OUR WINGED WEAPONS

World's Finest Warplanes

SCIENTIFIC AMERICAN

Including:
A DIGEST OF
SCIENCE & INDUSTRY

. . also . .

Amateur Photography

By Jacob Deschin

★

JULY
1940

35c
a Copy

Vol. 163

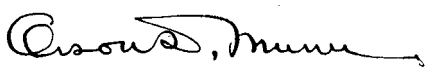
No. 1

ANNOUNCEMENT

Scientific American, a ninety-six year old international institution, will come to our readers in new form starting with the next—the August 1940—issue of the magazine.

Modern typography, a new cover design, a refreshingly different manner of presenting editorial material, will characterize the new Scientific American. Always in step with the trend of the times, the editors will give to our readers more news of the world of science and industry in more readable and compact form.

Yet, despite the increased tempo, there will never be any compromise with authenticity and accuracy. Old readers of Scientific American will appreciate what this means; new readers will quickly grasp the advantages of this editorial policy that has been maintained for almost a century.



Editor

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; all at 24 West 40th Street, New York, N. Y.

NINETY-SIXTH YEAR • ORSON D. MUNN, Editor

CONTENTS • JULY • 1940

IN the article starting on page 5 of this issue is given a compact survey of the world's finest warplanes—those employed by the Air Services of the United States. On our cover is illustrated the North American observation plane, O-47A. Note the windows in the lower part of the fuselage and the full-vision cockpit enclosure. The eyes of the Army must see all.—*Official Photograph, U. S. Army Air Corps.*

SCIENTIFIC AMERICAN, July, 1940. Vol. 163, No. 1, 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 Orange, 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.

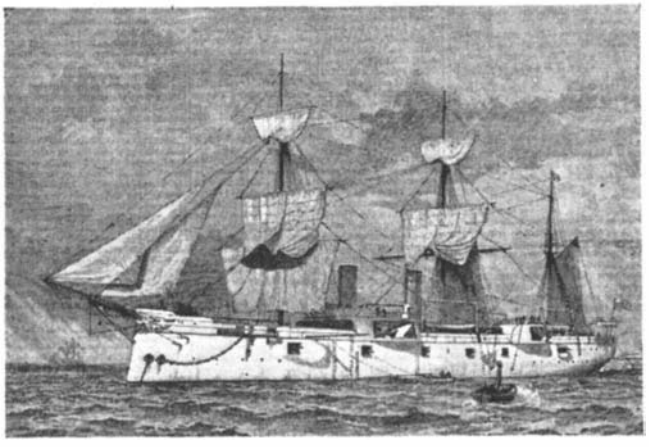
50 Years Ago in . . .

Scientific American

(Condensed From Issues of July 1890)

CANAL—"It is now over eight years since work was first begun upon the Panama Canal, and about two years have elapsed since active operations were suspended. The total cost of the work up to the present time, including the indebtedness of the company, is estimated at seven hundred millions of dollars, and the canal is hardly half finished."

CRUISER—"The squadron of evolution sent by the United States government to the Mediterranean, under command of Rear-Admiral John G. Walker, attracted much attention. The admiral's flagship was the frigate-built cruiser *Chicago* . . . constructed of mild steel, at a cost of about one million dollars, and launched in 1885. She is 334 ft. long, 48 ft. broad and draws 19 ft., having a displacement of 4,500 tons. She has two screw-propellers, with engines of 5,500 horse power, indicated; the machinery is protected by a partial steel deck. Her speed is 15 knots an hour, and she carries 940 tons of coal. The armament consists of four 8 in. breech-loading guns, on the spar deck; eight 6 in. breech-loading guns, in broadside, on the gun deck; and two 5 in. breech-loading guns aft; with six machine guns."



GUNPOWDER—"No evidence exists of the use of gunpowder as an agent of warfare until the middle of the twelfth century, nor did a knowledge of its propulsive effects come to the Chinese until the reign of Yunglop in the fifteenth century — a thousand years after its first employment in fire crackers."

GLASS—"A new method of obtaining stained glass is done by a process of printing. The design is embossed on an iron plate, on which a lump of hot glass is rolled until it takes the form of the plate on which the pattern is cast. The sunken lines are then filled with enamel and the whole plate is fired. This process obviously does away with the use of leads, is rapid in its execution, and has the additional advantage that the design may be repeated as often as it may be required."

TOOTHPICKS—"Quill toothpicks come from France. The largest factory in the world is near Paris, where there is an annual product of 20.000,000 quills. The factory was started to make quill pens, but when these went out of general use, it was converted into a toothpick mill."

GIRDER—"The Keystone Bridge Co. has just completed a girder for the new City Hall of San Francisco, which is the largest ever made in the United States. . . It is 105 feet long, and weighs 70 tons. A contract for two girders was given to the company last November, and they have been working on it ever since. The materials for the second one are now being prepared. The girders are intended for the ground floor of the building."

