a complement of planes which consists of squadrons of those types that are best fitted for offensive action against an enemy. Requirements peculiar to planes based on carriers include short take-off runs along the deck, ability to land on board, and spans sufficiently small to enable a large num-



Aircraft carriers *Saratoga* and *Lexington*, anchored off Diamond Head, Honolulu

ber of planes to be spotted on deck. These operating requirements somewhat curtail the full application of all the latest aerodynamic developments and likewise tend to limit the capabilities of carrier-based aircraft; nevertheless they are capable of offensive action of undisputed potency.

The term "striking force" as applied to a special force within the Fleet for inflicting early and effective damage on an enemy, is not normally used. The Fleet itself, as the first line of national defense, is a "striking force" when the need therefor arises. The carrier force, however, by virtue of the potency of its planes, is of its own power and as an arm of the Fleet, a very competent "striking force."

THE third class in naval aviation, the patrol plane, offers even greater possibilities as a striking force, for it flies to the scene of action instead of being transported by a vulnerable mobile airdrome.

During the World War naval aviation was employed generally to curb the submarine menace. Few of the planes so employed sighted and attacked submarines, only a small percentage of these registered damage; still it has been conceded that knowledge of the presence of aircraft in any sea area caused considerable restriction on the operation of submarines. The general name applied to this service and to the class of planes engaged in it was "Patrol." This term has been retained and at present we have patrol planes, the name indicating a particular class of aircraft with definite functions.

This type is the only one that is not restricted in size or performance to conform to the operating conditions peculiar to shipboard aircraft. As a consequence, its potentiality is limited only by the existing aeronautical development. This fact is of vital significance. Today, aircraft of this class greatly surpass those of a few years ago in speed, range, and weight-carrying ability. Its size has greatly increased and as yet the size limit for efficient performance has not been reached. Generally speaking, within the limits of effectiveness the larger the plane the more load can be carried. Put this load into armament, including bombs or torpedoes, and the large plane assumes more formidable possibilities than the smaller plane. Semi-protected sea areas serve as suitable seadromes from which to operate these aircraft. This, together with their large cruising range, enables them to accompany the Fleet and work in conjunction therewith by proceeding from one locality to another to any part of the world. Normally such planes operate from Naval Air Bases located along our coasts and insular possessions. However, to enable them to operate from protected waters, where no shore facilities exist, tenders are provided which furnish the services required. It is through these tenders that greater mobility of large numbers of planes is attained.

Our patrol planes are large flying boats. It may be recalled that a group of them made the flight from San Francisco to Honolulu in January, 1934, a distance of about 2400 miles. Considering their present speed, range, and weight-carrying capacity and also considering their susceptibility for future development along those lines, we can well visualize the usefulness and importance of the big flying boat in connection with the conduct of many naval functions.

THE question has often been raised: "Why bother about building additional warships, when aircraft can bomb and sink them?"

We are familiar with the effect of the torpedo which was employed so generally during the World War. The torpedo has all the effects of a bomb that explodes in a similar position relative to the underwater portion of a ship. We know that it sank merchantmen and that it more or less crippled warships, although it did not in all cases sink them. Modern warships are built with the idea of restricting damage to that small portion of the ship in the vicinity of the torpedo hit. A modern battleship, having been struck by a torpedo, may even continue to carry on a fight very effectively. However, as compared with aircraft, submarines are very few in numbers and extremely slow in speed. For this reason the menace presented by submarines is fairly well localized. If, on the other hand, submarines existed in great numbers and if it were possible to increase their speed tenfold, or to that of a patrol plane, would they not present an entirely different opposition for fleets to consider?

Aircraft bombs are of various weights, including those carrying twice as much explosive as a torpedo. Whether these heavy bombs will sink a ship, put it out of action permanently or temporarily, or merely do partial damage, depends on the efficiency of the protective features embodied in the ship and on the part of the ship in which the bomb explodes when a direct hit is made.

THE effect of aircraft bombs on ships is normally weighed from the viewpoint that they actually strike the ship; however, there is also the torpedo effect to be considered in case they miss the ship and land close alongside. From much published tests that were conducted in the past, the effect of a heavy bomb landing on a ship has led to much controversy. Without going further into the discussion on this point, it can be stated very definitely that the explosive effect of heavy bombs is terrific and that they can do much material damage. The main question cannot and probably never will be answered conclusively to the satisfaction of all. Much will depend on the answer to the following: "Considering the vast expanse of oceans, the relatively small targets presented, the concentrated anti-aircraft batteries opposing, to what extent will ships be subject to aircraft bombing attacks and how accurately can aircraft make bomb hits?"

I am not one of those who believe that because the airplane has become powerful the battleship has become obsolete. So long as any probable enemy has battleships, it will be wise for us to have them also. I do predict, however, that the battleship of the future will be quite unlike the battleship of today. And I am equally confident that as the years go by, the fleets of the world will grow less and less anxious to make themselves easy targets for enemy aircraft.

Do We Hear With Our Eyes?

Eyes Work Where Ears Fail . . . "Lip Reading" a Misnomer . . . Correcting Errors in Understanding

By JACK C. COTTON, M.Sc.
Phonetics Laboratories, Ohio State University

Booths used in hearing tests. The clinician is operating an audiometer and checking hearing test cards. She is also watching a row of lights controlled by those in the booths in response to their hearing of the varying tones of the audiometer

THIS question may seem ridiculous, but recent experiments at Ohio State University demonstrate quite conclusively that everyone often makes use of his eyes in "hearing" the speech of those about him where the ears alone would fail entirely.

An audience sits in a darkened room. In front stands a sound-proof booth equipped with a double glass window. Lights on opposite sides of this window shine directly into the eyes of the audience, thus shielding the speaker within the booth from view. The speech of this person is heard through a loudspeaker after being picked up by a microphone and amplified. An operator directs the speaker by telephone. At the beginning of the demonstration, speech from inside the booth can be understood readily although the speaker is not visible.

While the speech is being heard in this manner the operator turns on a noisy buzzer and switches a low-pass filter into the circuit, thus cutting out the high frequency speech components. In this way the understandability of the speech is reduced almost to zero, as frequently occurs in noisy places, over-reverberant auditoriums, and so on.

The inside booth lights are then switched on. The person within continues speaking, his speech still being as greatly distorted as before, but his face being visible. The ease with which his speech can now be understood is surprising. The experiment can be repeated in various ways to establish the fact that vision is responsible for the greatly improved understandability. The inevitable conclusion is that the eyes supply a large and important element in our understanding of speech under adverse auditory conditions.

"VISUAL hearing" is receiving considerable attention at Ohio State University. "Lip-reading" (a misnomer, since the movements and expressions of the whole face and other parts of the body enter into visual hearing) has long been used by the hard-of-hearing, but its use in supplementing minor defects of hearing is a fairly recent development. A hearing loss for high-frequency sounds is fairly common and the loss is seldom realized by the possessor. Of the freshmen entering Ohio State University in the fall of 1934, over 13.5 percent had a hearing loss of 20 decibels (approximately 25 percent) or more in one or both ears for a tone of 8192 cycles per second (about one octave above the highest "C" on the piano keyboard). Many of these students also had losses in other parts of their hearing range.

Set-up for demonstrating the importance of vision in speech understanding

A high-frequency hearing loss makes it difficult to hear or distinguish between such consonant sounds as *p*, *s*, *sh*, *t*, *th*, and so on. Numerous mistakes in speech understanding inevitably result. Many students are handicapped in this way. The situation is similar to that caused by defective vision. Widespread use of simple eye-tests have done much towards the relief of this situation, however, but we are just beginning to see the equal importance of hearing deficiencies which are so commonly overlooked.

Every student entering Ohio State University is given a comprehensive audiometer hearing test. Naturally, in a school where as many as 3000 students may enter in one quarter it is no simple matter to administer reliable tests. An elaborate system is used for handling this large number of students.

The remaining duty towards these students is the provision of a definite course of training whereby their latent visual hearing ability can be effectively strengthened. A motion picture method for accomplishing this result was developed in these laboratories and has been in successful use for the past five years. The films are carefully graded so that students are enabled to progress rapidly in proficiency. Two projection rooms are used on an average of eight hours daily.

STATES THAT BU

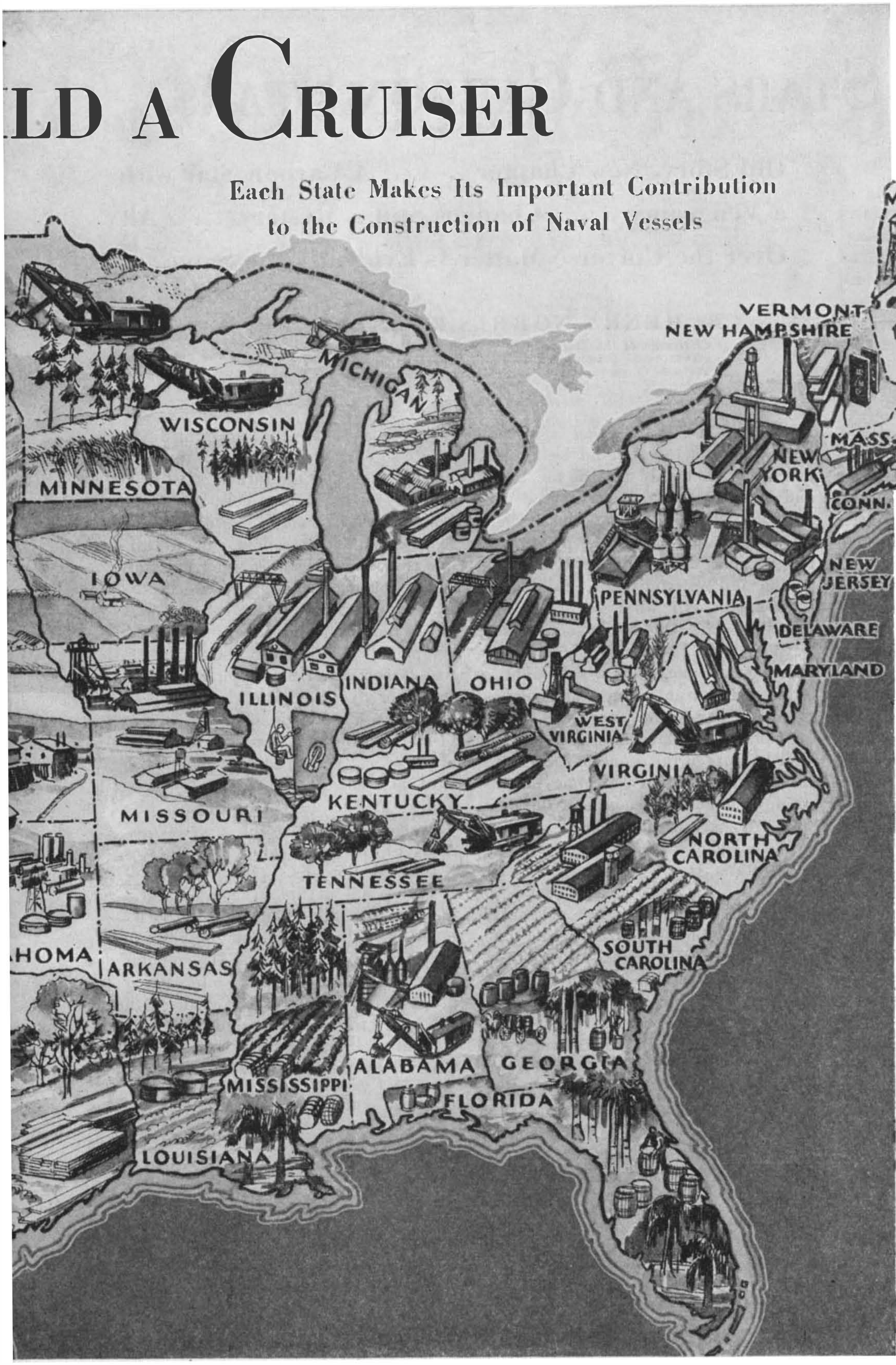
Alabama—Iron ore, limestone, coke, pig iron, pipe fittings $25,000
Arizona—Copper ore, silver *
Arkansas—Ash lumber $15,000
California—Sugar pine *
Colorado—Copper ore, lead, silver *
Connecticut — Brass and copper products, lighting fixtures, electric wire, hardware, cutlery, silverware, chain, ball bearings, valves, gages, clocks, counters $295,000
Florida — Cypress, turpentine, and naval stores $15,000
Georgia—Yellow pine, turpentine and naval stores, cotton $46,000

Idaho — White pine, lead $35,000
Illinois—Refrigerating machinery, hardware, valves, limestone, coke, paints $92,000
Indiana — Electric motors, pumps, limestone, alcohol, oak lumber $235,000
Kansas—Zinc *
Kentucky—Fire brick, oak lumber $35,000
Louisiana—Yellow pine, cypress, cotton, sulfur $25,000
Maine — Winches, windlasses, steering gears, capstans $93,000
Maryland—Steel plates, brass and copper, tubes and sheets, switchboard material, canvas, oakum $197,000
Massachusetts — Electric motors, turbines and generators, pumps, fans and blowers, rubber tile, furniture, rugs and draperies, plumbing fixtures, insulating paper, Manila rope, valves, office supplies, tools, leather belting, grinding wheels, navigation instruments $680,000
Michigan—Iron ore, limestone, white pine, plywood, hardware, furniture, soot blowers, tools, copper, paint $260,000
Minnesota—Iron ore, white pine, flax, linseed $92,000
Missouri—Lead and lead products, zinc $46,000
Mississippi—Yellow pine, cotton $25,000
Montana—Copper ore, wool *
Nevada—Silver *
New Hampshire—Ebony asbestos for switchboard panels *
New Jersey— Boilers and super heaters, oil burners, refrigerating machinery, deck mach-

From farm and forest, mine, quarry, and claypit, sheep ranch and oil well, come the materials of which our modern naval vessels are constructed. Visualizing a modern, steel-clad ship as a machine-made product, our tendency may be to forget that fact. Some inlanders may even feel that they have no part in the Navy since they never see one of its ships and perhaps, also, because they can see no connection between their preponderantly agricultural states and those metal monsters which are designed to keep us out of trouble. Yet the factory is only the middle-man. The factory processes the raw materials drawn from our store of natural resources and from our farms. Each state makes its important contribution—some greater, some smaller, depending upon various factors. And, since 80 or 90 percent of the cost of a naval vessel is for labor, general employ-

...LD A CRUISER

Each State Makes Its Important Contribution to the Construction of Naval Vessels



ment is aided everywhere by construction of each naval vessel.

In the map above, our artist has interpreted this nation-wide contribution, and in the panels at each side we have given the details as applied to the construction of a typical naval vessel, the 10,000-ton cruiser. All the products listed are vital. Without any of them—zinc from Kansas, hardwoods from Tennessee, wool from Wyoming, linseed from North Dakota, and numerous chemicals and paints made from farm products—it would be impossible to make this ship into an efficient unit in our scheme of national defense.

The Navy is, indeed, a living entity into which has been poured a life's blood composed of the labor, patriotism, and devotion to a high ideal of international peace of a whole people; and, in the pouring, each hand has done its part.

inery, elevators, fans, pumps, plumbing fixtures, switchboard instruments, electric cable, storage batteries, galley equipment, fire extinguishing apparatus, paints and varnish, zinc oxide, glass, steel forgings, babbit, rubber goods $1,175,000

New Mexico — Copper ore *

New York—Electric motors, turbines, generator telephones, communication and navigation instruments, life boats, boat davits, cast-iron radiators, furniture, rugs and draperies, carpets, linens, magnesite floor covering, galley equipment, glass, cork products, tools, foundry supplies, office supplies, scrap metals $1,100,000

North Carolina—Canvas, cotton goods, furniture, spruce and maple lumber $126,000

North Dakota—Linseed $12,000

Ohio—Steel shapes, steel and iron pipe, limestone, coke, glassware, quarry tile, sheet rubber, rubber hose, paint and varnish, anchors and chains, hardware, heaters, evaporators, distilleries, tools $330,000

Oklahoma—Fuel oil and lubricants, lead, zinc $35,000

Oregon—Oregon pine $35,000

Pennsylvania — Steel plates, shapes, pipe, ingots, forgings and castings, coal, limestone, coke, electrical machinery, refrigerating machines, deck machinery, thrust bearings, glass, magnesia pipe coverings, anchors and chains, wire rope, hardware, plumbing fixtures, cast-iron radiators, galley equipment, paints and varnish, alcohol, pipe fittings, tools, steam packing, office supplies, cement $2,130,000

Rhode Island—Machine and hand tools $82,000

South Carolina—Canvas, cotton products, turpentine and naval stores $25,000

South Dakota—Linseed *

Tennessee — Iron ore, hardwoods $25,000

Texas—Fuel oil and petroleum, ash lumber, cotton $44,000

Utah—Copper, silver, lead *

Vermont—Plywood *

Virginia — Iron ore, foundry sand, office supplies $35,000

West Virginia — Coal, coke, steel castings, spruce $163,000

Wisconsin — Iron ore, white pine, plywood $92,000

Wyoming— Wool *

*No amount specified.

OXYGEN STARS AND CARBON STARS

Old Story, New Chapter . . . A Carbon Star with a Vengeance . . . Changes Still a Mystery . . . All Over the Universe Matter Is Evidently the Same

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

RETURNING from our meeting at Paris, we American astronomers found that many interesting things have been discovered in the meantime. Some of these were passed from mouth to mouth at our conferences, and they have appeared in the technical journals, and so belong to the "now-it-can-be-told" class for a general article like the present.

One of these adds another chapter to a long story which began nearly 70 years ago. Father Secchi, one of the pioneers of spectroscopy, observing the stars with a prism in front of his four-inch telescope, discovered that there were two kinds of red stars. Both showed spectra crossed by heavy dark bands, far stronger than the lines of the solar spectrum: but in one variety the bands were sharp at the edge toward the violet and faded out toward the red, while in the other the sharp edge was toward the red and the shading toward the violet. In the later classification at Harvard the former were denoted by the letter M, and the latter by N. The bands in the N-stars were long ago recognized as produced by carbon in some of its compounds; those in the M-stars were identified somewhat later by Fowler, and are due to titanium oxide. More extensive studies, including hundreds of stars, reveal a curious fact. Practically every red star showed *either* the titanium or the carbon bands, but not a single one out of the hundreds showed *both.* What did this mean? The explanation was given 20 years or so ago by the late Professor Ralph H. Curtiss.

BOTH sets of bands are due, not to atoms, but to compounds of various kinds which form at the relatively low temperatures of the coolest stars. Those of the N-stars come from carbon molecules (C_2), or cyanogen (CN), or the simplest possible hydrocarbon (CH), while the M-stars show titanium oxide. Where compounds can form we have to do with chemistry, and the moment we think of the problem in this way the solution is plain. Suppose we were to take a mixture of carbon and of a metallic oxide and heat it to a temperature far hotter than that of any blast furnace, so that the refractory carbon itself was vaporized. With an excess of carbon—as in the industrial furnace—the oxide will be reduced, forming carbon monoxide and the free metal. At a higher temperature the vapors of carbon and the metal would appear. But if there was not enough carbon it would all be used up in reducing a part of the oxide, and there would be no carbon vapor, but only that of the metal and its oxide—partly decomposed perhaps into the metal-vapor and oxygen. These two situations—corresponding to the familiar distinction between a reducing and an oxidizing atmosphere—represent exactly what we find in the N- and M-stars. One might inquire why we do not find spectroscopic evidence of the carbon monoxide, which ought to be present; but the strong bands of this gas all lie far in the ultra-violet where we cannot get at them in the sun or stars because of the ozone in the earth's atmosphere. Free oxygen, too, has its strong lines out of reach, and the next strongest far in the deep red—very hard, though not impossible, to observe in the stars.