WELDING—"The great demand for artificial ice machines, and the necessity for furnishing long coils of pipe to be used in their construction, has furnished a new and extensive field for the pipe welding machines of the Thomson Electric Welding Company. The difficulty of welding pipe by the old methods is that, unless the joints are perfect, there is an escape of ammonia vapor which renders them practically useless. It is found that by the electric welding process these joints are perfect, and lengths of 400 or 500 feet of homogeneous pipe can be made without difficulty. The electric welds stand bending either hot or cold."

FOOD—"Probably no modern science presents a wider field for speculation than that of chemistry, and more especially, perhaps, that branch of the science which treats of organic compounds. . . In an address delivered at Heidelberg, by no less eminent an authority than Victor Meyer, it is announced that 'we may reasonably hope that chemistry will teach us to make the fiber of wood a source of human food.' What an enormous stock of food, then, will be found, if this becomes possible, in the wood of our forests, or even in grass or straw."

PAY-TELEPHONE—"A novel telephone station is being introduced in Connecticut. The instrument cannot be used unless a fee is paid. There are five slots in the machine for the reception of a nickel, ten cent piece, quarter, half dollar, and dollar respectively. . . To use the telephone it is first necessary to call up the central, as on an ordinary telephone. The objective point is then asked for, and when this is reached, the party who rings up is told to put the necessary fee in the slots."

SPEED—"A special train . . . on the 15th July . . . left Baltimore at noon, and thirty-five minutes later had traveled forty-two miles and was in the Pennsylvania railroad station in Washington. The speed averaged 72 miles an hour, or allowing for starting and stopping, at least 80 miles for the greater part of the run."

AND NOW FOR THE FUTURE

¶ Progress in the young and vigorous organic chemical industry. By Dr. C. M. A. Stein.

¶ Geriatrics — the newest medical specialty. By Barclay Moon Newman.

¶ Pattee's Caves, where medieval Irish monks may have lived in New England. By Prof. Hugh O'Neill Mencken.

¶ Evolution in the future: Will the human species ultimately produce a race of super-men? By Henry M. Lewis, Jr.

¶ Brilliant achievement in the improvement of commonplace textiles. By Philip H. Smith.

Personalities in Industry

DONALD W. DOUGLAS

BORN in Brooklyn, New York, in 1892, Donald W. Douglas was 11 years old when the Wright Brothers made their first flight at Kitty Hawk. Six years later he received his appointment as a midshipman in the United States Navy and was ordered to report to Annapolis. In 1909 the two American inventors of the flying machine brought their frail biplane to Fort Meyer, Virginia, for a demonstration to the United States Army. Young Douglas was among the few who saw the airplane leave the ground, fly around the course and return to its starting point. He did not know it then, but that event also marked the beginning of his career.

After three years of training cruises, navigation, and mathematics, young Douglas still had his mind on wings and skies instead of the seven seas, and was ready to turn to new, untried fields. His father, William E. Douglas, a New York banker, hoped Don would become a naval officer, but fate and Donald decreed otherwise. In 1912 he entered the Massachusetts Institute of Technology. His progress at the Institute was rapid. He was graduated in 1914 and in June of the same year received an appointment at that institution as Assistant in Aeronautical Engineering at a salary of $500 a year. It was his first job in aviation.

With Commander J. C. Hunsaker, young Douglas worked on the first wind tunnel, a step that laid the foundation for the amazing development of aviation in the last quarter of a century. In 1915 he joined the Connecticut Aircraft Company in New Haven as a consultant and there worked on the D-1, the first dirigible built for the United States Navy. Later in 1915 Douglas went to Glenn L. Martin and became his Chief Engineer. Within a year he was Chief Designer for the Aviation Section of the Signal Corps, but later returned to Martin. At 25 he was one of the outstanding men in the fascinating new field of aeronautics.

By 1920 Donald Douglas was working for himself. He came to southern California and with David R. Davis formed the Davis-Douglas Co. Their first office was "desk space" in a barber shop. There was designed the Douglas *Cloudster*, the miracle of its day. It was only a step from the *Cloudster* to a Navy contract for several airplanes.

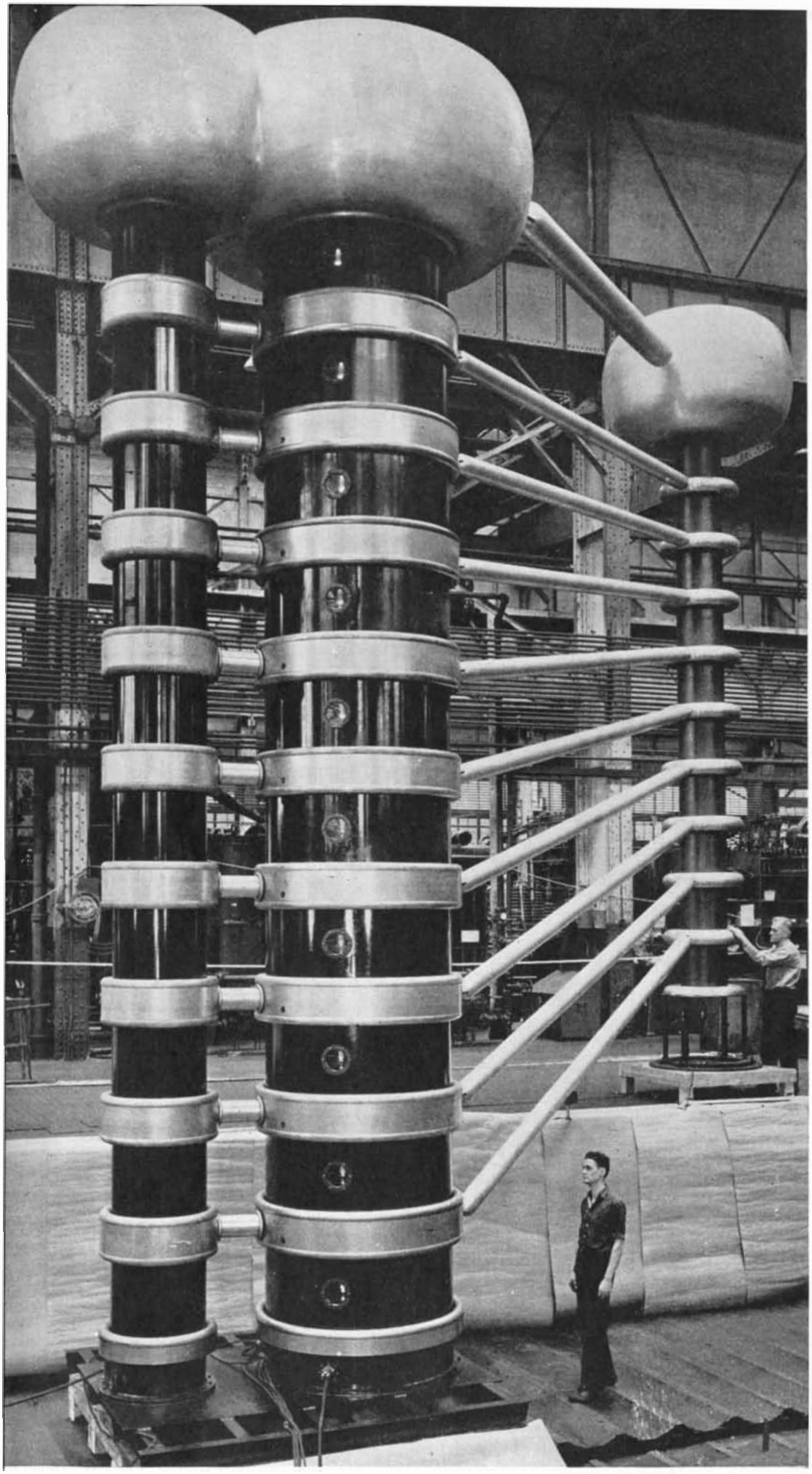
In four years Douglas was ready for another milestone in his career. A new model, the *DWC* was finished and the United States Army was on its way to make its historic flight around the world by air. The Douglas slogan became "First Around the World," and today is "First Around the World—Now the World Over."

At the age of 32 Donald W. Douglas was internationally famous. His organization grew until today the two Douglas factories at Santa Monica and El Segundo, California, are America's largest airplane plants. On May 1, 1940, Douglas employed over 17,000 men and women, with a payroll of approximately $28,000,000.00.

In 1932 Douglas entered a new field. The historic *DC-1* and the *DC-2* changed aerial transportation in America. Soon Douglas airliners were dominating the skies. The 425th ship of the "DC" series was delivered in May, 1940. Douglas airliners fly more than 350,000 miles every 24 hours in the United States and 22 foreign countries. To the safety record of 1939, when the airlines in the United States carried 2,000,000 passengers 815,000,000 miles without an accident, Douglas contributed equipment for 85 percent of this imposing record.

Universal acclaim and recognition made no change in Don Douglas. In 1936 when President Roosevelt presented him the Collier Award for outstanding advance in aviation, his associates still called him "Doug," as they did after he received, in January, 1940, the Guggenheim Gold Medal for the outstanding contribution to the development of commercial and military airplanes.

He is married and lives with his wife and children in Santa Monica, close to the huge Douglas plant. Reading, yachting, and quiet hours with a few close friends are his recreation. Never flustered, seldom disturbed, always calm and collected, he continues to keep pace with the amazing progress of the thing closest to his heart—aviation.