IT might be that in some particular star the amounts of carbon and oxygen were perfectly matched so that, on combination, each used up the other. In this case neither compounds of carbon nor metallic oxides would form, except in small amounts, and there would be no conspicuous bands in the spectrum. Detailed calculations show, however, that if either element were in excess by so much as 1 percent, fairly strong bands would appear, so that this perfectly balanced case would be very unlikely to be met with.

As a matter of fact, stars of spectrum M are about 100 times more numerous than those of class N of the same apparent brightness. It follows that excess of oxygen is the normal condition in the star, and that excess of carbon is rare. Why such differences of composition should exist no one knows. The observable N-stars are all of great absolute brightness, remote from the sun, and are scattered thinly in space, so that most of them appear in the Milky Way or the adjoining parts of the sky. Two or three of them are just visible to the naked eye.

This distinction between the "oxygen stars" and the "carbon stars" is the most conspicuous of all spectral differences, so long as the temperature is low enough to permit the formation of compounds in the atmospheres. For the hotter stars it seems to disappear—at least it was long sought for in vain. We know that the sun is an oxygen star, for the bands of titanium oxide appear faintly in the spectrum of sunspots where the lower temperature allows the compounds to form. The sun is therefore a member of the majority but, till the other day, no hot carbon star had been recognized. This has been done at last by Dr. Berman, formerly a student at the Lick Observatory and at Harvard, and now on the staff of a junior college at San Mateo, California, who has made a very careful spectroscopic study of the remarkable variable star R Coronae Borealis.

This is one of the strangest stars in the sky. Normally—sometimes for years together—it is of the 6th magnitude with insignificant fluctuations. At irregular and quite unpredictable intervals it drops fairly rapidly as far as the 11th or even the 13th magnitude—only 1/600th of its usual brightness. It may remain faint for but a few weeks or for many months—then it returns to normal, usually more slowly than it faded.

THE spectrum at maximum is of class F7 on the Harvard system—not very different from the sun's, except that it shows conspicuously the characteristics of a super-giant star. Like almost all other intrinsically variable stars, therefore, it is of high luminosity—greatly exceeding the sun, except perhaps at the bottom of its deeper minimum.

When the spectrum is compared in detail with that of an ordinary super-giant star, such as Gamma Cygni, Dr. Berman finds two notable differences: The hydrogen lines are very weak, as has been noticed before, and a few faint lines of carbon in the blue, which are inconspicuous in ordinary stars, are here remarkably strong. These lines are absorbed by free carbon atoms. The bands due to carbon molecules are also present but weak. By a detailed study of more than 600 lines, Dr. Berman has analyzed the atmosphere and determined the amounts of more than 20 elements which are present. For the metals the relative proportions are strikingly similar to those which occur in the sun, but carbon is enormously more abundant and hydrogen less so.

A direct comparison with Gamma Cygni (which, being a highly luminous star, is a fairer standard of comparison than the sun) indicates that, in the latter, the atmosphere is composed of 99 percent hydrogen (by number of atoms), 0.5 percent of carbon, and the same number of atoms of all the metals together, while in R Coronae there is 27 percent of hydrogen, 69 percent of carbon and 14 percent of metals. Here is a carbon star with a vengeance.

IT is unfortunately very hard to determine the amounts of oxygen in these stars, since the only available lines lie so far to the red that exceedingly long exposures would be required to photograph them. There can be no reasonable doubt, though, that carbon is in excess and that this star, if it could be cooled down, would turn into an N-star with very strong bands of carbon compounds. The discussion also indicates that the temperature of the star's surface is 5400 degrees—slightly lower than the sun's—and that the atmospheric pressure and the surface gravity are of the order of 1 percent of the values which prevail on the sun. The actual brightness can only be roughly estimated, but it is probably about 1000 times the sun's—making the star 20 or 30 million miles in diameter.

The extraordinary and erratic changes of brightness to which this star is subject are still a mystery. A few spectra taken while it was faint 10 years or so ago showed great changes, many bright lines being present. The star has grown faint again this year and, if enough good spectra are obtained, we may get some hint as to the cause of the variation. Whether the abnormal abundance of carbon has anything to do with it we do not know, but one fact is suspicious. There are 10 other stars which vary in brightness in the same peculiar fashion. Some of them have spectra of class G—not very different from R Coronae, though existing observations are not sufficient to detect whether the carbon lines are strong. The others are of class R and show carbon bands, though with less intensity than the N-stars. This suggests strongly that these strange objects may all be hot carbon stars. The rest of them unfortunately are so faint that detailed observations will be difficult.

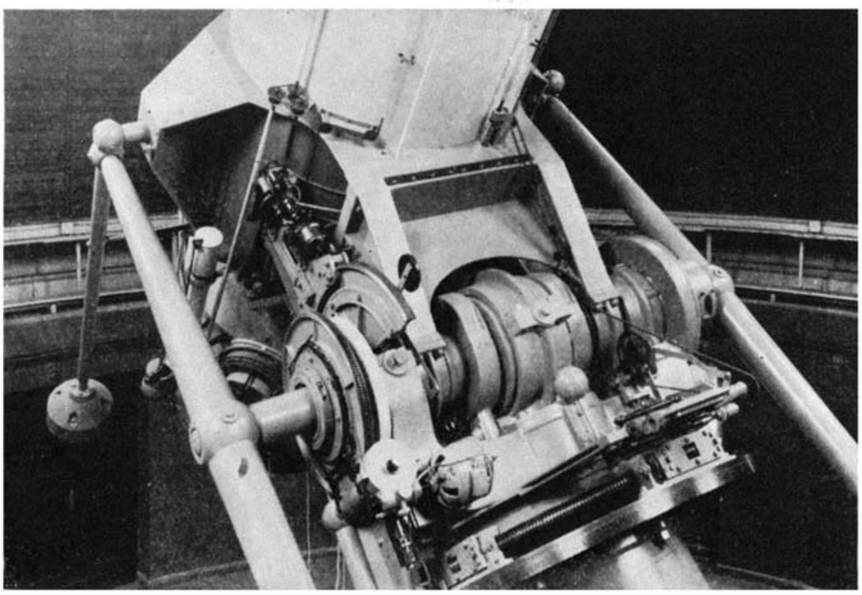
Whether carbon stars are to be found at still higher temperatures is still unknown. Among the Wolf-Rayet stars—the hottest of all—remarkable differences have recently been detected by Beals of the Dominion Observatory at Victoria. They fall definitely into two parallel sequences, one distinguished by bright "bands" (which really are widened lines) of nitrogen, the other by similar bands of carbon. The range of atomic excitation, and hence doubtless of temperature, is large in each series, and about the same for the two, so that it appears clear that they represent different kinds of stars of the same temperature. They are, however, enormously too hot for compounds of any kind to form—from 30,000 to 50,000 degrees, or even more—and no reasons can at present even be suggested why nitrogen should show up in one set and carbon in the other. In this case oxygen appears in the carbon stars and not in the nitrogen sequence, which makes the puzzle all the greater. While this new problem remains to be solved, an older one is rapidly nearing completion—namely, the composition of the gaseous nebulae.

Since Bowen's fundamental discovery, we know that the lines in their spectra are mainly of the "forbidden" type—which are emitted only by an exceedingly rarefied gas. Now atoms of all sorts have ordinary spectral lines, but only a limited number of them (which have spectra more complicated than the average) can show forbidden lines. Among the lighter atoms these are carbon, nitrogen, and oxygen; then come silicon, phosphorus, and sulfur. By removing an electron from the atoms, fluorine is added to the first group, in place of carbon, and chlorine takes the place of the silicon; another ionization puts in neon and argon. A year or so ago neon was recognized in the nebulae by the presence of forbidden lines of its atoms, some with two electrons missing, others with four. More recently, highly ionized argon has been detected in the same way. Now comes a note by Mr. Stoy, an English Commonwealth Fellow at the Lick Observatory, reporting the discovery of forbidden lines of chlorine. They arise from the doubly ionized atom, and lie in the green at 5538 and 5518A. They are so faint that an exposure of 10 hours was required to get a measurable photograph, but their reality appears assured.

THIS discovery is of universal interest since it is the first direct evidence of the existence of chlorine in an astronomical body. Though the element is so familiar in everyday life, it is not really very abundant—most of it on earth is dissolved in the sea as common salt. But this would not prevent its recognition spectroscopically, were it not that its strong lines are in the inaccessible ultra-violet, and its next best too far in the red.

All the first 30 elements, in their natural order, have now been identified in the depths of space. Those which remain unidentified are all rare on earth and we know good reasons why they should be hard to detect with the spectroscope. The last outstanding element of reasonable abundance was chlorine. Now at last it has been detected, and one more confirmation given to the conviction that the general composition of matter is everywhere the same throughout the universe.

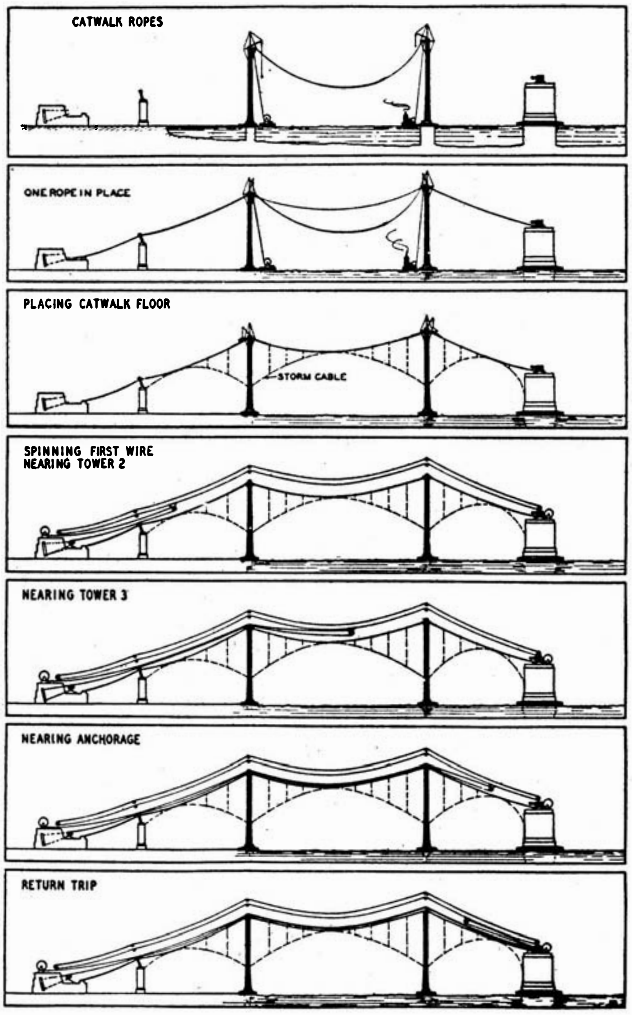
The central stars, whose ultra-violet radiation sets the nebulae shining, are exceedingly hot. Professor Menzel has just stated that the stars' temperature must be at least 100,000 degrees, Centigrade.—*Jamestown, Rhode Island, Sept. 2, 1935.*



The declination axis of the 1.25-meter (49-inch) reflecting telescope at the Neubabelsberg Observatory in a suburb of Berlin. The details of the German (Zeiss) design will seem unfamiliar to most American amateur telescope makers

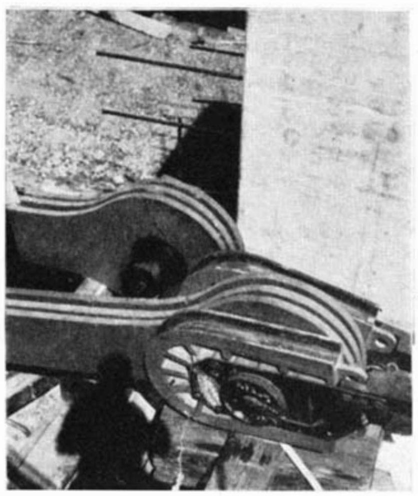
STEEL BRIDGE CABLES SPUN

Four Strands at a Time . . . Taken From 60-Mile Reels . . . Shuttled Over Three Towers . . . 4366 Trips of the Wheel



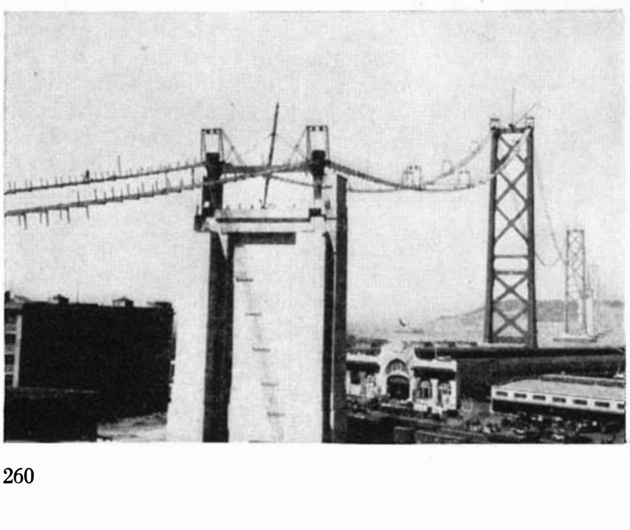
Seven drawings that show diagrammatically the steps in erecting the catwalks (engineers refer to rope-twist steel cables as "ropes"), and spinning the cables over the huge saddles at the tops of the towers of the suspension span

Right: The wires over the strand shoes near the edge of this illustration have been tightened to the correct tension. Above them is the wheel ready with two loops of wire for the return trip to the anchorage



Left: A close-up view of strand shoes in place, ready for the beginning of the spinning operation. Shoes are fastened to steel girders firmly embedded in concrete

Below: A general view of the construction work, after the catwalks were completed and before spinning. Note the "gallows frames" provided to support the wheel cables



Right: One of the magneto telephones at the end of the north catwalk. There are 52 telephones on the walks and towers, by means of which constant communication is carried on during the cable spinning operations

LIKE THREADS

By ANDREW R. BOONE

OPERATING with the precision of fine machinery, four wheels, each five feet in diameter, are spinning the barrel-size cables from which will be suspended a two-mile section of the San Francisco-Oakland Bay Bridge. [See also SCIENTIFIC AMERICAN, March 1935, page 124.—EDITOR.]

In the spinning operation, starting at the San Francisco anchorage, two bights, or loops, consisting of four strands of wire the size of a pencil are taken from two reels, each bearing 60 miles of wire, and passed around the spinning wheel. The haulage machinery is set into operation and the wheel rolls away across the main bay channel. Arriving at the center anchorage these loops are removed from the wheel, passed around strand shoes, which are fastened to steel girders embedded in concrete, new loops are taken from reels at that point and the return journey is made. The process will be repeated until the cables are complete, and the same method will be used on the eastern half of the bridge, between the central anchorage and Yerba Buena island, located in mid-bay.

Each spinning wheel is suspended by a gooseneck from an endless trolley rope, and contains two grooves. Loops of wire are shuttled over the tops of three towers on its long journey. Two wheels operate on each of two cables, leaving each end simultaneously and meeting in the middle of the bridge going in opposite directions. The wires are laid parallel and with the same sag as a guy wire carefully surveyed into position.

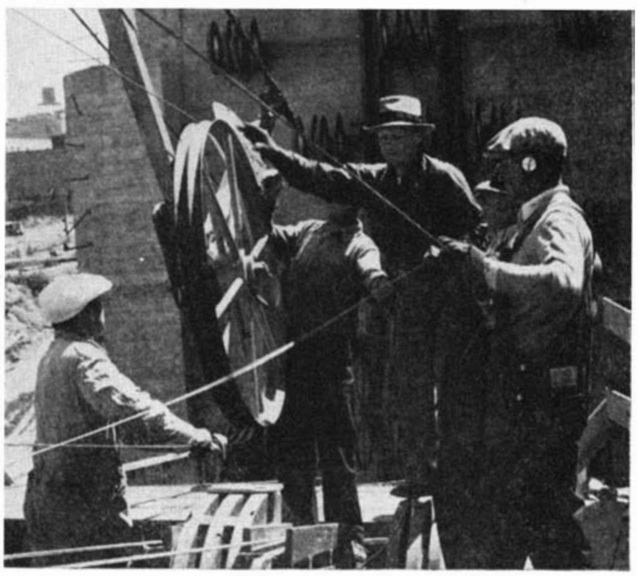
In order to make sure that all of the 17,464 wires making up one cable take their proportionate parts of the entire load, all are cut to the same length. Whenever the wire on one reel is used up, the loose end is spliced to the end of a wire on another reel, and the spinning continued.

Finally, when all the wires of one cable have been spun, a careful survey will be made to determine the correctness of the work. A powerful squeezing machine will then be moved along the length of the cable, and within its jaws this loose bundle of wires—as big around as a barrel—will be squeezed down to the smallest possible diameter. As this squeezing progresses the cable will be gripped at intervals by seizing bands and held in a circular form. Later, when other elements of the bridge are completed, the cables will be wrapped by wire wound spirally. This wrapping, together with galvanizing and paint, will serve to protect the cable against deterioration by the elements.

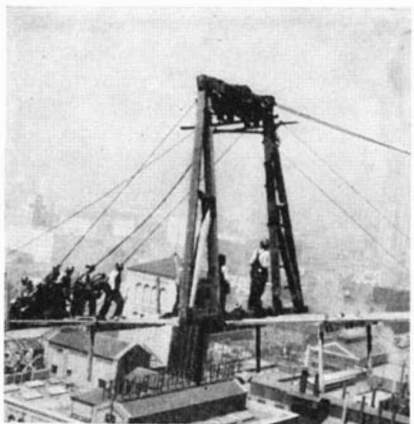
Oddly, the cables are being spun shorter than they will be when loaded, since the steel will expand due to stresses set up by the great weight. Mathematical calculations determine the exact positions where the cables must be spun so that later, when the weight of the bridge itself is supported by them, the cables will stretch and the towers will bend to bring the bridge to its planned elevation. At one point the cables are being spun 22 feet below the final elevation and at another 15 feet higher.

Workmen on catwalks, each 10 feet wide and constructed of wire mesh and cables, check the passage of the spinning wheels every 230 feet. At those intervals are located gallows frames, rectangular metal frames to which are secured the endless haulage lines which pull the spinning wheels. The catwalks are considered to be both fire and wind proof, since they are made of metal and "tied down" by storm lines. Workmen may cross from one catwalk to another over steel bridges.

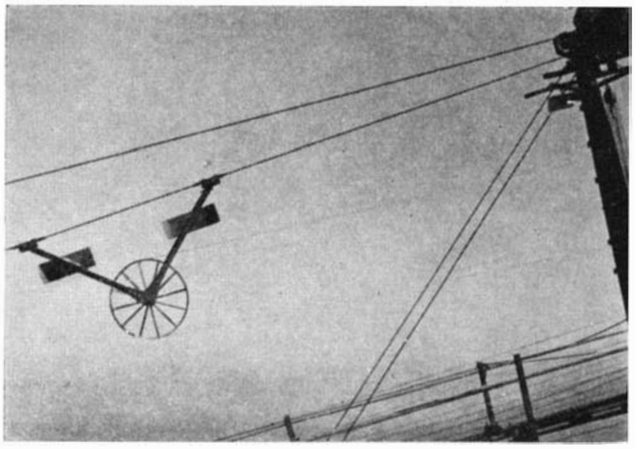
The cable wire was brought from eastern mills in coils containing 3500 feet of wire. At San Francisco the Columbia Steel Company rewinds the wire into larger reels, each containing 16 tons or 60 miles of wire. Each cable will be composed of 37 strands, each strand containing 472 wires. The spinning of each cable will require 4366 trips of the spinning wheel.