THE WORLD'S MOST POWERFUL X-RAY APPARATUS

THREE principal objects in this group are, at right, a 1,400,000-volt X-ray tube; in center, a high-voltage generator to feed it; at left, resistance units. General Electric has built this big apparatus for the National Bureau of Standards, which will use it, first, to explore X-ray dosage at the higher voltages into which medicine is pushing, later for producing neutrons and artificial radioactivity for physical research. The 1,400,000-volt, 10-milliampere X-ray tube is composed of ten sections of 140,000 volts each, in cascade; each section is fed individually by its corresponding section of the ten-part generator. This is composed of step-up transformers, capacitators, and kenotron rectifier tubes. Resistance units in left-hand stack are used in measuring the voltage. X-ray tube is 28½ feet high, and its beam of electrons travels 24 feet. In operation these electrons start at zero velocity and are given a velocity kick in each section, so that at the target the speed is 180,000 miles per second—very nearly the velocity of light. Curved tops of each stack are spun aluminum corona shields to prevent loss of electricity to the atmosphere.

Official photograph, U. S. Army Air Corps

A Boeing flying fortress, world's largest service ship, which will be dwarfed by a 72-ton ship now building

AMERICA'S WINGED WEAPONS

World's Finest Warplanes . . . Built to High Standards and of Superior Material . . . What the Various Types are Designed to Accomplish

By JAMES L. H. PECK
Author of "Armies With Wings"

AN embittered Spain, a disunited Poland, and a capitulated Finland bear mute testimony to potency of modern airpower; what remains of the Old World appears destined to suffer at the hands of this new weapon—swiftest, most far-reaching of Man's war agencies. And all of this has a very definite effect upon American defense in general and our air arm in particular.

The sleek warplanes, which are literally the sinews of this American air arm, are much in the news these days; current discussion is international as well as national. These fighting craft are of several types, each of which is designed for one of the tactical sub-divisions of our Army Air Corps or Naval Air Service. The tactical branches of the former include pursuit, attack, observation, and bombardment. Naval branches are somewhat similar, and comprise fighter, scout-observation, patrol, and bombing squadrons. The small but colorful Marine Corps flying organization is an integral part of the Navy Bureau of Aeronautics, and their equipment is of essentially the same pattern.

Fighters and pursuit-interceptors are the smallest of combat craft, their tactical function entailing the destruction of enemy bombers and combat ships. The designation "interceptor" has been applied to American planes only recently, although England has, for many years, employed single- and multi-seater planes of this type. Its primary use is to fly up and out to intercept approaching hostile planes. The interceptor is usually designed for extremely fast climbing and is heavily armed. Fighters and pursuits are usually more maneuverable, and engage in close and rapid in-fighting while the interceptors indulge in hit-and-run tactics. The new Air Corps pursuit-interceptors are single-seaters, having four machine guns and aerial cannon mounted stationary within the wings or the cowl in front of the pilot's cockpit. The ships are aimed and flown at the target, while the guns are fired automatically by hydraulic or electric devices, the triggers being mounted handily on the ship's control sticks.

The much-publicized Bell P-39 "Airacobra" and Vultee "Vanguard" are typical prototypes. The Bell YFM-1 "Airacuda" and Lockheed P-38 are twin-engined craft of somewhat larger dimensions; the former being our only multi-seater (five-man) fighter. The newest models are the Curtiss P-42 and P-46 and the Navy's Brewster F2A-2. All of these sparkling craft are superior to any in the world in their respective classes—which is why the Anglo-French Purchasing Commissions are not exactly unhappy.

COMBAT planes are evaluated in terms of their performance—how fast they fly at both cruising (with 60 to 75 percent full power) and top speeds, how easily and rapidly they may be maneuvered through the aerobatics occasioned by combat, and how quickly they can take off and climb to high altitudes to meet the enemy. In addition, they must have a high "factor of safety" and good flying characteristics in general, with safe landing and take-off abilities in particular.

This behavior, however, is but a means to an end. High speed is essential mainly for the purpose of overtaking or escaping enemy craft; a rapid rate of climb, to get the defending planes up to the altitude of the approaching ones; and maneuverability, for the sole purpose of outflying hostile ships so that the guns—"firepower"—may be brought to bear. No warplane is any more effective than its armament, and the successful employment of this, in turn, depends upon the man behind the gun.

None of the World War II warplanes

rank so high on *all counts* as do our new pursuit-interceptors, two of which are some 70 miles faster than any Nazi ship known to be in service, and four of which will climb to 10,000 feet in far less time than Britain's "Spitfire," topmost World War II climber.

Planes of the attack branch are designed for assaults on ground troops and matériel in a low-flying operation called "strafing," employing machine-gun fire, small and medium-sized bombs (30 to 100 pounds), and contaminating chemicals. After using attack planes which were slightly larger than pursuits for several years, the Air Corps has found the 60-foot, twin-engined attack bomber more satisfactory. These "winged tanks" carry more fuel and bombs than the smaller attack plane, and this added gas capacity permits them to accompany larger bombers on a mission far beyond the cruising range of the former type. The two motors make for increased speeds and also provide better forward visibility for the pilot. This is paramount when flying 400 miles per hour at tree-top altitude! The new Douglas A-20A almost attains this pursuit-plane speed with a full warload of bombs, fuel, and war chemicals. Although this ship, the Martin 167W, and North American NA-40A, carry crews of from three to five men, the forward-firing guns, which are mounted in the wings, are fired by the pilot in the same manner as those on a pursuit plane. A rear gunner holds forth in his enclosed turret to ward off would-be back-biters, and the bombardier bombs from his vantage point in the ship's nose.

Encamped troops, or those who are marching, are easy prey of attack bombers, and these ships support friendly infantry advances by strafing enemy trenches, artillery, and machine gun emplacements. A most important mission, however, is the support of bombing operations, wherein it becomes the strategy of the attack planes to "neutralize" or destroy the anti-aircraft batteries which protect the objectives sought out by their big brothers, the medium and heavy bombers. The low-flying onslaught enables the attack bombers to flash from behind terrain features and trees upon the unsuspecting victims with the element of surprise and blinding speed in their favor. Anti-aircraft gunners who are being harassed by parachute bombs and mustard spray are practically helpless for all their marvelous fire-control gear; all of which makes the attack-bomber the most deadly thing on wings.

THE air raider's tactical function is to bomb to destruction such enemy objectives as air bases, power stations, reservoirs and pumping stations, shipping and docks, mills, factories, and other sources of matérial and food supply, communications and transportation centers, troops and fortifications—most of which are to be found within city limits and necessarily involve the military and the helpless alike.

Heavy bombers, such as our Boeing flying fortresses, are designed to carry huge fuel and bomb loads for long distances. A six- or eight-man "combat crew" comprises pilot, co-pilot, bombardier, radioman, navigator, and gunners, most of whom are quite versatile in that they can exchange places and jobs when necessary. These types are four-engined monoplanes having machine guns disposed about the huge ship in such a manner as to provide defensive fire from all angles. The Air Corp's Douglas B-19, now building, weighs 72 tons and has a cruising range that will permit a round trip flight between New York and Paris.

However, not all bombardment missions call for long-distance flying, and because of the poor strategy involved in employing the long-range bomber for not-so-long operations, the fortress' little brother, the medium-bomber, came into being. This is a twin-engined monoplane which is smaller and faster, and carries less warload over shorter distances.

Because of the diversification of Navy bombers, a word is timely regarding the "egg-layers" of the flying fleet. In lieu of the heavy bomber, the Navy employs a 13-ton patrol bomber of the now famous Consolidated PBY type which gained popularity through the record-breaking formation flights to Hawaii and the Canal Zone sometime ago. These are twin-motored monoplane flying boats. The boats of Patrol Wing Five are conducting the Neutrality Patrol

Official photograph, U. S. Army Air Corps

Rated as the world's fastest pursuit-interceptor, this Lockheed P-38 has two 1150-horsepower engines

Official photograph, U. S. Army Air Corps

Note the wing guns in this Martin 167 attack-bomber. Top speed is 355 miles per hour

off the Atlantic coast. These are the aerial cruisers of the fleet, and with their formidable range the PBY boats can fly hundreds of miles to spy out enemy ships.

The torpedo bomber is a single-engined, low-wing monoplane of about 50-foot wing span. These craft carry a 2000-pound torpedo and are carrier-based landplanes. In action, they skim just above the waves, headed straight for their floating target, release the "fish," then pull up and away before the explosion occurs.