Lower left: **The spinning wheel arrives at the San Francisco anchorage and the loops of wire are removed from the grooves. These loops are then placed in the strand shoe below the wheel**



Upper right: **Workmen fastening the guy cables that hold one of the gallows frames securely on the catwalk**



The spinning wheel starts on its return trip. Wires previously spun hang just below the catwalk hand-ropes

SYNTHETIC RUBBER

FATHER NIEUWLAND of the Congregation of the Holy Cross (C.S.C.), the author of the accompanying article, was born in Belgium but was brought to America when an infant. He was educated as a botanist at Notre Dame University but while doing graduate work at the Catholic University in Washington he undertook chemical research on acetylene and has pursued it ever since. This led to his discovery of Duprene, a synthetic rubber which is superior to natural rubber in many ways, and nearly as good in every other way. It resists heat, light, oils, chemicals, and oxidation much better than natural rubber.

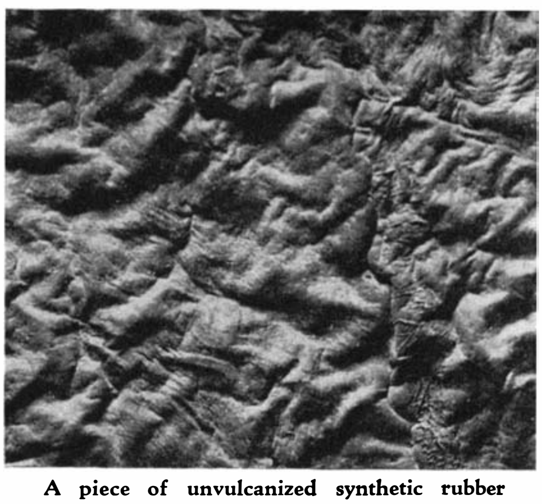
According to Rev. Father Eugene P. Burke of Notre Dame, Father Nieuwland still goes on botanical forays; he goes often to the movies and annually to the circus; often seeks a quiet corner in the Science Building to smoke the most ill-smelling pipe in St. Joseph County, while reading detective stories; plays the guitar, and has defined a gentleman as a man who can play the saxophone and doesn't. He is a hater of shams.

For his successful research in chemistry Dr. Nieuwland was honored last spring by the gold medal of the American Institute (Scientific American, April 1935, page 173), and later by the Nichols Medal of the American Chemical Society.—*The Editor.*

THERE is something particularly fascinating about discoveries in science. Not so very many years ago people were known to travel many miles to hear and see a radio. Today we look forward to the perfection and popularization of television. Who has not heard or read about heavy water, neutrons, positrons, cosmic rays, and many other equally mysterious and wonderful things without wondering what eventually will be done with them? Well do we know that the most abstruse scientific truth discovered today may tomorrow be put to practical use.

Occasionally we hear or read about the successful "synthesis" of some commercial commodity. At present we have synthetic dyes, medicinals, plastics, textiles, rubber—to mention but a few. These products are not only important to us as individuals in our daily lives, but they are most important to us collectively as a nation. Synthetic chemistry is just one phase of applied chemistry and every synthetic product has its own lengthy history—a tale of many years of patient study and experimentation by many scientists the world over.

Synthetic rubber-like materials, for example, have been known for almost three quarters of a century. The early work was carried out in European laboratories and was of theoretical interest only because the products were decidedly inferior to natural rubber and far too expensive. It is quite obvious that before any synthetic material can become a commercial commodity it must be able to compete with the natural product, both as to quality and price, or else be so superior (at least for special purposes) as to be able to command a better price. Not infrequently, however, it happens that a valuable synthetic material has no known counterpart in nature. Witness, for example, the multitudinous synthetic dyes, of every hue and color, which are commodities today but which have not been isolated from any natural source. The same is true of many of our medicinal products. Synthetic rubber, on the other hand, must compete with a very highly developed natural product. It is to be remembered that science, and particularly chemistry, has been very extensively applied to improving upon natural rubber.



A piece of unvulcanized synthetic rubber

A synthetic rubber was actually produced and used in Germany during the late war but, as far as is known, was used only during that crisis; for, with the advent of the Armistice, Germany was again able to obtain ample supplies of natural rubber and the synthetic material was once more relegated to the chemical laboratory. Like the modern Duprene, German rubber was synthesized from acetylene. Before proceeding further it should be remembered that acetylene itself is a synthetic material. At present practically all of the world's supply of acetylene is made from coke, lime, and water.

THE steps involved in the synthesis of German rubber were essentially the following: The acetylene was combined chemically with water to yield acetaldehyde, and this was then combined with oxygen from the air, giving rise to acetic acid. (Much of our acetic acid is still made in this way.) The acetic acid was then converted to acetone and this, in turn, reduced to a compound known as pinacol. Dehydration of the pinacol yielded dimethylbutadiene, known also as methyl isoprene. This material is a volatile, non-viscous liquid. To be made into a rubber it must be polymerized; that is, it must be made to react with itself. During this process, which is promoted by light and traces of air or other chemical agents, the liquid dimethylbutadiene increases in viscosity and finally becomes solid and elastic. Notice that, in all, six distinct chemical processes are involved, starting with acetylene and including the final polymerization.

Time, space, and a lack of definite information prohibits a discussion of the value of this rubber. Nevertheless, while it is not made today, one plant in Germany was reported to have had a manufacturing capacity of about 150 tons of this product per month. Most of that which was actually used was fabricated into solid tires and, as a hard rubber, into battery jars, and so on.

The process involved in the manufacture of Duprene, while also involving acetylene as a starting material, is entirely dissimilar from the German rubber process just described. Furthermore the finished product is chemically different from other synthetic or natural rubbers.

Duprene is the outgrowth of a purely theoretical study of acetylene reac-

FROM A GAS

Practical Application of an Abstruse Scientific Discovery . . . Opens the Way to a New Industry

By J. A. NIEUWLAND, C.S.C.
Professor of Organic Chemistry, Notre Dame University

tions. As early as 1906 we noticed that a reaction took place when acetylene was passed into a solution of copper and alkali metal chlorides. There was no violent reaction, no liquid or solid was formed. But there was an odor of something new! A slim thread of evidence indeed. Since no product was isolated it was believed that a new gas had formed whose odor was constantly detected. For the next 14 years experimentation was continued at frequent intervals in an attempt to increase the reaction rate so as to obtain the reaction products in a quantity sufficient for isolation and study.

Finally ammonium chloride was substituted for the alkali metal chlorides. When acetylene was passed into a solution or mixture of cuprous chloride, ammonium chloride, and water, the reaction proceeded much faster and large quantities of acetylene were absorbed in a short time. To our surprise an oil was formed, along with the gas previously noted. In 1921 it was found that this oil is divinylacetylene, a new compound formed by the chemical union of three molecules of acetylene. Divinylacetylene proved to be a very reactive substance. While examining this compound it was found that treatment with sulfur dichloride produced an elastic material resembling natural rubber in some respects, though too plastic for practical use.

IN 1925 an Organic Chemical Symposium was held in Rochester, New York, which I attended and before which I had occasion to refer incidentally to some of these new acetylene reactions. Representatives of E. I. Du Pont de Nemours and Company became interested in this work, and arrangements were made whereby they might take over the commercial development of these materials. The possibilities of the divinylacetylene rubber were first studied, but this proved to be disappointing. These products did not retain their elasticity for any length of time and means to correct this fault were not found.

In the meantime, chemists of the Du Pont company were investigating the gaseous material first observed in our study. Fortunately our belief that this gas could be produced in quantity proved correct. This product was soon found to be monovinylacetylene, a compound formed by the union of two molecules of acetylene.

The reactions leading to mono- and divinylacetylenes are catalytic; that is, they proceed through the agency of a catalyst. A catalyst is a substance which promotes a chemical reaction without itself appearing to undergo chemical change. Theoretically at least a catalyst is never consumed. The mixture of cuprous chloride, ammonium chloride, and water, constitutes a catalytic system which brings about the reaction of acetylene with itself to produce mono- and divinylacetylenes—the first a gas, the second an oil. By controlling certain physical factors either product can be made to predominate. This is extremely fortunate because the monovinylacetylene alone is useful for the production of Duprene.

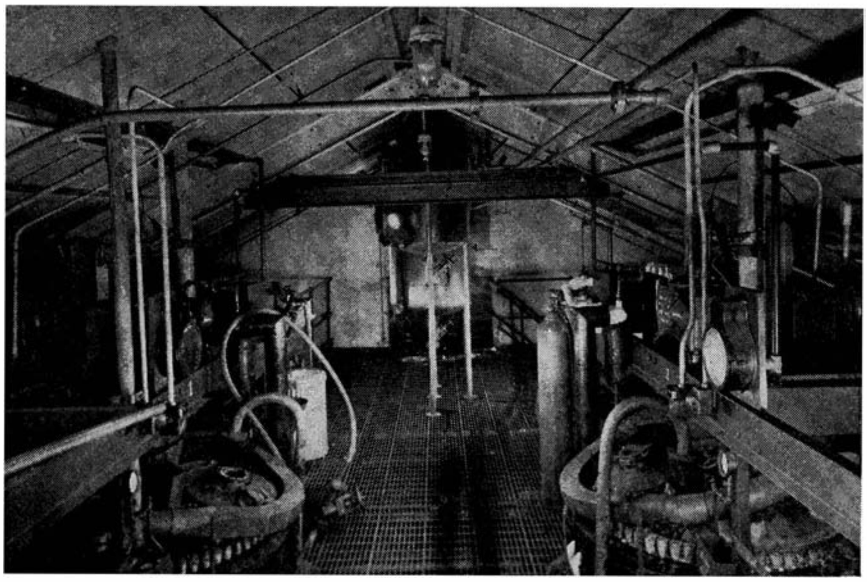
In chemical research one discovery generally leads to many new problems. It is only by following each and every one of these to its logical conclusion that a problem is completely solved. We knew how to prepare mono- and divinylacetylenes. An efficient catalyst had been discovered. Divinylacetylene could be made into a synthetic rubber but the products so produced had proved to be commercially impractical.

WHILE the study of monovinylacetylene was in progress in the Du Pont laboratories, it was found that this gaseous compound could be made to react very readily with hydrogen chloride (from hydrochloric acid) to produce a new volatile liquid known as chlorobutadiene or chloroprene. On standing for a few days chloroprene undergoes rapid polymerization. The liquid compound increases in viscosity and finally is changed into a plastic substance which can be vulcanized by heating to form an elastic, non-tacky, tough material—a synthetic rubber of excellent quality. This new rubber is now well known under the trade name of Duprene.

At the present time Duprene is more expensive than natural rubber. However, Duprene lends itself to many uses for which natural rubber is unsuited. It is remarkably resistant to gasoline, kerosene, oils, ozone, air, acids and so on, thus opening many new avenues in rubber technology. As has been pointed out previously, these unique qualities create a synthetic rubber industry in times of peace—an industry which may be easily expanded in periods of war or during other national emergencies.

It is apparent that the raw materials needed for the manufacture of Duprene are readily available in our own country. Coke and lime for acetylene, salt for hydrochloric acid—these are the necessary basic materials.

Chemistry has pointed the way to a new industry and has once more contributed to our national self-sufficiency.



Chemical reactions in the manufacture of Duprene take place here

PREHISTORIC FINGERPRINTS

Rock Carvings on an Island Near France Now Believed to Have Been Symbols of Fingerprint Religion

By B. C. BRIDGES
Superintendent, Bureau of Identification, Alameda, California, Police Department

FINGERPRINTS are now universally recognized as an infallible means of identification, and as a modern utility, their worth is unquestionable; but their present-day practical status is only a portion of the rôle they have played in the affairs of mankind during the past. In Egypt, Assyria, Persia, China, Japan—in fact, in nearly every country—their records survive; not housed methodically in prosaic filing cabinets, but imprinted here and there where time's scroll was touched by the hand of romance.

Looking backward across the vista of years, through the eyes of fancy, we see fingerprints faintly outlined on the illumined pages of hallowed, once-forbidden testaments. Dimly they still endure in hardened clay of oddly fashioned pottery shaped by hands that perished with Herculaneum and Pompeii. As mute evidence of forgotten crimes, they blacken the stone treasure chests where thieves, long dead, broke in and plundered the tombs of ancient Pharaohs.

However, the age of even these prints becomes trivial when compared with the petroglyphics of Gavr'inis—stone carvings believed to be copies of fingerprints, and conservatively estimated as being at least 30,000 years old.

The rock carvings closely resemble the loops found in finger prints

Although their discovery on the little island of Gavr'inis off Morbihan, France, was made some time ago, they were not at first recognized as fingerprints. The original find uncovered some megalithic monuments hidden beneath earth mounds, while further excavations revealed subterranean passages, spacious galleries and chambers paved with flagstones and braced with vertical stone supports. Many of these rock surfaces were inscribed with strange markings which greatly intrigued the archeologists. They at first appeared incomprehensible. The dominating figures were concentric circles, half-circles, elliptics and spirals, seemingly placed together without order. They resembled the dolmens in Irish sculpture, particularly those of Lochcrew and New Grange. Without doubt the tools used in their reproduction were stone implements.

THEY were considered by some to be Druid emblems, while others saw in them alphabetical signs similar to those of the Phoenicians, Celts or Etruscans, and felt that they might have some connection with the famous Stonehenge megalith.

An acceptable explanation was found in the conclusion that the carvings represented fingerprint patterns. This was not so surprising, even considering the great age of the records. Reproductions of the human hand are found in many caverns of the Spanish Pyrenees, ornamented during the paleolithic age, as well as in traces left by earlier inhabitants of America. Likewise, Pre-Columbian engravings were discovered in 1893 on the side of a rock near Lake Kejimkoojik in Nova Scotia, representing a hand with definite indications of palm and finger ridges.

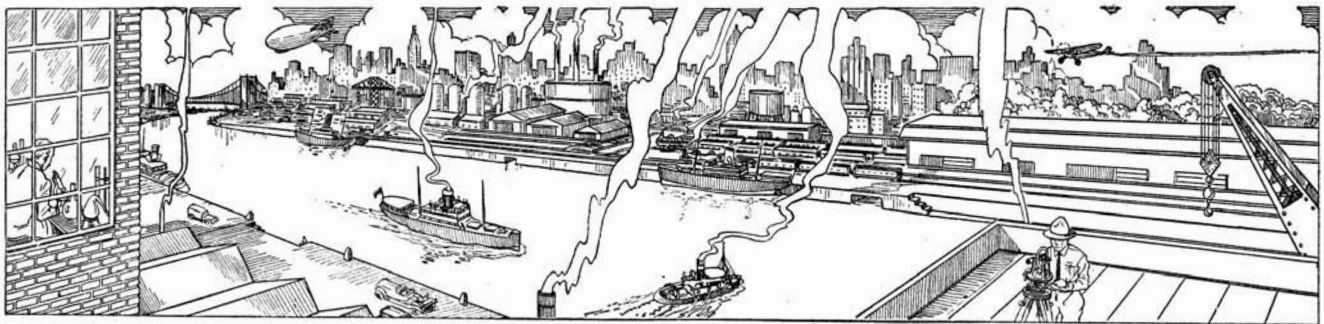
It is possible that the ancient pseudoscience of palmistry as practiced in India, Chaldea, Egypt, and among the Jews and Chinese, may have had its influence on the early observation of epidermic anatomy. Furthermore, cooking utensils, water jugs, and so on, were made from clay by aboriginal savages. We can not suppose that these primitive potters failed to notice the impressions of their hands, which in many cases must have remained on the finished product as accidental decoration. When once attention had been called to these markings and their ornamental character, the impulse to reproduce them is quite understandable.

Compare these with the details of your own finger and thumb tips

Further consideration of the engravings in question only serves to strengthen the conviction that they are the replicas of hand and finger designs, and when placed side by side with similar sized reproductions of actual fingerprints they present what would seem to be proof of real identity.

The one great factor common to all peoples in all times, influencing their arts and practices, is some form of Faith. In view of the innumerable archeological specimens that feature digital tracery, found in such widely separated places and various ages, it might be justifiable to postulate the pre-existence of a mystical, universal religion with fingerprints as one of its salient symbols.

The Gavr'inis carvings, as related to modern dactyloscopy, are unique, to say the least, but whether their significance may be symbolic or decorative we cannot say. However, we must perforce accept the concrete evidence that Neolithic man has shown in his dolmen sculptures a sense of observation and a fidelity of reproduction which many authorities had considered absent in the primordial races; and that the skin structure of the hands of men in the Neolithic age was the same as that of today.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

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

A. E. BUCHANAN, Jr.

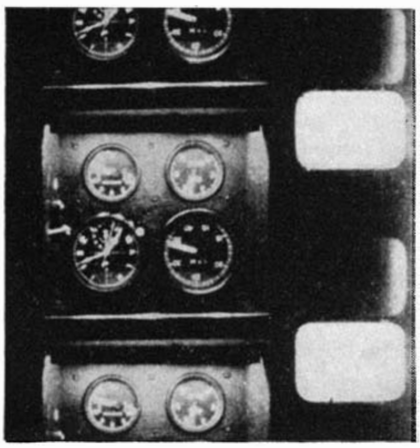
Lehigh University

Movies of Racing Car Instruments

WHEN Sir Malcolm Campbell drove his redesigned *Bluebird* at a speed of more than 300 miles per hour on a dry lake bed in Utah recently, he made use of a movie camera to record the readings of his instruments. Hitherto, Sir Malcolm says, it has been impossible for him to take his eyes off the course when making such great speed and therefore he has never known what the reading of any of his instruments has been. Naturally he is especially interested in the revolution counter, for only the reading of this instrument can give him some idea of the percentage of wheel-spin when compared with his officially timed speed.

The apparatus is housed in a cabinet approximately three feet by eight inches and is 10 inches high. One end of this has a duplicate chronometer, revolution counter, oil and blower pressure gages, mounted on a board, which are illuminated by three 24 watt lamps, the current being supplied from a six-volt accumulator.

The camera is a specially constructed Ciné-Kodak 8 driven by a six-volt electric



Movie shows racing car instruments

motor, a feature of its construction being that it can be instantly removed from the cabinet for reloading with film or testing, without breaking any connections, as it is fixed in position by a special type of plug which not only locates the camera so that it is in correct focus, but also makes the electrical connections.

The film used is Super-Sensitive Panchromatic and is 100 feet in length, which will give 8196 separate pictures, each .173 by .130 inch. The exposure is made at $f/3.5$ at eight frames per second, instead of the usual 16 frames per second, so as to provide as long a run as possible without changing the film in the camera.

After processing, the film can be projected onto a screen up to two by three feet or even larger.

HUMAN HORSEPOWER

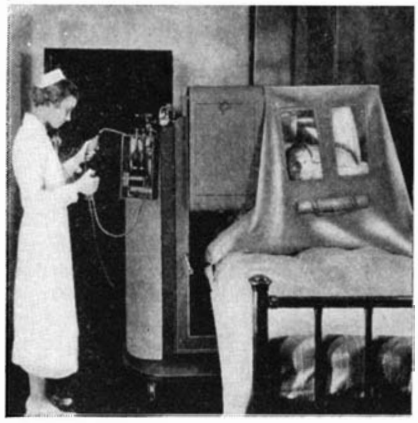
A 160-pound person, climbing an ordinary flight of stairs at the rate of one step per second, exerts approximately the energy required to lift one end of an upright piano, according to Dr. S. Calvin Smith, author of "How Is Your Heart?"

Oxygen Tent with Windows

OXYGEN therapy is today an indispensable part of a physician's practice and is also used extensively in hospitals in the treatment of such cases as asphyxia, asthma, pulmonary and heart diseases, anemia, and diabetes. Administering this life-sustaining gas has heretofore been so expensive that many patients have not been able to pay, except in part, for their treatments.

A new machine, the Oxygenaire, manufactured by the American Hospital Supply Corporation, has been designed to overcome the drawbacks of the older types, according to the *Du Pont Magazine*, keeping the patient foremost in mind.

It is a completely assembled unit, available for instant use, and can be stored in a space of less than two by three feet. The oxygen is fed from a regular tank resting on the chassis, and it is regulated by a gage that indicates a flow of one half to 15 liters per minute. The simplicity of operation is extended to the air-conditioning system which works on the convection principle. Ice and soda lime are stored in the cabinet and the patient provides the heat. The de-



More comfort in an oxygen tent

mountable canopy is made of non-conductive material and has a capacity of more than ten cubic feet. The whole is sturdily constructed to give long service.

The Oxygenaire is said to operate at one half the cost of the older units. It requires no electric power, making it doubly valuable in case of emergency. It contains no motors or blowers and is absolutely silent, offering no annoyance to the patient on this score and insuring safety from sparks and other fire hazards. In the southern states, particularly, it has come into favor because it maintains in the tent a humidity of 50 percent and a temperature of 65 degrees, Fahrenheit, or less, no matter how warm and uncomfortable the air outside may be.

The mental ease, comfort, and safety of the patient are assured by this machine. The roomy tent allows him to assume any desired position and to change it at will. The feeling of confinement so harmful to those bed-ridden for long periods has been avoided to a considerable extent by the unimpaired light and vision afforded by the numerous large windows. There are seven in all: six, 16 by 18 inches; and one, 16 by 20. "Plastacele" was chosen by the manufacturer for these windows because it is light in weight, transparent, durable, and easy to fabricate.

Redistilled Magnesium

TO the layman it may sound strange to hear of a metal being distilled. That, however, is exactly how the useful, light metal, magnesium, is produced. Now, chemists have discovered that by distilling the

Navy Day

APATHY seems a predominant American trait—apathy toward many of the things that count, coupled with a belief in the power of wishful thinking as a means of solving difficult problems. Nowhere has this characteristic been more noticeable than in connection with our Navy, in particular, and the armaments question generally. As a nation, we have not faced naval facts squarely—until recently. Now that we are beginning to understand the needs of the Navy and have taken steps to fill those needs, there is good reason for us to manifest our individual and collective interest more forcefully to the end that we do not slip again into a fatal apathy.

It is good to note, therefore, that there has just been organized a Citizen's General Navy Day Committee to promote a wider observance of Navy Day, October 27, and thus bring about a new understanding of the Navy. As this Committee—composed of over 30 leaders in various walks of life in America—is sponsored by the Young Men's Council of the United States, it is fitting that we quote here part of a statement recently made by the Council's National President, Robert J. S. LaPorte:

"The policy of the Young Men's Council of the United States, in regard to our Navy, is: We do not advocate huge Armaments. Neither do we advocate disarmament by example as a means of securing peace. We advocate insuring peace by what we may term the balanced armaments method, which has many advantages. By following it we can, by limiting armaments, reduce their cost, and by balancing them among the various nations make war at least improbable.

"We urge our government to do everything within its power to effect another naval armaments limitations treaty. Failing at that, we demand that our government build and maintain a Navy second to none."—*Editor.*

commercial metal over again, they obtain a product that is much more chemically active than the ordinary metal. It decomposes water at the ordinary temperature, the reaction proceeding for several hours until the metal becomes coated with magnesia. On exposure to pure and dry carbon dioxide, the metal gradually absorbs the gas at the ordinary temperature with formation of a small quantity of magnesium carbide. It should be only a question of time before the unique properties of the re-distilled metal establish new uses for it.—*A. E. B.*

Pose Your Own Portrait

IN the September, 1931, issue of SCIENTIFIC AMERICAN was described a system of photography in which the sitter actually posed himself in a desired position and could see his image reflected in mirrors exactly as it would ultimately appear in the finished portrait. Now Luther G. Simjian has announced a noteworthy improvement on this portrait system, in which the sitter has the choice of innumerable positions, rather than the five poses available with the older set-up.

The new equipment, shown in the accompanying photograph, includes a central cabinet provided with a mirror, behind which is located the camera. On each side of the central cabinet is a small movable cabinet also containing mirrors which are mechanically connected so that, as the cabinets are moved back and forth, the mirrors always remain at the correct angle to reflect to the sitter the image which is formed on the mirror in the central cabinet. Thus, for example, in the accompanying photograph, the young lady is posed for a full profile view. Looking directly into the mirror in the right hand movable cabinet she sees the image which is formed on the mirror in the central cabinet, and thus can vary her position just as she pleases to obtain the best angle. When the operator presses the button, the central mirror drops, the camera shutter is actuated, and the exposure is made.

Above the side cabinets are specially designed projection lamps which provide perfect lighting of the features.

Many poses may be assumed before the newest "self-portrait" camera

"ALL WET"

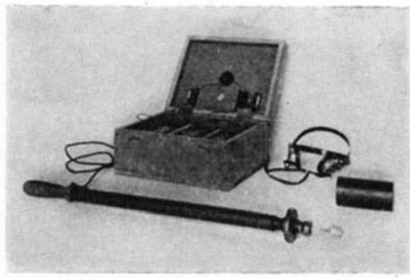
PURE water is essential to health. Seventy percent of body weight is water, the lens of the eye contains 98.7 percent, the lungs 79 percent, the heart 79.5 percent, the blood 80 percent, our bones 25 to 50 percent—even our brains contain 90 percent water!

"Radium Hen" Detects Lost Radioactive Material

ACCORDING to a *Science Service* note, the "radium hen" comes from London and was described to American physicians and hospital workers by the London correspondent of the *Journal of the American Medical Association.* The hen is really an instrument developed in the National Physical Laboratory in England. It gets its name from the clucking sound it makes when placed near radium. The nearer it approaches the valuable element, the more rapidly and excitedly it clucks.

Hospitals occasionally, in spite of extreme care, lose or mislay radium "seeds," the tiny gold needle-like containers inserted in the body in cancer therapy. Every now and then one gets washed down the sink. Water can be poured down the sink and then tested for radioactivity, usually with negative results. Traps may be taken out and examined, but still the radium needle frequently goes undetected. Now all a hospital needs to do is to bring in the "radium hen." It leads quickly to the point in the pipe where the needle is lodged.

A letter addressed by the editor to the National Physical Laboratory mentioned above (an institution which occupies much the same position in Great Britain as the National Bureau of Standards in the United States) brings the accompanying photograph and the comment that the apparatus



The glow lamp and other essential components of the "radium hen"

"is essentially a simple and robust form of Geiger counter." (The Geiger counter was described in the September SCIENTIFIC AMERICAN, page 133.) The British laboratory continues as follows: "The ionization chamber consists of an ordinary neon glow-lamp, enclosed in a light-tight container, and supplied with a voltage just lower than that at which the discharge normally commences. In the presence of ionizing radiations the discharge voltage of such a lamp is somewhat lower than normal, so that the lamp glows more readily near a source of ionizing radiation. The operating voltage is supplied by a condenser charged through a suitable resistance by means of a dry battery, with the result that when the lamp glows the exciting voltage falls and the glow is extinguished. A pair of head telephones in series with the lamp thus records each discharge as a discrete click. In use, the possible locations of the missing radium container are explored and the presence of the radium is revealed by a rapid increase in the rate of clicking.

"The construction of the apparatus is shown in the photograph. The box contains the necessary batteries, while in the lid are mounted the condenser and resistances. The glow-lamp itself is mounted on a long handle suitable for exploring in corners and connected to the rest of the apparatus by means of shielded cables."

Non-Tarnishing Metal Fabrics

A NEW material, making possible non-tarnishable metallic fabrics, is made of metallized slit cellulose film, and is manufactured by depositing a metallic finish on one side of a sheet of Cellophane. Two such sheets are then laminated together, so that each side is metallic coated, and added strength is given to the stock. This sheet is then slit to narrow yarn widths, which then may be woven into a fabric with rayon, silk, wool, or cotton. This material is the latest contribution of the chemical industry to the textile world. It is claimed for it that it will not tarnish or oxidize, thus solving a problem which has always proved difficult in the production of metallic textiles, of which there has been such a great vogue recently.

The new material was designed primarily for decorative use but its adaptation to other purposes has been so satisfactory that it is being employed also in the fashion field. The fabric is light in weight, flexible, and drapes well. Various forms of it are possible, thus making it conform to current trends in women's fashions. For example, a simple flat weave can be made for evening wear and a closely woven weave has been introduced for evening bags and footwear.

After many tests, it has been found to have a place also in the industrial field. It is adaptable to commercial methods of decorating such as lithographing, silk screen stenciling, embossing, corrugating, creping, shredding and other methods of decoration. —*A. E. B.*

Fast Airplane Tested for Navy

FLOWN by Paul S. Baker, the first of 84 new scout-bomber airplanes under construction for the Navy by Chance Vought Aircraft took off from Rentschler Field recently on its maiden test flight, under the watchful eyes of Vought executives and Navy inspectors.

Developed as a result of three years of design and testing in close co-operation with the Bureau of Aeronautics, the new type is expected to show higher performance characteristics than have previously been achieved by service types of airplanes of this class. It is a two seater biplane, designed to meet the limitations in size and landing speed imposed by the relatively small decks of the Navy's aircraft carriers, and is intended both for bombing and long-range scouting activities, which until now have been performed by two distinct types of airplanes.

The new airplane, designated as Model SBU-1, represents a distinct departure in many respects from the well-known Vought Corsair type which for many years has been in wide use on the aircraft carriers, battleships, and cruisers of the United States Fleet. Its structure is composed of metal, with fabric covering except for the fixed tail surfaces, which are metal-covered. Detailed description and performance data may not be released, but Vought officials said the results of the first tests were "entirely satisfactory".

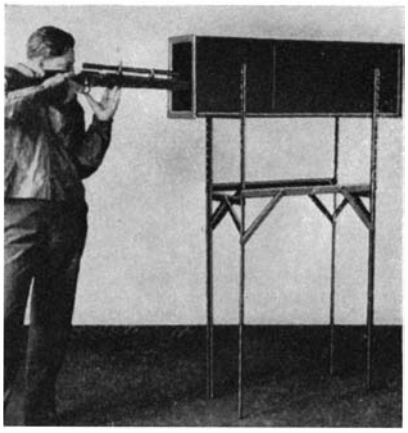
The new combined bombing and long-range scouting airplane described above

HONEY AND GASOLINE

GASOLINE cost enters into the cost of producing honey, strange as it may seem. This is due to the fact that about 10 percent of the cost of a pound of honey is in the transportation of the honey itself and also of hives which frequently must be moved from place to place.

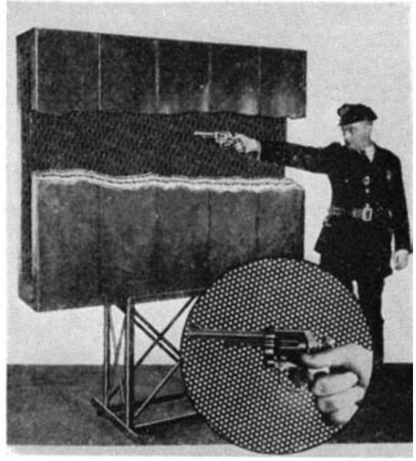
Target Range Mufflers

IN the Museum of Science and Industry, New York City, one exhibit shows the sound deadening qualities of certain felted materials. Two small tunnels, both made of wood and about six feet long, have at their opposite ends tiny bells. One is unlined while the other is lined with felt. When a button is pushed to ring the bell behind the unlined one, the metallic clang sounds very sharp to the ears. When the bell behind the lined tunnel is rung, a very subdued muffled tone emanates from the open end.



Muffling the sound of rifle fire

This principle has now been adapted to a muffler for use on target ranges, particularly those indoors where the noise of rifle or pistol shots is very disturbing to the shooter as well as to spectators. These have been produced by the Burgess Battery Company, Acoustic Division, and are shown in the accompanying illustrations.



A cut-away view of the pistol muffler, and a close-up of the walls

The inner walls of both the rifle and the pistol mufflers are perforated sheet metal with balsam wool between the perforated metal and the sheet metal outer walls. The principle of operation is based on the remarkable absorption of sound by the wool, the principle of which is shown in the exhibit mentioned above. As the mufflers have no connection with the gun, their use is not prohibited by the laws against gun silencers. The only noise heard when a gun is fired is a dull thump. One particular advantage is that these mufflers permit complete lighting of indoor target ranges because the front sights of guns are so covered in firing that there is no reflected glare to disturb the aim.

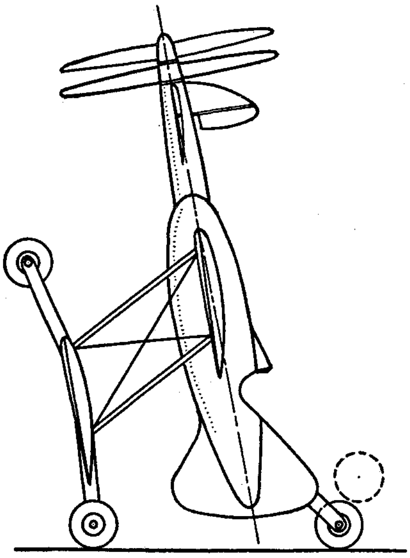
Protective Paint For Metals

A PAINT process developed by the Harrington Paint Co., Inc., is claimed to transform rust on metal surfaces into a light-proof color body of high weather-alkali-acid resistance. Instead of requiring hours of labor for its removal, the rusted surface becomes an essential part of the protective coating. The paint is made on a Tornesit (chlorinated rubber) base which in itself shows approximately 99 percent proof against moisture penetration and provides a non-inflammable and tough film with great adhesive powers. It is reported to have a rapid drying rate, ease of application, and long life under adverse conditions. —*A. E. B.*

An Airship Conference

FRIENDS of the large rigid airship have not lost hope. The Airship Survey Committee is hard at work and will in time produce a broad fundamental study of the problems of the airship. At the Daniel Guggenheim Airship Institute, the recent forum on lighter-than-air craft was well attended by a number of specialists, and valuable papers were read. These papers were so highly technical in character that only the briefest review is possible.

Airships are complex structures and very difficult to analyze mathematically. But by observing certain laws of dynamic similarity, it is possible to construct small models from which the behaviour of the full-size airship under load can be accurately predicted. One such model method employs



Above and right: **Two types of orthoplanes suggested by Dr. A. F. Zahm, and described on this page**

wires to represent the complex girders of the actual machine.

A strong plea was made at the forum for the metalclad airship, as being stronger, more resistant to weather, and less wasteful of helium gas than the conventional fabric covered airship. This plea was all the more timely because the only metalclad airship ever built, the *ZMC-2*, has just completed its sixth year of consecutive service, with Lakehurst as its base. It is in splendid shape, with not a single serious mishap to mar its record.

We have become accustomed to one main type of airship, comprising a hull, with longitudinal girders, transverse frames, and transverse wiring; with the propellers mounted at the side of the airship, along the side, and so on. At the forum were discussed a number of interesting possibilities departing from the conventional. Thus in the Respess airship, a suspension bridge construction is proposed, in which a rigid center beam would be embodied, with cables replacing the rigid framework. Lighter structure and lesser maintenance charges are claimed for this novel design. Automatic control has been utilized quite largely and successfully for the airplane. Why not automatic control for the airship where the pilot's problems are even more complex? The control surfaces of an airship are always placed at the tail. Why not place control surfaces at the bow—either at the bow alone or in conjunction with tail surfaces? Actuation of the controls might then be accompanied by less vertical displacement.

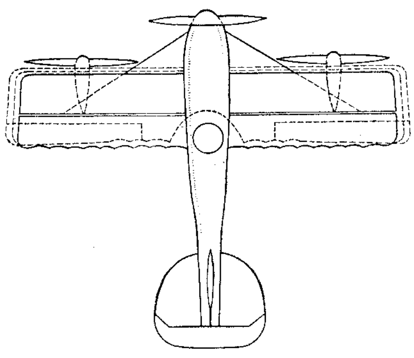
Dynamic lift is that part of the lift which is produced by the reaction of the air on the moving hull as distinct from the aerostatic lift of the gas cells. It was pointed out that the possibilities of dynamic lift have not been fully exhausted. Another suggestion was that the airship should be provided with a large central passage, and the propellers placed inside this passage. Boundary layer control was mentioned, with suitable ejection or suction of air through the outer covering to diminish the drag. Boundary layer control has been investigated in regard to airfoils but such control might be much more effective in the airship.

All this indicates that the airship people have not given up the good fight, and that hitherto unexplored avenues of research still remain in this field.—*A. K.*

Orthoplanes

DR. A. F. Zahm, of the Library of Congress, one of the most distinguished American aerodynamicists, has sent us an interesting note on a suggested type of aircraft which he terms "orthoplanes." The orthoplane is an airplane designed to fly straight up from rest, with all control surfaces in the slipstream.

"Given adequate blast, such controls can function in any flight attitude, at all flight speeds, and at no speed," writes Dr. Zahm. "Suitably proportioned, the controls would obviate stalling and spinning dangers, for



in the strong wash they could overcome the auto-rolling urge of the wings. Three slipstreams indeed are not essential, as all the surfaces can be placed in one or two streams. Now suppose each motor is a Pegasus X air-cooled engine weighing about 1000 pounds and easily supplying 800 horsepower to an airscrew of small diameter, say one giving a static thrust of three pounds per horsepower. The three engines total 2400 horsepower, weight 3000 pounds, and exert 7200 pounds thrust. This can lift vertically the engines and a loaded airplane weighing 3000 extra pounds, and still leave 1200 pounds excess thrust for swift vertical climb. Throttling the power a pilot could hover, or descend at moderate speed, tail downward; leveling off he could sweep forward at very great speed with a thrust initially exceeding the whole 6000 pounds weight of plane and engines combined. The craft shown could take off and land in the usual way. Because of its large propeller race, covering most of the wing surface, it would hover with its axis far from vertical.

"Another type of orthoplane can stand upright and function as a helicopter, besides taking off and landing as an ordinary plane. It should be a useful scout for rough terrain; and enable light burdens to hop from a roof in one city to a roof in a neighboring city in much less time than by usual transport planes starting from suburban airports."

Besides making these interesting suggestions, Dr. Zahm very rightly insists on the desirability of a world-wide competition for direct-lift aircraft. Such a competition would undoubtedly excite the greatest interest.—*A. K.*

What is the Power of an Engine?