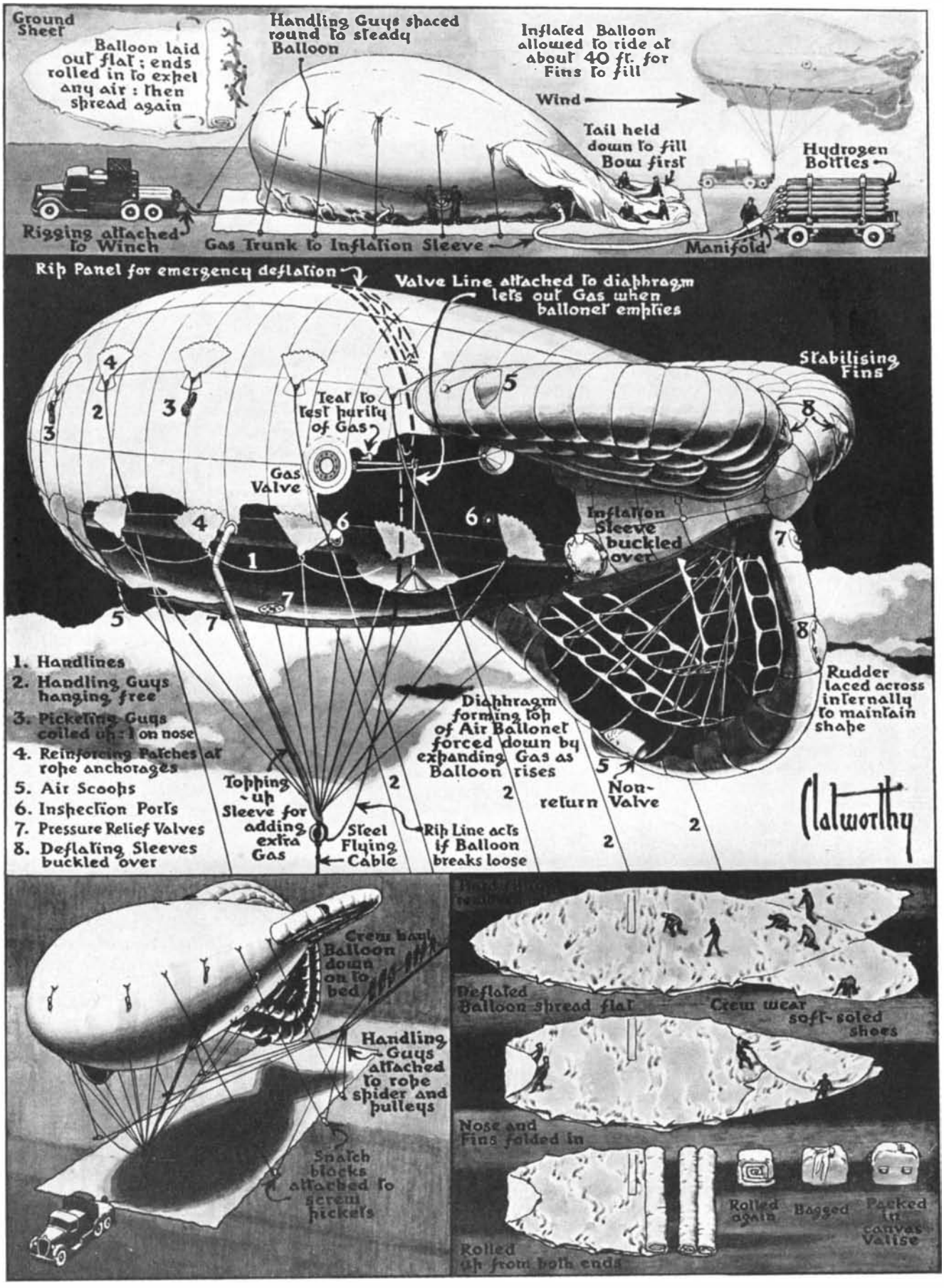
The scout-bombers and dive-bombers are smaller—the Curtiss SBC-4 "Helldiver" having a 34-foot span—and faster. The scout-bombers carry on short-distance reconnaissance, and when necessary they stop scouting and commence bombing. Both these prototypes employ the spectacular vertical dive attack, in which they scream down at around 400 miles per hour, aimed at the target, release their bombs, then pull up when about 500 feet above the sea.

Bombing teams—pilot and bombardier—of the patrol bombers and the Air Corps types lay their death eggs in a less spectacular method from higher altitudes. When the bombs are released from the racks in which they are suspended in the plane's belly, they do not fall straight downward, but travel forward with the ship for a distance before heading earthward in a parabolic trajectory. This behavior—that is, the forward movement from point of release—is called "range," and it varies with the plane's speed and altitude. From 6000 feet, a bomb would have a range of about a mile and a quarter if the bomber is flying 240 miles per hour; at the same speed, the missile would have twice this range—or 13,648 feet—if dropped from 12,000 feet. But range is only one of many considerations, and all these are neatly taken care of by the bomb sight. The bombardier makes settings to correspond to the plane's speed, altitude, wind drift, ground speed, and other technicalities, and sights down and ahead until the target is lined in the telescopic view finder, then merely presses a button. Electrical apparatus and science take care of everything. The miraculous accuracy of our Sperry sight is pretty well known by this time—both in and out of the United States!

OBSERVATION work is not so glamorous as that of the combat branches, but it is equally important. Aerial reconnaissance—the "eyes of the Intelligence"—is perhaps the most important original source of enemy information available to ground commanders. Flights over the hostile back areas, trenches, and cities, and the photos thereof, supply invaluable information of enemy movements. The North American O-47A, an all-metal, mid-wing monoplane, which is provided with a windowed belly for the observer and his all-important camera, is the current Air Corps observation plane.

Another unglorified branch which is employed by both the Army and Navy forces bears the simple title "Utility," but it is most essential to the smooth operations of the air forces. Cargo ships fly all sorts of equipment to air bases or outlying posts. Transports—which are largely of the Douglas DC-2 type seen at most airline terminals—are necessary for the rapid movement of personnel and staff officers. Ambulance craft have saved many a life by swift, comfortable transportation of injured personnel to a place where medical attention was available. The military version of the Douglas transports employed for these purposes is known as the C-39. Last, but far from least, come the vitally important training craft of "primary" and "basic" designations; two of the newer types being the Army's Vultee "Valiant" and the Navy's North American SNJ-2. Fledglings must undergo gradual, carefully supervised transition from these trainers to the speedy, tricky pursuits or giant bombers.