WE have been accustomed in these columns to mention a given engine as having such and such a power at a given revolutions per minute. As the art progresses, engine ratings have to be given more explicit definitions. In fact, there are now three different kinds of ratings applicable to any one motor, as follows:

1. *The take-off rating.* The maximum permissible power output at low altitudes to which an engine may be pushed for a few minutes.
2. *The maximum power for protracted periods.* This is the maximum power which may be used to reach destination in the event of an emergency.
3. *Cruising rating.* This is the maximum power which may be safely used for continuous, normal operation.

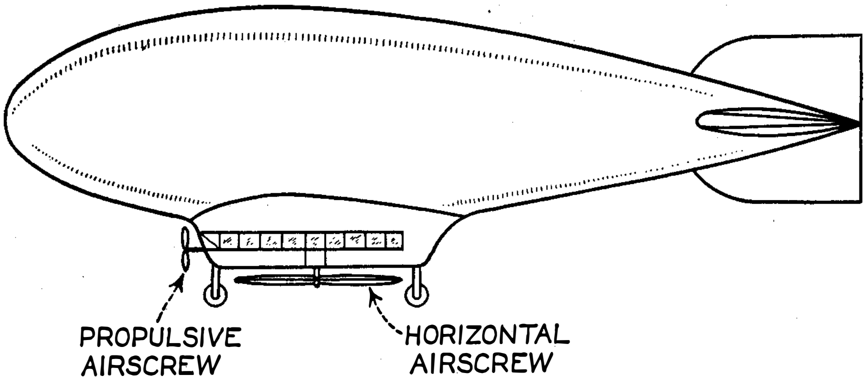
The Department of Commerce is making a thorough study of the problem and will certainly issue new regulations, defining the various ratings of all existing engines in this manner.

As an example, we will give the ratings adopted by United Aircraft Corporation for one of its Wasp models.

1. Power allowable for take-off, 450 horsepower at 2300 revolutions per minute.
2. Cruising power for continuous emergency operation, 300 horsepower at 2000 revolutions per minute at 9600 feet altitude.
3. Maximum power for continuous emergency operation, 400 horsepower at 2200 revolutions per minute.—*A. K.*

Airship plus Helicopter

THE veteran French balloonist Toussus-le-Noble has successfully demonstrated at a flying field near Paris, a small dirigible which is really an airship in combination with a helicopter. The peculiar craft is illustrated in one of our sketches. In addition to the ordinary hull and suspended gondola, and a 60 horsepower engine driving a propulsive airscrew, an auxiliary 12



A type of airship-helicopter that has undergone successful tests in France

horsepower engine is provided which drives a horizontal airscrew.

The new aircraft has been dubbed a helicostat. It is slightly heavier-than-air; that is, the gross weight of the craft is greater than the lifting capacity of the gas bags. By operating the horizontal airscrew, the craft can rise or descend vertically. At first the horizontal airscrew lifts the craft vertically upwards. Then the lifting airscrew is stopped and the forward engine gives the dirigible a speed of 40 miles per hour.

It may be objected that precisely the same thing can be achieved with the use of ballast. But the provision of the lifting airscrew eliminates the use of ballast and renders the operation of rising, hovering, or descending much less delicate.—*A. K.*

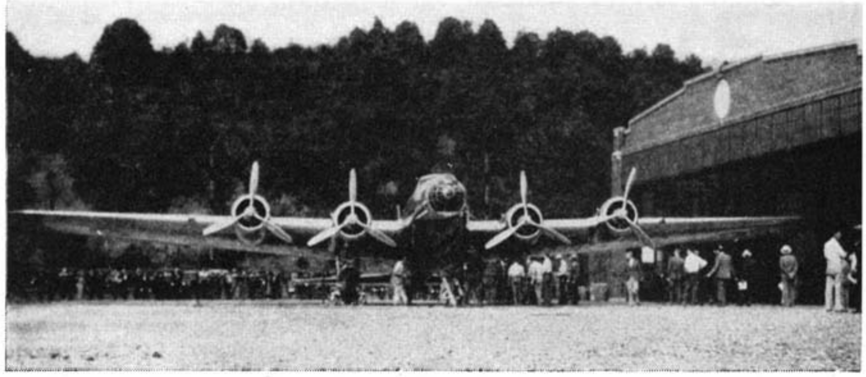
AIRCRAFT PRODUCTION

IN the first six months of 1935, 851 airplanes were produced in the United States, a 14 percent increase over the corresponding period in 1934. These new planes include 517 for domestic civil use, 173 for military purposes, and 161 for export.

A Huge Bomber

EUROPEAN countries are arming frantically and certainly are not neglecting aircraft. In fact, certain American experts on returning from over-seas have recently spoken of supremacy in military aviation passing from the United States. The construction of such airplanes as the new Boeing bomber is reassuring in this regard. The Boeing 299, which weighs over 15 tons, has a wing span of approximately 100 feet, an over-all length of 70 feet, and a height of 15 feet. It is of the all-metal mid-wing type, and is equipped with four Hornet engines of over 700 horsepower each. A three-bladed variable pitch propeller is employed, built by Hamilton-Standard. The streamlining is excellent and the landing gear and tail wheel are both retractible.

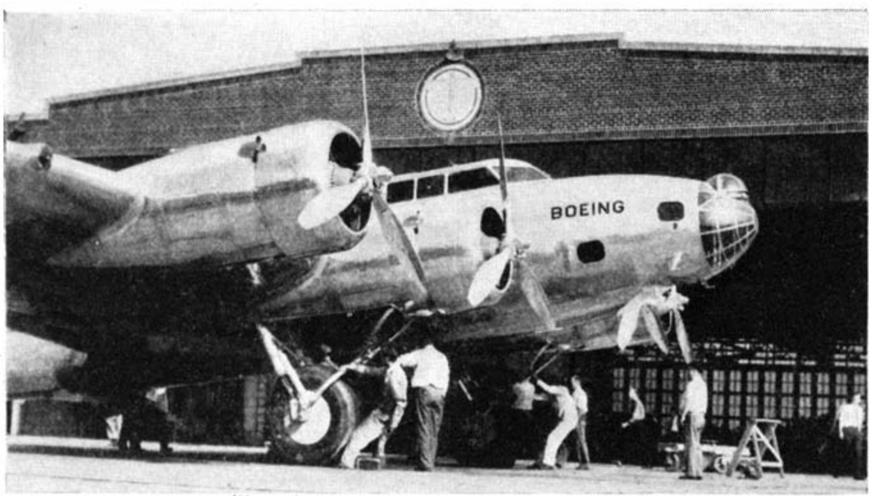
The bomber, at the time of writing, is undergoing trials at Wright Field, Dayton, Ohio, in competition with other designs. The system of procurement employed by the Army is curious. Constructors submit design bids in line with a specification issued by the Army. A small number are awarded experimental contracts. But these contracts merely mean that the manufacturers are privileged to present models for the competition at their own risk, and may never receive a penny for their best efforts. Thus, bidding for Army contracts on new types is a speculation of the wildest possible sort. Since hundreds of thousands of dollars are involved, we should imagine that in no other business is so much cool-headed gambling required of the executives.



New Boeing bombing plane ready to take off

The 299 has already made a world's record for sustained speed, flying 2300 miles in exactly nine hours, at an average speed of 255 miles an hour!

The 1931 Boeing twin-engine bomber was the forerunner of the twin-engined Boeing transport, and well-informed gossip has it that the new four-engined plane will also serve to introduce a large transport. The continuous and rapid growth in the passengers, mail, and express carried on American airlines also serves to confirm a rumor that a larger Douglas commercial transport will soon appear on the scene. At present our airliners do not pay even when flying loaded almost to capacity. If 32 passengers could be carried instead of 16, with the same flying personnel and practically the same ground crew and ground organization, the possibilities of profitable operation would undoubtedly be much brighter.—*A. K.*



The enclosed gun turret may be seen in the nose of this giant bomber

Helium in Sweden

A NEW source of helium has been found on Osland Island along the east coast of Sweden, according to *Industrial and Engineering Chemistry*, publication of the American Chemical Society. Natural gas containing 1.4 percent helium has been tapped. Other borings on Gotland, a neighboring island, are expected to yield petroleum as well as appreciable amounts of helium, the Scandinavian correspondent says.

Air Transport Statistics

THE scheduled operations of American air transport lines are showing remarkable growth. The following figures for the first six months of three years are so striking as scarcely to need comment:

	1933	1934	1935
Passengers	229,075	223,381	367,357
Passenger Miles	73,288,579	88,955,113	160,013,357
Percent of scheduled miles flown	92.4%	91.2%	90.5%

Each month this year shows an increase in activity over the preceding month and over the corresponding month of 1934. Now that both the House and the Senate have passed a bill which will allow the I.C.C. to raise the airmail rates, better times are definitely in sight for the operators!—*A. K.*

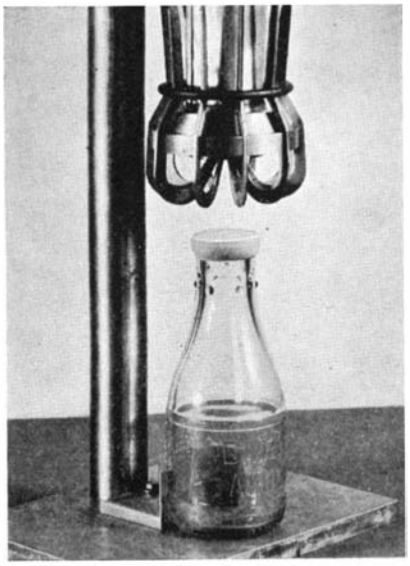
Air War over London

THE Society of British Aircraft Constructors has given a reliable account of the recent air "war" over London, in which 365 airplanes flew some 400,000 miles. It appears that this air war is an annual affair, with the testing of London's defenses as its special purpose.

The incoming raiders flew at greater heights than in previous years—over 19,500 feet—and the bombing formations flew through clouds with the aid of blind flying instruments. This made the task of the defenders still more difficult, since they had to depend largely on listening apparatus to locate the enemy. Some of the bombers proved to be almost inaudible on the ground when flying at an altitude of 15,000 feet.

The defenders were adjudged to have inflicted serious losses on the bombers, but on the other hand the attacking fleet had many of its units passing the defensive network, and a light bombing squadron operating on the outskirts of London made three dive bombing attacks and scored 80 to 85 percent of hits. This accuracy is far greater than that of the most accurate gunfire.

Air Marshal Sir Robert Brooke-Popham declared significantly: "This year's exercise has shown up the difficulties which may be expected in conducting defense against more silent aircraft, flying at even greater altitudes."



Flexible milk bottle caps may be applied by hand or automatically

British opinion is that the only real defense against bombing raids is in counterattacks on the enemy's military objectives, which may be expected to prevent the departure of his bombers. This is a paraphrase on the old saying "Attack is the best defense." The best protection of our seaboards against air attacks from an enemy fleet would be in the form of destructive bombing forays against such a fleet. This is a moral which the United States would do well to take to heart.—*A. K.*

Illuminator for Star Charts

AMATEUR astronomers often find it difficult to provide for the practical use of charts of the heavens when out of doors at night at the eyepiece of their telescopes. If a strong light is used to see the charts, the eye at once loses its observing sensitivity for immediate use of the telescope. James S. Andrews of Rutherford, New Jersey, a well known variable star observer, tried placing his charts on a glass covered box, and illuminated them very faintly from below. This proved to be so practicable that he refined the same apparatus into a finished device, as shown in an accompanying photograph.

The lamps are controlled by rheostat and, by dimming them to minimum chart visibility, the pupil of the eye is not caused to contract unduly as would be the case with a strong light. Mr. Andrews has also put a flap-covered tunnel in the end of the box, for storage of rolled charts. His batteries are hidden between the box and sloping reflector, although 110-volt current may be extended to the same device.

To an amateur astronomer the picture otherwise explains itself. The star charts are ordinary blueprints and are 8 by 10½ inches in dimensions.

New Milk Bottle Hood

AN unusual coverall milk bottle hood made of a pliable composition material which has sufficient resiliency to allow it to be stretched over the top of a milk bottle, is stiff enough to cling to the bottle and not come off under the type of usage to which the bottles are subjected.

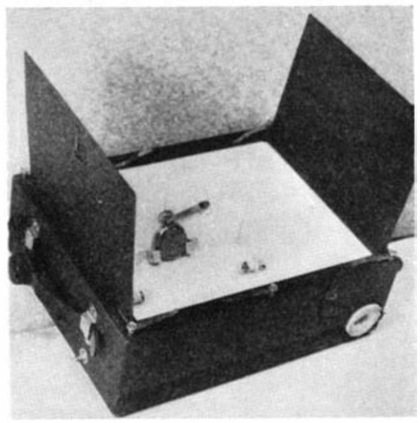
Being always under tension on the top of the bottle, the new cap is always a perfect seal and will not loosen as a result of a jar or bump. It also has the advantage of not being pushed off the top of the bottle if the milk is allowed to freeze in cold weather.

The inventor, John R. Gammeter, has designed capping and printing machinery for the hoods. A hand capping machine for the small dairy will place the hoods on the bottles at the rate of 20 to 30 per minute. Automatic capping machines for larger dairies may be placed in the filling lines at practically no extra cost.

Lighting a Windowless Building

SOME interesting lighting problems have been solved in connection with the interior illumination of a completely air-conditioned office building of the Hershey Chocolate Corporation. It was found that, with completely artificial lighting, a better effect can be had than with a combination of daylight and artificial lighting or wholly daylight, because of the wide variations in the intensity of daylight.

There will be maintained at the working



Rolled charts may be kept in the end of the star-chart illuminator

level on the desks an intensity of 20 foot-candles, which is considered good practice for office work. The lighting will be almost completely indirect, using a combination fixture which contains both mercury vapor and Mazda lighting. The reason for this is that incandescent lights give little of the violet and blue whereas the mercury vapor lighting is weak in the orange and red part of the spectrum but strong in the violet and blue. A combination of the two within the same fixture approaches daylight and gives a far better effect than any single source. Within each fixture there is one 750-watt Mazda lamp and one 300-watt mercury vapor, making a total of 1050 watts per fixture.

Should the source of current fail while the employees are at work, an automatic throw-over switch will re-establish electric current from an entirely separate source. The second source of supply will also provide energy for the operation of the motors driving the ventilating fans of the air conditioning system so that the supply of air will not cease even though the first source should be inoperative.

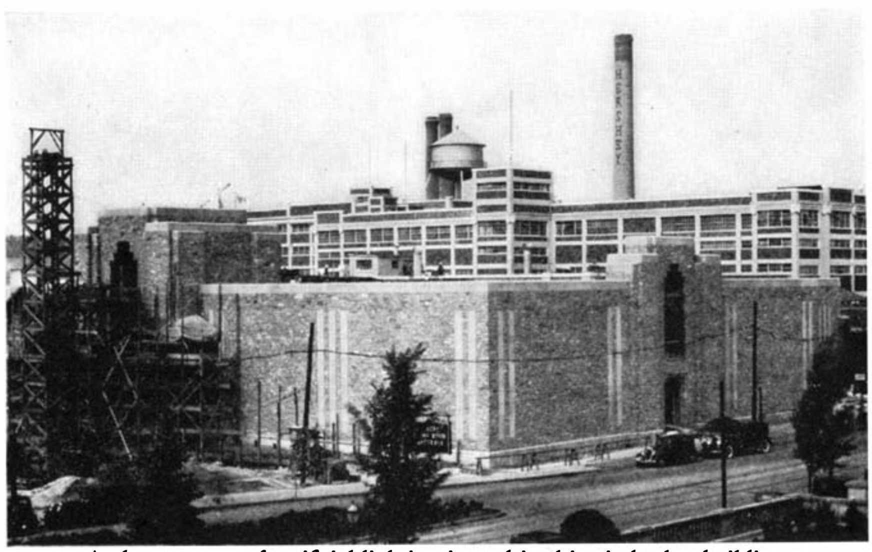
SNAKE AGE

FOR two reasons the number of rattles carried by a rattlesnake do not tell its age, contrary to general opinion. One is that the rattle is brittle and segments occasionally break off. The other is that a new button is exposed each time the snake sheds and this process is repeated from two to seven times a year.

More Soap

FIRM in the belief that "cleanliness is next to Godliness," the American public continues to raise its per capita consumption of soap at an amazing rate—we now use 100 cakes per year per person as against five in the Soviet Republics—and backed by one of the most intensive advertising campaigns of any American industry, that rate is accelerating tremendously.

The increased consumption of fatty oils in all groups has been remarkable. Comparative figures for 1914 and 1929, compiled by *Chemical Industries,* show an increase in all uses of the oils of the food and soap group from about 2,350,000,000 pounds in 1914 to 4,025,000,000 pounds in 1929, a gain of 71 percent. In the same period the population increased but 25



A clever system of artificial lighting is used in this windowless building

THEIR HAMMERS PROCLAIMED THE

second Declaration

OF INDEPENDENCE

Again, in 1800, war clouds were gathering over the Atlantic. Any day, the infant American Navy might be called upon to defend its shores against invasion. Shipyards all along the coast were rushing to completion stately frigates and swift privateers.

But one concern lay heavily on the country. It had won its independence politically but not economically. Many manufactured articles still came from England; most vital of all . . . the copper sheathing, essential to speedy ships.

So the Federal Government turned to Paul Revere. $10,000 was advanced to him to build the first American copper-rolling mill. Strange assignment for an artist-silversmith? Yes! But Revere was already working copper into spikes and bolts, casting bronze bells . . . as he had learned the secret of making copper malleable.

Soon he was rolling copper. And, appropriately enough, the first hull to be coppered with Revere sheets was that of the famous frigate "Constitution" in 1803. It is recorded in the "Constitution's" log that, as the workmen pounded into place the last sheet of Revere copper, the sailors burst into a great cheer. For every man knew the significance of that moment. America had declared her economic independence. America could copper her own ships.