These are the world's finest warplanes; they fly faster and farther than any of the respective foreign types known to be in service or building, and they are built to higher specification standards and of superior material. Our services, unlike most of those across the water, believe as a matter of policy that American airmen are worthy of the finest airplanes that engineering ingenuity and money can provide—and we have more of both than any country in the world.



CREW OF TEN HANDLES A LONDON BARRAGE BALLOON

EFFICIENCY of the London balloon barrage has been proved by the unfortunate wrecking of two friendly airplanes since the war began. Such barrages have shown their effectiveness to discourage mine-laying by airplanes in estuaries. Each balloon requires a winch-truck and a trailer; and is made ready for flying by ten soldiers and a corporal.

OUR POINT OF VIEW

Who Ever Dares Say Never?

IT isn't safe any longer to assert that anything will "never" become possible. Since a long time ago every scientist has known that you never could expect to see clearly objects much smaller than about 1/100,000 inch in diameter, no matter how expensive a microscope you might devise. The watertight reason for this was the obvious one that a hundred thousandth of an inch was not far from the size of pattern of the very thing by means of which you did the seeing; that is, light. Things smaller were not properly noticed by the light to afford a clear image and there was nothing you could do about it. So we had reached the ultimate limit of working magnification at little more than 2000 diameters.

This permitted you, however, to see most of the disease germs. You could see them about as clearly as you can see and recognize a man standing off at some distance, with the naked eye; that is, you could see their general outline but not much of their detail. By wholly different methods than seeing, science could, of course, deduce and prove the existence of many things smaller, smaller, smaller, smaller, smallest, by several degrees of size, than germs; that is, disease viruses, large organic molecules, common inorganic molecules, atoms, parts of atoms. These proofs established the existence of such sub-entities just as fully as if you could see them—perhaps more so, since seeing isn't always believing. Yet you always felt that you wanted an actual look at these things and you were told that you would never get that look.

Today, thanks to the electron microscope so lucidly explained on another page by the young physicist, Jean Harrington, we expect soon to behold clearly, not, it is true, parts of atoms or even whole atoms, but the entities that stood next higher on the forever forbidden list; that is, viruses and large molecules—the latter have been seen already. The electron microscope at one jump has multiplied our power to peer into the vastness of the minute just about fifty times; it permits a magnification of 100,000 diameters! It would even permit us to see atoms if certain wide practical discrepancies between its theoretical and actual power did not still bar the way. Won't these "bugs" be disposed of? Some may. Yet the men who have wrestled with the problem in the flesh think the electron microscope never can come within five percent of its full theoretical resolving power. Some practical reasons are: human inability to attain perfect symmetry of parts, to a degree way past even fine machine work; tiny residual irregularities in coil windings; residual ripples in voltage control that cause variations in electron speed, though you control it, as RCA has, within three volts in 70,000; and, finally, the very same hard-boiled family of aberrations — chromatic, spherical and the others — that have always bedeviled glass lens design.

This super-microscope, which is now coming into its fruition stage after about a decade of difficult development, is the result of a combination of strategem with a great deal of invention, experiment, tenacity, and refinement of technique. Confronted by a blank wall, science made a flank movement. Since images of things far too small to fit the pattern of ordinary light were needed, resort was had to a kind of light having far finer texture—electron waves. Electron waves being invisible to our eyes, they were then transformed, by means of the substances on the fluorescent screen, into waves which our eyes could perceive. These substances can take in the electron energy, change it into light, and send it out again—visibly. And there, on that screen—for example, in the electron microscope at the Camden laboratories of the RCA—you can look into a glass-covered window and, with entire comfort—no squinting—see large greenish images of things magnified as man never before hoped to see them. It makes you feel a bit creepy. Here is a chain of streptococci linked together by a narrow waist, like the waists between linked sausages. It is molecular in size. Or a typhoid germ with flagella, like little whips, extending from it.

There are three important things in the biological world which for a long time have greatly annoyed scientists by being just too small to descry clearly in microscopes—the virus, the gene, and the bacteriophage. Viruses—known cause of measles, influenza, smallpox, infantile paralysis, yellow fever, and the common cold—have for some years been suspected of being either half alive living things or half alive chemicals. Will the electron microscope lead us to a better understanding of viruses and thus to a cure of the virus-caused diseases? Second, the gene, that hereditary factor in our cells which determines our physical and other characteristics. Will the new tool enable us to discover new facts that may ultimately make for better animals and plants—even human beings? Third, the bacteriophage, a sort of predatory germ—the germ's own germ—which kills bacteria. Medicine would greatly like to know just what this perplexing entity really is. Some scientists think it is as much smaller than a germ as a germ is smaller than an amoeba.