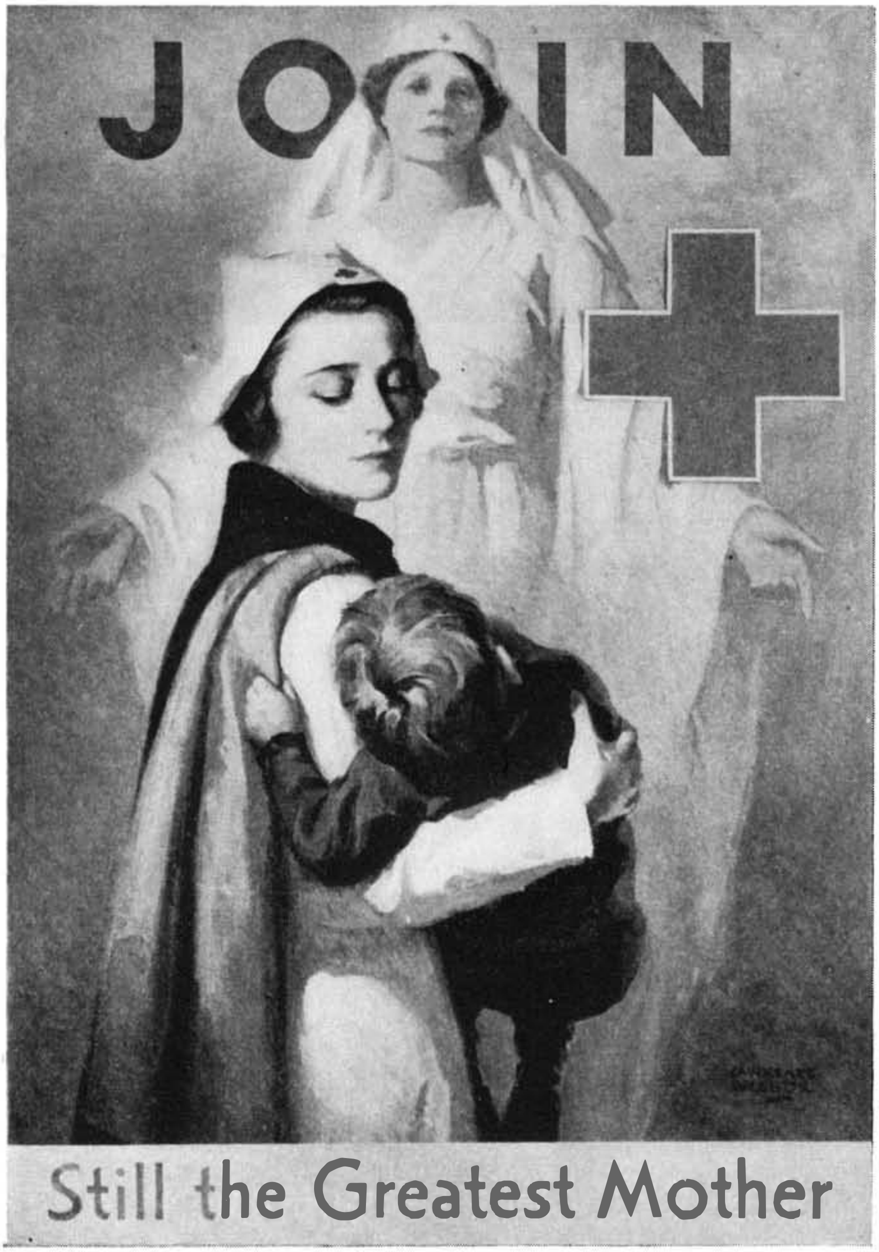
After 135 years, the United States Navy still demands copper and its alloys. Some of today's uses are for condenser tubes and tube-sheets; tube and pipe for water, gasoline, oil, and steam lines; bus bar copper for electrical installations. The Navy, too, has found our Technical Advisory Service helpful in extending the usefulness of copper. This same service is offered to you.

Revere Copper *and* Brass

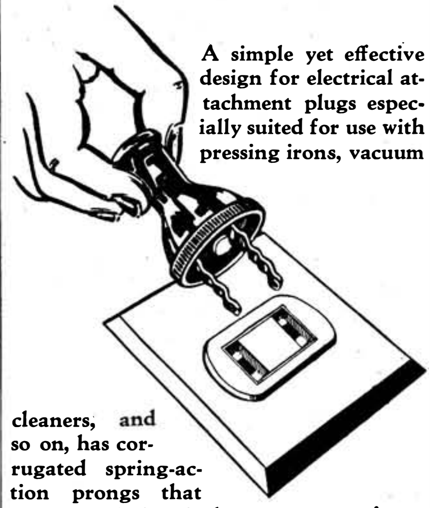
Founded by Paul Revere in 1801

INCORPORATED

EXECUTIVE OFFICES: 230 PARK AVENUE, NEW YORK CITY



percent. Again, excluding lard, foreign oils represented 10 percent of the total consumption in 1914, whereas by 1929 imports had risen to 30 percent of the total. Nor did the consumption of oils decline as sharply in the depression years from 1930 to 1935 as did most other commodities. In 1934 total factory consumption excluding lard ran over four billion pounds.—*A. E. B.*



A simple yet effective design for electrical attachment plugs especially suited for use with pressing irons, vacuum cleaners, and so on, has corrugated spring-action prongs that make good electrical contact yet grip so firmly that it is almost impossible for the plug to loosen accidentally

Bees

THE photograph of a swarm of bees appearing on page 126 of our September number should have been credited to Edward F. Bigelow, ArcAdiA, Old Greenwich, Connecticut.

Warning Against Dinitrophenol

BLINDNESS from the use of dinitrophenol for reducing weight has not stopped the use of the drug in spite of repeated warning, says W. G. Campbell, Chief of the Federal Food and Drug Administration. The eye cataracts observed in dinitrophenol poisoning develop with a rapidity and malignancy hitherto unknown, and result in total blindness within a comparatively short time. This drug may produce acute poisoning, the symptoms of which are nausea, stomach and intestinal distress, sweating, flushed skin, high fever, rapid breathing, and muscular rigor followed by death. The drug also damages the liver, kidneys, heart and sensory nerves. It produces agranulocytosis, a blood disorder also noted in cases of poisoning with amidopyrine, a common ingredient of medicines for the relief of pain.

The Food and Drugs Act, according to Mr. Campbell, is practically inoperative against this public health hazard. He says, "The only application of the law to these products is through some misstatement of fact or some false and fraudulent curative claim in the labeling. In any event, the law can be invoked only when the product has been transported across a state line."

Of all the products containing dinitrophenol now on the market, only one has been confiscated under the Food and Drugs Act, the Administration reports. That was

"Slim," against which legal action was brought because of a label claim that it was "safe to use," whereas medical opinion is unanimous to the contrary: Dinitrophenol is sold under many fanciful names sometimes accompanied by a statement of the presence of the drug itself. Some of the names under which it has been or is now being sold are reported by the Food and Drug Administration as follows: Nitromot, Dinitrolac, Nitra-Phon, Dinitriso, Formula 281, Dinitrose, Nox-Ben-Ol, Re-Du, Aldinol, Dinitrenal, Prescription No. 17, Slim, Dinitrole, Tabolin and Redusols.

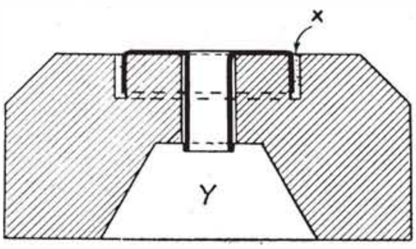
"It is interesting to note," said Mr. Campbell, "that all the so-called reducing preparations on the market fall into three categories: first, laxatives that deny the body the benefit of its food intake, as the salts, crystals, and herb teas; second, obvious frauds that depend for effect upon the stringent diets prescribed as part of the 'treatment', as 'Syl-Vetto' and 'Stardom's Hollywood Diet'; and third, the unquestionably effective but dangerous articles containing thyroid or dinitrophenol, both of which act by speeding up the utilization of food. All of them are unwarranted impositions upon the public, which cannot evaluate claims made for the preparations, and cannot readily appreciate the harm that may result from careless use of the products."

Alloy Orifice Gives Uniform Glass Flow

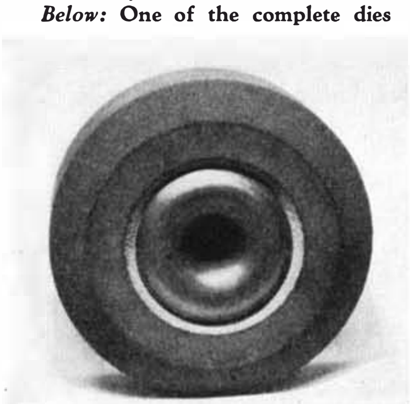
DEVELOPMENT of a refractory die with an alloy lining has made it possible to obtain a uniform flow of glass when filling electric lamp bases and has brought to Henry K. Richardson and Frank A. Newcombe an "Award for the Outstanding Accomplishment" of the Westinghouse Lamp Company.

The alloy lining has increased the life of dies by 190 times and production from 7 to 15 percent. Uniform glass flow has in turn permitted the adoption of automatic temperature control for oil burners on the glass furnaces.

Black insulating glass in the bases of



Above: **Section of new alloy-lined refractory die described in text.** ***Below:*** **One of the complete dies**



incandescent lamps is delivered to the basing machine from a tank so small that no stack is required. A positive pressure is always present in the furnace. An oil burner, acting both as a melting and delivery burner, fires the tank from one side. The batch is changed intermittently every 20 minutes.

At a speed of 220 per minute, the brass shells of medium screw bases, such as those on general household lamps, are indexed automatically into the glass stream flowing through an orifice in the bottom of the furnace. In this fraction of a second, an exact amount of glass must fall into each base. Hence the temperature, diameter, and speed of flow of the glass stream must remain within close limits to assure uniform production.

In the past, the porcelain die would erode within a few hours, making it difficult to maintain a uniform stream. Glass delivery had to be adjusted at frequent intervals by changing the temperature in the furnace or by doctoring the batch with sand or soda. Sooner or later the glass composition became unstable and fractured glass frequently occurred.

Finally the operation had to be stopped altogether to allow for a complete new start. By the time 200,000 bases were filled (15 hours at the most) a new plug or an entire new die had to be installed. The time for these adjustments slowed production, introduced considerable wastage, and in general contributed to high manufacturing costs.

With the new alloy-lined die, these difficulties have been minimized until they are now negligible factors. Uniform flow of glass and automatic temperature control make it possible to fill approximately 38,000,000 bases without a die change.

After numerous tests with high-temperature alloy metals and various refractory compositions, none of which proved better than porcelain, an alloy of 90 percent platinum and 10 percent rhodium was found best in resisting the abrasive action of the hot flowing glass. A lining of this alloy, 0.030 inches thick, is inserted into an Alundum refractory support to form the die now in general use.

Bubbles for Cement

THE "bottle of bubbles" flotation process which worked such wonders in the separation of metals in western mining, has now been applied to cement materials, reports *Chemical and Metallurgical Engineering*, and is again working wonders. By putting the raw rock through the bubbles, desirable elements are floated out—and in most cases a single type of rock, treated this way, can be made to yield material for every type of cement.—*A. E. B.*

Bones Made "Rubbery" to Correct Deformities

GIVING crippled patients "rubbery" bones and then bending the deformities straight is the new technique described before the Fifteenth International Physiological Congress in Leningrad, by Dr. I. William Nachlas of the Johns Hopkins University Hospital, Baltimore.

In collaboration with Dr. David Shelling, Dr. Nachlas has worked out a diet and routine of internal medication which softens skeletal structures.

"This change of the bone to a more or

less rubbery structure will permit the manual correction of deformities for which surgical treatment is either undesirable or impossible," Dr. Nachlas explained. "The straightened limbs are then held in position by a cast or other form of support while the bones are rehardened."—*Science Service.*

Fast Color Molding Plastic

MOLDED plastic parts exposed to acetone and other strong solvents or acids sometimes are subject to bleeding of the dye, and to overcome this General Plastics, Inc. has recently brought out a non-bleeding material called "3973 Black." Although originally developed to overcome the bleeding troubles in molded bottle caps in contact with strong solutions, the new material has found many industrial applications. With a low-moisture absorption rate of 0.7 percent, "Durez 3973" has a rich, high gloss finish and high torsional strength, and is recommended for textile machinery parts where any bleeding of the dye under the action of solvents would prove troublesome. It has a compressive strength of 30,000 pounds per square inch.—*A. E. B.*

Severe Vitamin Lack Causes Breakdown of Nerves

VITAMIN lack in the diet, if severe enough, causes an actual breakdown and "death" of nerve tissue, experiments on rats by Dr. Charles Davison, of Montefiore Hospital, New York City, have demonstrated. In the experiments, rats were fed diets adequate to sustain life, except that each diet wholly lacked one or another of the vitamins, from A to E. The animals became ill, finally losing the use of one or both of their hind limbs.

When they were chloroformed and dissected, it was found that the nerves leading to their muscles were abnormal in appearance and structure, with an actual breakdown of the nerve substance itself, and in some cases brain hemorrhage.—*Science Service.*

Engineering Index Predicts Great Progress

THAT especially far-reaching developments are about to be made in the fields of television, mining, power plant equipment, aviation, and automobiles is indicated by a barometric reading of the Annual Volume for the fiftieth year of the Engineering Index.

This complete assembled record of engineering advancement in all its branches in all parts of the world for the last year contains 1320 pages, describes engineering items in 2000 different publications, lists 40,000 separate items of periodical literature under 5000 various subject headings, and cites 25,000 separate authors who wrote in 40 different countries and in 20 different languages.

The whole story of American industry, of course, cannot be read between the lines of the Engineering Index. In addition to the trends which the Index points out, there

(*Please turn to page* 279)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

AMATEUR telescope makers and astronomers who regularly read this department and who enjoy organizing societies will derive practical pointers based on actual experience from a short article published below, on "Organizing an Amateur Astronomy Club," written by Leo J. Scanlon at our request—or rather in order to provide an answer to the requests of numerous readers who have at various times asked us how to organize a club of this kind. Scanlon has had good success at organizing and is enterprising. His energies and those of his club group burn steadily and through several years they have not petered out. Some amateur clubs in the past have been a little more like novæ or new stars: They blaze forth, shine brilliantly for a time and then decline to a lower candle power. They doubtlessly start too auspiciously, and the more gaseous parts of the nova soon pass off into the circumambient ether, or are exhausted by direct conversion into brilliant radiation. New clubs also fall, sometimes, into the clutches of those who would make the organization an end in itself (one we knew of had about nine vice-presidents), and who insist on regimenting everybody to such an extent that it is more fun to go home and play telescope by one's self and not be ordered around all the time. In these things there is a happy medium and such, we reckon, is what Scanlon, no flickering, fluctuating nova but just one of the steady stars of the firmament, outlines as follows:

"WHEN two amateur telescope makers get their heads together over a polishing barrel—a group is started. When two friends meet on a warm summer night, and their thoughts turn to the moon and stars—a group is started. In either case, it's merely a matter of securing the companionship of others of like interest—which is the point we shall now discuss. It will be our aim, in organizing this group, to help others to enjoy the many pleasurable hours we have spent tracing out the constellations upon the deep blue of the night sky, or to have them feel the peculiar satisfaction of having achieved a telescope mirror that will show them more clearly the myriad wonders of the universe of stars. We shall have a secondary pleasure in watching others succumb to the insidious addiction of which we have experienced, grinding glass with Carbo, and painting the household with rouge.

"If you have made a telescope, or purchased one, you are the logical one to start the organization. If you built your own telescope, the local newspaper would be more than willing to publish a photograph of it, with a description of your harrowing experiences in grinding, polishing, regrinding and so on. The sensitivity of the knife-edge test is always amazing to the uninitiated, and is often the one thing about making a telescope that awakens an interest which is never satisfied until the witness has performed it repeatedly on a mirror of his own making.

"If you have no telescope, write for your local newspaper short articles on objects of interest in the sky at different times, concentrating attention on a particular object, describing it in the detail that is at your command. These articles should appear more or less regularly. Soon others will seek you out and declare their interest in the same subject.

"Go to your library, and see who has been reading the astronomical books. Contact them by mail, avow your interest in the same subject, and it's an easy bet that you and your opposite get together. Answer all correspondence promptly, even if it hurts.

"Don't hide your light under a bushel. If you want to have the benefit of the experience, assistance, and personality of others, you must let them know where you are. If they're at all interested, they will get in touch with you.

"Business houses are usually willing to permit a group to set up a display of your workmanship in their show windows; it is good advertising for both of you.

"When you have secured the names and addresses of a dozen persons in your locality who are interested in astronomy or telescope making, call a meeting at the home of one of them. Have someone elected by acclamation to conduct the meeting. He will be known as President, Chairman, or what-not—but as yet the group will not have a name. Do not attempt at this time to name it—a name will gradually suggest itself. When you do find it necessary to identify yourselves, make the name as concise as possible—or it will take up too much room on your meeting notices. [We forgot to mention that Mr. Scanlon's organization is known as the 'Astronomical Section of the Academy of Science and Art of Pittsburgh.'—*Ed.*] Have a rubber stamp made with the name on it—and give it to the Secretary.

"Meet regularly, regardless of how few attend. Remember that the best organization is not necessarily a large one. Only one person out of a thousand will be interested in your subject, and that is a high percentage.

"Make the meetings informal; don't read any minutes during the first year. Report on activity of different members; talk about latest developments in astronomy.

"Get a standard astronomy textbook, and let each member take a particular chapter in turn and explain all about it, to the best of his ability—then discuss it.

"Buy, borrow, or rent lantern slide or motion picture lectures on astronomy. Large corporations often have them for free showing; lectures can be rented from observatories for a nominal charge.

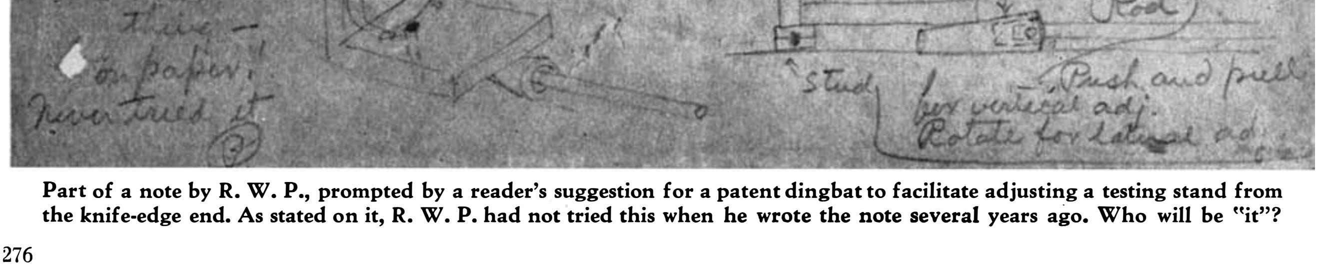
"The major activities of the group will be building and using telescopes; the telescope building will progress almost unaided after someone makes a start.

"Since it is the aim of the telescope builder to supply himself with a 'scope at low cost, using the instrument upon completion is a foregone conclusion. However, undirected observation of the skies tends to become monotonous unless one has the proper guides, such as sky maps, handbooks, and so on. It should be the duty of the Secretary to post himself upon all such publications and secure them for members of the group.

"One of the first activities of the group should be to conduct a class in elementary astronomy. There will be no difficulty in securing a standard text on astronomy, and having each member study and present to one of the meetings a selected chapter from the book. A half hour of each meeting period could be thus profitably spent.

"Start a lending library among your members. Loan each other scientific books, taking a receipt for them, and receive a promise of their return within a reasonable time. Return promptly all books you borrow.

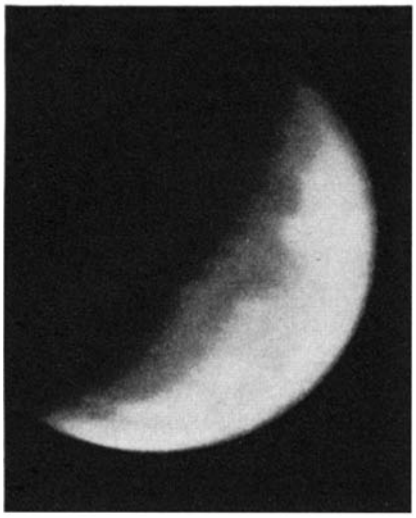
"Photograph the constellations, moon, and planets with your own modest equipment. There are books available dealing with this subject; get them through your



Part of a note by R. W. P., prompted by a reader's suggestion for a patent dingbat to facilitate adjusting a testing stand from the knife-edge end. As stated on it, R. W. P. had not tried this when he wrote the note several years ago. Who will be "it"?

group library. Have the photographically inclined member do the developing and printing of the plates, and make lantern slides from them. Give informal lectures with these and other slides secured elsewhere to churches, clubs, and groups, gratis.

"Start a club scrap book. Keep photographs of the activity of the various members; clippings from newspapers and journals dealing with your hobby; photographs contributed by other amateurs or groups. Co-operate with other groups in exchanging information, ideas, and materials.



What happens when an attempt is made to photograph the moon without a clock drive and with a five-second exposure—a blur. Submitted by E. T. K., of Marshalltown, Iowa

"Those without equipment may be interested in studying meteors. This field is still new and open to anyone.

"Someone with the zeal to do 'real scientific work' will want to observe variable stars. This is one work that always offers the possibility of a thrilling discovery and sudden fame—the discovery of a comet or a nova is frequent enough to be encouraging.

"Arrange visits to local points of interest; visit newspaper plants, industrial concerns using science in their business; arrange at least one visit each year to some observatory where you will have unrestricted use of a telescope of considerable power, under the direction of a sympathetic astronomer.

"Take advantage of the various talents to be found in your own group; have the mathematical shark compute an orbit or explain the movements of the planets; have the draughtsman design your mountings; have the chemist lecture on the intricacy of the silvering process; have the photographer explain celestial photography; have the skilled mechanic devise better means of moving and holding your telescope. Interest your friends who are not members of the group in your hobby; they are usually willing to help you secure materials and service at less than usual cost.

"In summary: Consider yourself a committee of one to start the organization going. When you have gathered a few interested ones, co-operate with them in every way; give freely of your service.

"Don't urge anyone to join your group.

The Astrosonus Observatory and the reticle for use in meteor observing

If people do not have the desire to ally themselves with you without urging, they are not the ones you want; don't have a membership campaign—build up your membership slowly and firmly.

"Make your membership requirements simple; be certain that the members are interested—be certain they are good fellows!

"Work as a group, for the interest of the group. Don't promise to do anything you can't; do more than you promise.

"Don't enjoy your hobby painfully; if you don't feel like observing on a cold night, don't do it because someone expects you to do it. If you don't feel like grinding your mirror, forget it for a few nights and read a book. Follow the hobby for the fun of it—be the master of your hobby, not its slave."

ORGANIZER Scanlon also wishes us to publish the announcement that there is to be another exhibit of amateur astronomers' work, in connection with the science exhibit at the annual convention of the American Association for the Advancement of Science, to be held this year at St. Louis, December 30 to January 4. All amateurs wishing to submit exhibits in the form of photographs, transparencies, or material made or used by amateurs, should communicate with him (Leo J. Scanlon) at Valley View Observatory, 106 Van Buren St., Pittsburgh, Pa. The exhibit he organized last year at the same association's meeting was a big success—a compact crowd filled the booth throughout; even Professor Einstein came.

THE spider web shown in the picture on this page is a reticle used by the amateurs at the "Astrosonus Observatory," and the picture was sent by Arthur DeVany and Bernhard Nordblum, Jr., 929 Grand Ave., Davenport, Iowa. These two state that the Midwest Meteor Society, of which Prof. C. C. Wylie of the Iowa State University at Iowa City is president, worked out this method for determining the height of meteors. The four converging rods join an open ring, the "eyepiece," and the meteor's path may be accurately read as is crosses various parts of the reticle. Two reticles, separated by 30 to 60 miles, make simultaneous readings, and the rest is a matter of triangulation. The observatory shown is near the banks of "Old Man River," and houses a 6-inch Clark. Another observatory dome near by houses a 10-inch reflector made by the group (Tri-Cities Astronomical Club), which also has on the site six cameras of wide aperture, a 115-foot sun telescope, and a comet finder. Meteor shooting is a kind of astronomer's skeet game, and said to be lots of fun.

EARLIER this year Russell Porter was ill and confined to home for about five months, but relatively few knew about it at that time. Then, just when he came on deck again and went to work, word got around that he was very ill—a sort of phase lag in news arrival. To lay the ghost of the rumor, we quote what he writes: "I am on the job now, all cylinders." Everybody will be glad to hear this. While in bed he wrote a long chapter on mountings, for the fourth edition of A. T. M.

IT seems a pity that no more spectrohelioscopes have been made. The total score is one—just one—made by Prescott of Wells River, Vermont. Someone in England made one, it is true, but did not tackle the tough part, the 13 optical surfaces, as the courageous, tenacious Henry B. did. Picking up the July number of the *Journal of the British Astronomical Association* (by the way, why don't more join this amateur society—every club should have at least one member in it, in order to get the *Journal* and pass it around) we find an article by F. J. Sellers, one of the mechanical group of British amateurs and the same Sellers whose chapter on a simple clock drive is in A. T. M., and read that the mean daily frequency of solar prominences during three recent months was 8.93, a lot to look at if one had a s'h'scope. He describes the 50,000-mile prominence of June 22-23, "a most remarkable prominence display. The outbreak was dense and brilliant, changing very rapidly." In the same number he describes a solar prominence spectroscope, with instructions for making and using it; a grating is attached to a 30-60-90 prism, and the dispersion is large.

MORE short, compact instructions for making setting circles, also for collimating different types of telescopes, are needed for the A. T. M. Supplement, as no one person seems to be able to write complete chapters on these subjects. We have some mighty fine material for this book, and more is promised. The latter ought to be sent in soon—we are working on this book every spare minute. Please don't ask us when it will appear, for we don't yet know. It will appear as soon as limitations of necessary sleep permit, and it will surely be announced, so you won't miss it. The fourth edition of A. T. M. has just gone to the printer as we write these words (Sept. 3), but when it will be ready depends upon the time it takes this one little fella to correct first, second, and third proofs, and then read the whole book in order to make a new and more complete index—a tough job in itself. So much depends upon good luck, available time, eyesight, and strength of back, that we can't yet set a date, but you won't miss this book, either—we shall of course announce it. This one—the fourth edition—is to come out first, the Supplement later. The fourth edition will not be increased in size, but there will be a number of new chapters, in place of material which is out-moded; also numerous smaller substitutions and corrections.

BENJAMIN J. Phillips, 67 Albion St., Somerville, Mass., a member of the Amateur Telescope Makers of Boston, recently sent us one hair from his head, which he had been using for a sort of Ronchi test. When tried, this proved interesting and revealing. One hair, fastened across a supporting opening or a key ring, and used with the ordinary pinhole, throws on the mirror one element of the Ronchi shadows. It will show up a zone or a turned edge about as well as an elaborate rig with fancy slits. Someone—wish we could recall who—told us a hair comb was good for the Ronchi test and we used it thereafter. No slit—merely the lamp with a cardboard around it to keep direct light out of the right eye, and the comb used as in A. T. M., page 266, Figure 3, being simply held in the two hands without complication. The jet black bars show what the mirror looks like, very clearly. The old comb works about as well as something elaborate would.

The Ronchi is a convenient side partner of the Foucault, in ordinary mirror work, but is not generally a substitute. On a short focus mirror it is a godsend for, instead of individually testing zones, as is necessary when below about $f/5$ because the depth of the shadows is then a poor gage of the smoothness of the curve, you simply look with the Ronchi, and if the bands are straight you have a sphere.

HERE is a problem for somebody: perhaps it will prove too tricky and sensitive to be practical. Perfect a dingbat which will permit an instructor to coach a beginner by watching the same shadows the beginner sees as he manipulates the knife-edge. In army rifle coaching, the coach lies prone near the prone rookie, at right angles to him and, by looking into a peep hole, sees the sights and target exactly as the rookie does, and can coach him vastly better than he otherwise could do. The rookie does the holding. Through this common link the two minds make full contact all the time. The problem would not be so simple on a mirror test—more delicate.

THE SCIENTIFIC AMERICAN DIGEST

(Continued from page 275)

is the question of obsolescence. Obsolescence and depreciation in normal years amount to about five billion dollars. None of the replacement has been made for the last three years. Are we merely going to replace the old equipment, or are new things going to take their places?

The publications covered by the Index fall under three main classes. The largest of these is made up of periodicals or magazines devoted to engineering, pure science, other technical subjects, and industrial literature. The second class includes the transactions, proceedings, and other publications of every engineering or allied technical society anywhere in the world. The third class includes a wide variety of so-called irregular serial publications such as government bulletins, bulletins of universities, of engineering experiment stations, research organizations, and industrial companies. Altogether they comprise the one complete, authoritative index of engineering.

FISH EAT FISH

CANNIBALISTIC fish may serve the cause of science. Recently, an ichthyologist found, in the stomachs of catfish, specimens of the great Caspian sturgeon, which they had previously been unable to study. He suggests that his fellow-scientists dissect the stomachs of aquatic animals with a view to finding other fish which they have swallowed.

FIND DRUG THAT SOBERS UP DOGS

A DRUG that will sober up intoxicated dogs in less than half the time it took their fellow drunks to recover from an alcohol jag was reported by Prof. R. N. Harger and H. R. Hulpieu of the University of Indiana School of Medicine at a recent meeting of the American Society for Experimental Pharmacology and Experimental Therapeutics.

The drug is the yellow powder known to chemists as dinitrophenol which has recently been used to cause fat people to lose weight. Because it is very dangerous when used without a physician's supervision, the Indiana scientists particularly warn the public not to use it as a home remedy after a spree. "Severe poisonings and several deaths have resulted from its rather widespread use by overweight people," Prof. Harger said.

"We wish to emphasize that our experiments were done only with dogs and that the presentation at this time is solely for its scientific interest. Until further carefully supervised work is done this drug should not be used in treating intoxication in human beings.

"Otherwise, when 'hubby' returns home 'soused' at four A.M. and takes a capsule of this drug in order to be sober when he goes to the office at nine, he might accomplish the desired result, but again he might go to the undertaker instead."

So dangerous do Prof. Harger and his associate consider this drug that they have hesitated to publish their discovery of its sobering-up effects for fear that some unscrupulous medicine manufacturer might exploit the drug as a treatment for drunkenness and thereby produce cases of serious poisoning or even death.

Their experiments showed that the drug enabled the dogs to burn the alcohol they had been given much more rapidly than the usual rate.—*Science Service.*

Metal Cleanser

An effective cleaner for sheet metals such as steel, aluminum, tin, galvanized iron, and so on, makes use of phosphoric acid, one of the strongest acids known to chemistry. Sold under the name "Sol-Klean," this mixture of phosphoric acid, solvents and other ingredients necessary to produce efficient cleaning is said to impart rust-proofing properties to the metal.—*A. E. B.*

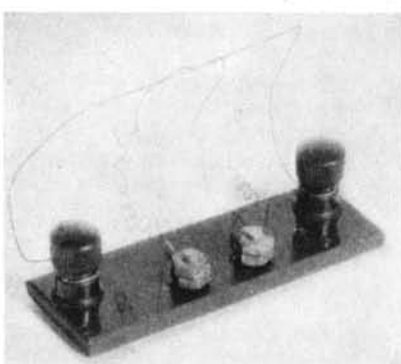
Heated Wire Anemometer

A new type of anemometer, especially designed for measuring slow air movements such as are present in refrigerator cars, has been developed by the Bureaus of Agricultural Engineering and of Plant Industry, United States Department of Agriculture. Operation of the instrument depends on the cooling of a heated wire when exposed to air currents. The accompanying illustration speaks for itself.

So far, the instrument has been used to measure only horizontal velocities, but engineers believe it can be used to measure velocities of any direction. Use of the anemometer will result, it is expected, in a better knowledge of the requirements for air circulation and of the conditions under which maximum circulation may be obtained in refrigerator cars.

The instrument is small enough to be placed under the floor rack of a car and may be read from the outside without disturbing conditions inside.

Previous to the development of this anemometer, observations of air velocities in cars were confined largely to smoke tests. Puffs of dense smoke were released at certain points in cars and observations were made of how long it took the smoke to travel to other points. The general direction of air movements could be followed and



Simple heated wire anemometer

some idea of velocities of currents was obtained in this way. Difficulty of access to many positions in cars and diffusion of the smoke limited the usefulness of this method.

Also in making smoke tests, it is necessary for at least one observer to be in the car. In some cases, the presence of an observer is likely to set up independent convection currents or otherwise distort those being measured, engineers believe.

Curbing Cannibal Chickens

The peevish pullet that exhibits cannibalistic tendencies by picking at her neighbor is a real menace to the egg and chicken market. Losing her tail feathers and skin is hardly conducive to the health and


Chicken muzzle aids egg production

happiness of Madame Hen, not to mention the blow to her dignity. A hen thus blighted develops an inferiority complex, fails to eat and drink properly; in short, becomes a cull, which is an ugly word among chickens.

Nor is the evil entirely one-sided. The transgressor gets a crop full of feathers, which, though filling, are lamentably lacking in essential vitamins and such things. Thus the hen becomes ill, stomach complications set in, and egg production drops.

An ingenious method of eliminating this wasteful and unsanitary habit consists of equipping the fowls with protective devices to prevent extra-curricular picking. One of these, developed on the West Coast, consists of a midget triangular shield called a "Pikgard" which covers the beak of the chicken and pivots on a pin near the base of the beak. The guard is so balanced that it automatically falls away when the hen lowers her head to feed or drink, drops back into place when the head is raised. Made of aluminum, it is unaffected by moisture and is so light in weight that it does not interfere with the chicken's normal head movements. This device is now extensively used by poultrymen throughout the United States, as well as foreign countries, with highly satisfactory results.

Smokeless Coal

A process for taking the smoke out of coal before it has burned was reported to the American Chemical Society by S. C. Jacobsen and G. W. Carter, of the

University of Utah. Estimating an annual loss due to soft coal smoke in the United States at 500,000,000 dollars, the advocates of smokeless coal declared that a process that would eliminate soft coal smoke would easily justify the expense involved by the necessary pre-treatment. The process recommended involves treating coal with super-heated steam at 1000 to 1400 degrees, Fahrenheit, thus removing the hydrocarbons which give rise to smoke during combustion.—*A. E. B.*

Wax on Wood Won't Wear Off

FLOORS and furniture that never need to be waxed to polish them are within the realm of possibility since the discovery of a process whereby wax is absorbed deeply into the fiber of the wood instead of merely covering the surface. The first step in the "embalming" process is a chemical treatment that makes the wood permeable to the melted wax. Beeswax and stearin are among the waxes so far successfully used. Dr. A. J. Stamm, United States Forest Products Laboratory, Madison, Wisconsin, inventor of the process, states that rosin, linseed oil, and other substances that will mix with wax can also be used. The process is said to render wood waterproof and resistant to warping, shrinking, checking, and cracking.—*A. E. B.*

Military Aircraft Ideas

THE United States at the moment is definitely in the lead as far as aircraft and aircraft engines are concerned. In some quarters, however, the view is expressed that Europe may take this advantage away from us under the tremendous impetus which its vast expenditures for air war purposes are certain to give. Therefore, such pessimists argue, it behooves us to forge ahead in experimentation in every possible way. A correspondent, E. Burke Wilford, the designer of the Gyroplane, sends us a number of interesting suggestions for worthwhile experiments and investigations. These suggestions he divides into two classes—those applicable to naval aircraft and those for Army use.

For the Navy he discusses, first of all, wheels in floats. When a seaplane, mounted on one or two floats is built, it requires the help of a retractible gear to convert it into an amphibian. Naturally this increases weight and complexity. Is it perhaps possible to mount fixed wheels at the bottom of the float, projecting enough to secure a land alighting machine, but so arranged with relation to the float as not to interfere with its water take-off characteristics?

A great deal of research work has been done in regard to the location of air-cooled engines relative to the wing. The engine nacelle usually is so located at the leading edge, and the motor so protected with a Venturi cowl that the combined resistance of wing and nacelle is fairly low. Perhaps this process of resistance reduction could be carried still further, by placing the engine within the wing, leading the cooling air through passages inside the wing, and driving the propeller through a shaft transmission. This would certainly bring us a step nearer to the conception of the flying wing. The problem to be solved is partly aerodynamic, partly mechanical. Experiments along these lines have already been made and should certainly be continued.

In regard to Army aircraft, Mr. Wilford is equally stimulating. When engines become extremely powerful in relation to the size of the airplane, the question of engine torque becomes important. In the Schneider Cup races the 2500 horsepower engine torque was so great that lateral equilibrium was secured only by placing one float farther away from the center than the other, and by putting all the fuel in one float so that its weight would counteract the turning moment of the engine. This would not be practicable on a land plane. The remedy here would be to use two propellers at the nose of the aircraft, one immediately behind the other, and rotating in opposite directions. Presumably one propeller would have a hollow shaft, with an interior shaft driving the leading airscrew. A subsidiary advantage of such an arrangement would be that slipstream effects on the vertical tail surfaces would be eliminated, and the problem of keeping a straight course simplified.

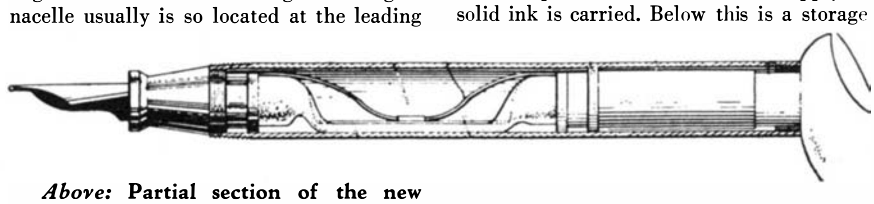
The study of beryllium alloys for aircraft use is also advocated. Beryllium is still expensive, but some of its alloys weigh less than duralumin and are stronger. Certainly nothing would make for more rapid progress in aircraft structure than an improved method of refining the vast supplies of beryllium ore available, which would bring down its cost to a reasonable level. So great is the value of weight saving in aircraft that even a relatively high cost could be absorbed without any difficulty.

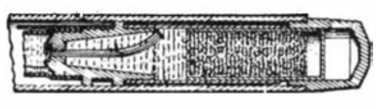
It is fine, once in a while, to think broadly of the future, and not to restrict ourselves to mere refinements.—*A. K.*

Fountain Pen Filled with Water

A NEW type of fountain pen which can be filled from any supply of ordinary water, and yet makes possible writing as with ordinary ink, is called the "Camel" for obvious reasons. In the design of this pen, every precaution has been taken to make it as foolproof as possible and to cause no more trouble to the user than any ordinary pen filled with the conventional liquid ink.

In this pen there is provided a chamber in the top of the barrel where a supply of solid ink is carried. Below this is a storage





***Above:* Partial section of the new water-filled fountain, showing filling mechanism. *Right:* Section showing ink cartridge and storage chamber**

chamber and still farther down is a rubber sac provided with a means for compressing and releasing it. When water is drawn into the rubber reservoir, by pressing and releasing a button on the upper end of the barrel, the water comes in contact with the solid ink cartridge, some of the ink is dissolved, and the pen is ready for use. When the pen is carried upright in the pocket, constant dissolving of the solid ink into the water in the reservoir is prevented by the small storage chamber in which is held a certain amount of water and ink in concentrated form. Surface tension prevents this concentrated solution from reaching the reservoir except as needed to keep the liquid in the reservoir at the proper "writing color."

It is claimed that for ordinary use the solid ink cartridge in this pen, produced by the American Writing Instrument Company, will last for at least a year.

CURRENT BULLETIN BRIEFS

Progress Demands Knowledge is a 16-page pamphlet which explains in some detail the Engineering Index service. This Index is of inestimable value to all engineers, research workers, and executives in any technical field. *Engineering Index, National Committee, 25 West 43rd Street, New York City.—Gratis.*

Petroleum, the Story of an American Industry, is an illustrated booklet of 96 pages that covers the subject completely from a definition of petroleum through its history, refining, marketing, taxation, and conservation. This booklet will be of great value to anyone who uses petroleum products in any form. *American Petroleum Institute, 50 West 50th Street, New York City.—15 cents.*

Protective Devices for Head, Eyes, Nose, and Throat is essentially a catalog of a manufacturing organization but is unusual in that it is devoted entirely to devices which have been developed to insure safety in various industries. It lists, illustrates, and describes a complete line of protective goggles, welding helmets, respirators, and blasting helmets. *Willson Products, Inc., Reading, Pa.—Gratis.*

Audubon Wire Cloth describes and illustrates a complete series of various types of woven wire cloth adaptable to many industrial uses. A complete catalog is also available in addition to this eight-page folder. *Audubon Wire Cloth Corporation, Castor Avenue, Allen & Bath Sts., Philadelphia, Pa.—Gratis.*

Brookville Locomotives describes a full line of industrial locomotives ranging from two and one half to six ton models, all powered with Ford V-8 engines. *Brookville Locomotive Company, Brookville, Pa.—Gratis.*

Tip Top Tubes are made of various flexible materials such as paper, cloth, cellophane, and so on, and are adaptable to packaging of many different types of manufactured products. The tubing is available in all sizes and is readily sealed by a cleverly designed machine. A pamphlet describing these tubes will be mailed gratis on request. *Midland Products Inc., 3176 Brannon Avenue, St. Louis, Mo.*

THE PROBLEM OF THE FAR EAST

(*Continued from page* 239)

tance from Europe, is in the best position to oppose the further dismemberment of China by Japan. But we are engrossed for the time being with our domestic situation and plagued by national scuttlers who would give up our foreign trade and over-seas possessions in a childish effort to secure peace by becoming a hermit nation like China was. For the moment, Japan seems to have everything her own way.

Is There a Remedy? Is there still a chance to save China? On first examination the answer would certainly be "No!" Torn by internal dissensions, militarily feeble in comparison with Japan, lacking interior communications, and temporarily denied outside assistance due to European rivalries and our domestic situation, China seems an easy prey for Japan.

A Possible Solution. There is great latent resistance in the Chinese people, there is a national spirit that can make itself felt, and *perhaps* it will make itself felt long enough and strong enough to delay the progress of Japan until the inevitable consequences of Japan's success become more plainly apparent and force Great Britain and the United States to take joint measures to stop this alarming advance.

The Woeful Alternative. If the statesmen of these two great countries can not find a formula for joint action in the near future, they will witness not only the extinction of the century-old trade with China but they will see a Japan securely entrenched in an almost impregnable line of islands extending from the Kuriles through the Philippines to the Dutch East Indies. Australia and New Zealand will then lie at Japan's mercy and the western Pacific will become a Japanese lake.

Some Jeremiahs will doubtless say it is already too late, that Japan is already unassailable in the Far East. These doleful souls should recall how securely Napoleon *seemed* to be established in Spain, and how easily he was ejected when the Spaniards united and decided to resist, and Great Britain with her sea power and small army seized the opportune moment and came to the rescue. There is still hope for China if the Chinese will keep up their resistance long enough for Great Britain and the United States to realize the inevitable implications of Japan's further encroachments on China. Given this realization, the opportunity will soon arise for successful and comparatively easy intervention by the two great sea powers, and the grandiose plans of the Japanese war lords will tumble like a house of cards about their Chauvinistic heads.

CAMERA ANGLES

Conducted by JACOB DESCHIN

Greetings by Photography

GIVE your friend a basket of fruit culled from your own garden and he'll appreciate it no end, vastly more than the fanciest you could purchase. The same applies to greeting cards, whether during the holidays or for special occasions, such as birthdays. A greeting card you have made

Examples of photographic greeting cards described in these columns

yourself will be the only one like it in the world—unless you make a number of copies yourself—and the person who receives it will know you mean everything you say.

The making of greeting cards by photography appeals enormously to the imagination, for it leaves one free to roam the whole world of fancy and fun to choose the design suited to the occasion and the person for whom it is intended. A greeting card may be planned as a single copy for one person and no other or it may be printed a great number of times for distribution to a great number of people, as at Christmas or New Years. The latter, of course, must be so arranged that it will be sure to have a general appeal, yet be far beyond the stereotyped method.

Bookplates may also be designed and completed by the same methods employed in making photographic greeting cards. By making one's own bookplates, different ones may be designed for different classifications of books in one's collection, such as volumes of history, fiction, poetry, and so on.

The simpler the subject matter, the more appealing the greeting card or bookplate. All outdoors as well as indoors is good hunting. A bookplate may reflect one's hobbies or tastes, a greeting card may show a picture of a subject mutually familiar to sender and receiver, such as a charming picture of the baby or of a corner in one's garden. No worth-while subject will be found too trite if it means something to you or your friend and is tastefully handled.

Greeting cards may consist either of a photograph mounted on a white or buff card with even spacing at top and sides and doubling the margin at the bottom, as in mounting any picture, with the sentiment written in on each card in one's ordinary handwriting, or they may be more elaborate. The two here illustrated are examples of the latter. Neither required any great ingenuity and may suggest to the reader other and better methods.

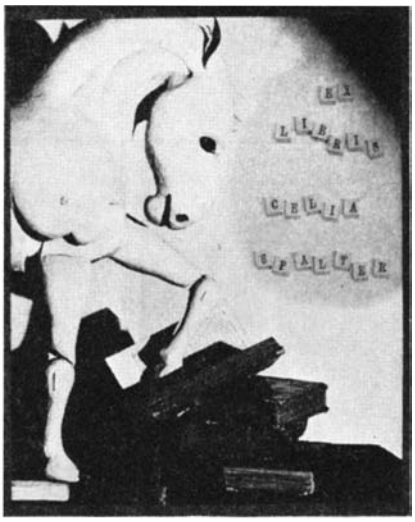
The one showing the two youngsters watching a puppeteer at work is the result of two separate negatives, one showing the

boys and the puppets and strings, the other the holiday string formed into the word, "Greetings." An ordinary large white blotter was used as the background for the latter. The two negatives were placed in the holder together and printed through simultaneously.

"The Season's Best" card was made by projecting a cardboard cutout of a window with a piece of cheesecloth thrown over one side of it to simulate a curtain. An ordinary white sheet was used upon which to project the shadow design. The lighted candle in the corner helped along the sentiment as well as aiding in the composition. The sentiment was hand lettered in opaque directly on the photographic negative.

It is a matter of choice whether the greeting card shall be a single card or a folder. In the latter case it seems less wasteful to mount the print on some sort of mounting cardboard than to print on a large piece of sensitized paper so as to have enough left over to fold.

In the bookplate illustrated the lettering is a separate negative in which anagram blocks were arranged on a blotter. A print



A photographic bookplate

was first made of the learned hobby horse negative, the latter removed and the lettered negative inserted in the proper place, all but the lettered portion of this negative being held back by a piece of cardboard which at the same time "dodged" in the lettering.

Since bookplates are intended for pasting into books, a very thin printing paper should be used. The paper generally employed for this purpose is that known as "insurance bromide" and may be obtained for you by your dealer.

The use of such materials as string, paper clips, sugar or salt sprinkled on a black cloth, lend variety and humor to the designing of the lettering in greeting cards and bookplates. Other materials for this purpose will readily suggest themselves to the worker when he starts thinking along these lines.

Negative File

THE importance of carefully storing negatives to protect them from dust as well as to make them easily accessible, is realized by all serious workers. The "Book of Negatives," recently brought out, is a file, bound in imitation leather stamped in gold and having the appearance of a book, consisting of transparent glassine containers arranged to accommodate negatives up to and including size 116. Its capacity is 100 to 400 negatives, depending on the size.

"Bas-Relief" Photography

CONSIDERABLE interest has been aroused recently in an old process by which an ordinary photographic print is made to give the appearance of a piece of sculpture in low relief. One starts with a negative, which is placed in contact with a glass plate or film and then exposed, thus producing a transparency. The negative and the positive, or transparency, are then placed face to face and about 1/32nd inch off register, and bound all around with gummed cloth or paper. The negative-positive may then be used either for contact printing or making enlargements.

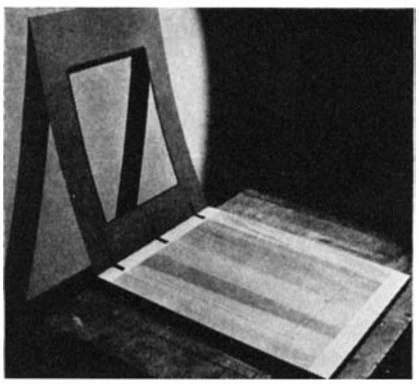
Flash Synchronizer for Small Cameras

EVEN miniature camera users may now enjoy the advantages of the photoflash synchronizer formerly almost exclusively available to the press cameraman. The Kalart synchronizer is now readily adaptable to the smallest as well as the larger cameras and opens up a vast new field for amateur exploitation—the taking of fast action pictures at night. Speeds as high as 1/200th of a second at night are not unusual with such an aid as the photoflash synchronizer.

Home-Made 11 by 14 Mask

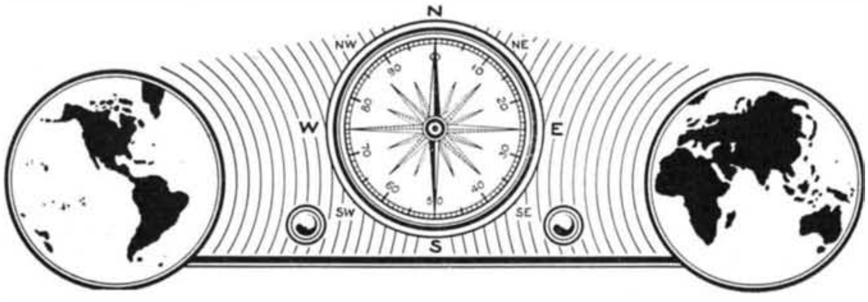
THE worker who finds occasional use for a mask larger than the largest accommodated by his regular easel can solve the problem easily and cheaply by constructing one himself. The materials needed, which may be purchased for less than a dollar, are an artist's drawing board, because of its non-warping characteristic, a piece of stiff cardboard the size of the drawing board, some black adhesive tape, a straight edge and a knife with a sharp point. Any artists' supply store can furnish these materials, if they are not already available.

The particular mask here described was made to take 11 by 14 inch paper and provided for a half-inch border all around. The cardboard was first cut to fit the dimensions of the drawing board. An opening was then cut in the cardboard with the sharp knife to measure 10 by 13 inches and



The home-made mask

sharp edges assured by lining the edges with black adhesive tape. The mask was then made fast to one end of the drawing board by means of the same adhesive tape, inside and outside, so that the mask could be "opened" and "closed" like a book. With the mask down, a line was then marked for the inside dimensions, the portion of the paper to be exposed. "Opening" the mask, a rectangular line was then drawn in ink 11 by 14 inches to provide for the accurate placing of the paper. To insure sharp borders the mask may be held in close contact with the paper by means of weights or push pins or both.



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

THE BEAT-FREQUENCY OSCILLATOR

WHEN you are cruising through the numerous wave channels in search of new stations, or merely seeking a desired short-wave broadcaster, there is no assurance that you will hear each and every station tuned in. The stations are there, but a number of them may escape your notice.

This inability to spot all short-wave broadcasters on the air within the range of the receiver is no reflection on your technique of tuning, nor on the qualities of the radio set. The apparent absence of stations at their proper dial-scale settings is frequently due to other causes.

Short-wave signals are subject to rather severe fading at times. Therefore, though the receiver may be tuned to the proper frequency for a given station, the signals may be so weak that they are lost in the background noise. Yet a few minutes later signals from the very same station may roar in.

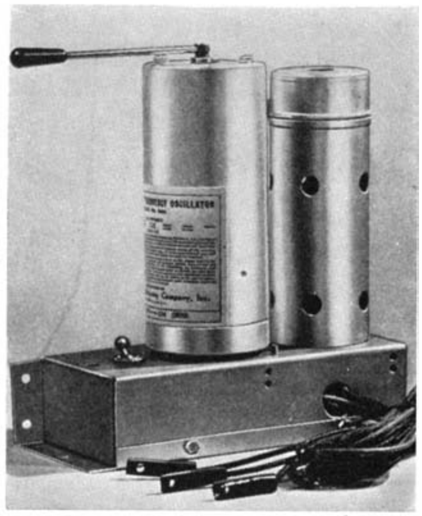
The condition of fading is further aggravated by the fact that foreign short-wave broadcast stations are more often than not run for extended periods with an unmodulated carrier; that is, the signal carrier is left "on the air" minus a program transmission. So long as a station carrier is unmodulated there is nothing to be heard except possibly a gentle hissing sound. If the carrier is passing through a period of fading while unmodulated, there certainly will not be any evidence of its presence at the receiver.

Since the carrier wave of any radio transmitter has a frequency far beyond the audibility of the ear, it cannot be heard through the medium of the radio receiver, unless it is modulated by an audible frequency. Consequently, a listener may readily skip by numerous short-wave broadcast stations without realization, or assume that a desired broadcaster has failed to maintain its program schedule.

Happily there is a simple solution to this problem; one may attach to his all-wave receiver a small device, known as a "beat-frequency oscillator," that will make each and every station carrier distinctly audible, irrespective of whether or not the carrier is modulated. Several radio manufacturers market this device in unit form so that it may be employed as an auxiliary tuning contrivance or "station finder." These units can be used only with receivers of the super-heterodyne type.

The beat-frequency oscillator generates electrical oscillations which are, like a broadcast-station carrier, above audibility. The oscillations are injected into the receiver circuit and made to "beat" with the station carrier in a manner such that the resultant frequency is audible in the loud speaker. The following explanation will provide a better understanding of just what takes place:

In a superheterodyne receiver all signals received are converted to some lower, intermediate frequency, before they are actually detected and made audible. If the intermediate frequency of the receiver is 456 kilocycles—and this is a frequency commonly used—then all signals tuned in are converted to this frequency. Now, if a beat-frequency oscillator is attached to the receiver and its frequency adjusted to, say, 454 kilocycles, there will be three rather than two frequencies in the detector circuit—the original 456-kilocycle frequency of the signal, the 454-kilocycle frequency of the beat-frequency oscillator, and a "beat frequency" of two kilocycles, which is the difference between the first two frequencies.

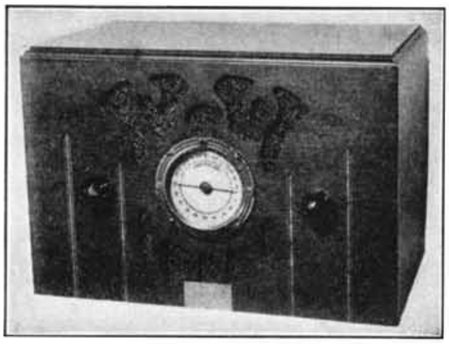


A standard beat-frequency oscillator

Now the beat frequency of two kilocycles is audible. A kilocycle is 1000 cycles; therefore two kilocycles is 2000 cycles—well within the range of the ear.

If the beat-frequency oscillator were to be set at 452 kilocycles rather than 454 kilocycles, the resultant beat would still be audible. The beat frequency in this case would be four kilocycles, or 4000 cycles. The beat-frequency oscillator is provided with a small adjusting knob so that the listener may select the most desirable beat frequency. Once this adjustment has been made, it

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.



need not be touched again when tuning.

In operation, the beat-frequency oscillator is turned on and the receiver tuned in the usual manner. Each time the receiver dial pointer reaches the setting for a broadcast station which is on the air, an audible whistle is heard in the loud speaker. The beat-frequency oscillator is then turned off, at which time, of course, the whistle ceases, and in its place will be heard the program —or possibly nothing at all if the carrier is unmodulated or passing through a fading cycle. In any event, there is little chance of skipping by a station inadvertently.

The question may arise as to why even a whistle can be heard, when using a beat-frequency oscillator, under conditions of maximum signal fading. This is due to the fact that detection of a signal carrier by the beat-frequency method is many times more sensitive than the usual rectification means of reception. It cannot be used for the detection of broadcast programs because of the interfering whistle.

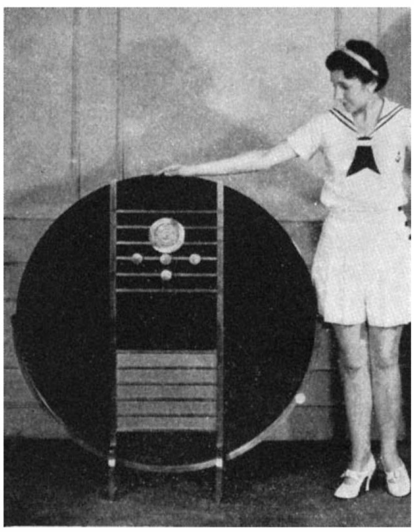
Timing Programs

THERE are a number of electric time-clock switches now on the market specially designed for use in conjunction with radio receivers. In place of the minute and hour hands, these devices have two adjustable pointers; one for "On" and one for "Off."

Hooked into the electric supply to the receiver, a device of this sort may be used to turn on the radio set at any desired time, and turn it off again at the completion of a program. This would suggest that, aside from its use as an automatic reminder, the device can be employed as a "radio alarm clock," or as a means of turning off the radio at some pre-determined time after one has retired for the night.

Cabinet Design

RADIO cabinet design has long been tied to the apron strings of custom. It has been presumed that the radio instrument should be disguised rather than revealed; that it should have an exterior which will induce the impression that it is something other than an instrument of sound reproduction.



No disguise for this radio set

It is encouraging to learn that one manufacturer, realizing that the radio instrument, like other mechanisms, should have an exterior design compatible with its function, has indicated a willingness to experiment with the idea.

There is shown in an accompanying illustration one of the new Sparton all-wave sets which, to say the least, is breath-taking in appearance. The cabinet is a midnight blue mirror with chromium steel trim. It was created by the well-known industrial designer, Walter D. Teague.

This cabinet design is interesting because it is functional. Primary consideration has been given to the mechanics of the instrument, rather than to the influence of early cabinet makers.

Although purely experimental, the Teague design may prove to be the forerunner of a functional era in radio cabinets.

Multiple Aerials

BETTER results may be obtained from all-wave receivers by employing two antenna systems in conjunction with a change-over switch.

Since most antenna systems have directional characteristics, the use of two, strung at right angles, permits the listener to use the one that will bring in the desired signal with the greatest volume.

The two transmission lines are attached to the contacts of a double-pole double-throw switch; the antenna and ground terminals of the all-wave receiver are connected to the switch blades. Thus the change-over problem is simplified.

Changing from one aerial to the other will often bring up a weak signal to sufficient volume to be understandable.

Five-Meter Reception

QUITE a number of the 1936 all-wave receivers are equipped for reception on frequencies as high as 60 megacycles. Heretofore it was necessary to use a separate receiver for covering such high frequencies.

One of these new all-wave receivers covers the ultra-high frequency band extending from 18,000 to 60,000 kilocycles (18 to 60 megacycles). In this band are a number of foreign broadcasters, two amateur bands and an ultra-short-wave police radio band . . . unexplored territory to the average listener.

Some real long-distance reception is possible in the vicinity of 18 megacycles. However, very little "distance" reception may be expected at frequencies around 60 megacycles. Nevertheless, the amateur 5-meter band, in the vicinity of 60 megacycles, has become very active and suffers less from interference than do the 20- and 80-meter 'phone bands.

Pre-Selectors

A PRE-SELECTOR is a self contained, and usually self-powered, tuned radio-frequency amplifier. The sensitivity of any superheterodyne all-wave receiver may be increased considerably by the addition of this device. Aside from increasing sensitivity, the pre-selector also reduces "image interference" and increases receiver selectivity. Using a pre-selector is the simplest way of boosting all-wave receiver results outside of purchasing a new set.

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(see page 229)