Finally, the electron microscope promises much of wealth-controlling value for industry. Probably there is no industry, using any kind of material, that will not ultimately profit by the deeper insight into the real nature of the materials it uses which the electron microscope is expected to provide. Examples are the rubber industry (rubber's complex molecules), the cement industry, the paint industry, and the colloidal metals' industry. Laboratory workers equipped with this new instrument can not merely count the number of particles of a given material, as has long been possible by ordinary optical microscopes and ultra-microscopes (which do not, however, resolve them into clear images), but now can actually see their all-important size, shape, and especially their uniformity or variety. Industry already is awake to this new implement. Some companies—the Eastman Kodak Company, for example —are already using electron microscopes of their own design.

It cannot be said yet, and it may never be true, that the electron microscope will be accessible easily to every man who would like to have one around home just to amuse himself. The instrument now placed on the market by RCA costs, with its 100 kv regulated voltage supply, $17,500. It weighs 700 pounds and stands ceiling high; it is no portable, vest-pocket apparatus. Nor could the average man use one without special training; for it would be about as difficult for him to steer as a temperamental wife. The thing examined must first be placed on a film of nitro-cellulose only 1/3,000,000 inch thick—literally next to nothing! Air must be evacuated from the whole interior, because the big atoms and molecules in it otherwise would obstruct the flying electrons and alter their necessary precision of path, just as a dense thicket of trees would obstruct a snowball fight. There is a delicate technique to be mastered before use.

This question of vacuum bears pointedly on a question we have several times heard suggested. "Why not make an electron telescope working on analogous principles?" To accomplish this it would be necessary to create and maintain a vacuum—a sort of "tunnel full of vacuum"—clear down through the earth's atmosphere to the instrument, and this would be such a tall order that the electron telescope will nev. . .—*A.G.I.*

THE CHEMICAL GIANT

Corrosive Sulfuric Acid . . . Indispensable in Peace and War . . . Used in Most Industries . . . Annual Production Runs into Millions of Tons

By WILLIAM H. WAGGAMAN
Chemical Engineer

THE present European conflict which threatens to engulf the world has been defined as a war of metal, petroleum, and high explosives. But war also demands one other product about which the average person knows very little. He is still less familiar with the part which it plays in manufacturing those weapons so essential in conducting modern warfare. Yet, without this product, we would be unable to turn out the huge tonnages of fabricated steel, prevented from producing the millions of barrels of refined oil and gasoline, and powerless to manufacture the immense quantities of high explosives demanded by war.

This product is sulfuric acid, a colorless, odorless, heavy liquid, the most useful of all manufactured chemicals—and also the cheapest. It is produced in such enormous quantities that, even under normal conditions, the annual output is measured in millions of tons and, under war conditions, its production must be stepped up sharply to meet the increased demand.

TABLE I
Sulfuric Acid Consumption in the United States by Industries, 1938

	Short Tons
Fertilizer	2,100,000
Petroleum	1,120,000
Iron, Steel, & Metals	850,000
Chemical	790,000
Coal Products	585,000
Paints and Pigments	430,000
Rayon and Film	310,000
Explosives	185,000
Textile	90,000
Miscellaneous	300,000
TOTAL	6,760,000

The only sulfuric acid which most of us have seen is that contained in the battery of our automobile. We know this acid vaguely as a highly corrosive chemical which forms bluish green incrustations on the main cables leading from this storage battery, and that it will burn our hands and eat holes in our clothes if we happen to get splashed. "Oil of vitriol," as concentrated sulfuric acid is commonly called, conjures up visions of a destructive product—and it is just that. The main reason why we are so unfamiliar with this acid is that it seldoms appears in the final product which it is instrumental in manufacturing.

As is the case with almost every essential product entering into our complicated system of civilization, the United States leads the world in production of sulfuric acid. Within a period of 27 years—1889 to 1916—our annual output of this chemical increased over 700 percent. According to the latest figures of the U. S. Bureau of Mines, we produced, in 1938, 6,760,000 short tons, having a value of approximately $67,600,000. This acid was distributed to the various industries as shown in Table 1.

The most recent figures available showing how the various nations compare in respect to their output of this acid are those of 1937, when their proportion of the world's total production was as itemized in Table 2.

WAR and preparation for war are reflected in the figures for Japan and Germany, since these two nations stepped up their production enormously during the past few years. Yet, in spite of the fact that we were at peace with all countries, the United States produced nearly one third of the world's total sulfuric acid in 1937, and twice as much as our nearest competitor, Japan, which was operating its plants at capacity in a feverish effort to end the "little Chinese Incident." Should we be drawn into war, our normal output of this chemical could be quickly increased by 50 percent.

Sulfuric acid is a compound of sulfur, oxygen, and water. Since water and the oxygen in the air are free, the chief raw material which must be purchased is sulfur or a sulfide ore (pyrites) containing sufficient sulfur to support combustion.

While sulfur is now obtained as a by-product in a number of industrial processes, most of the European countries are still dependent on outside sources for a considerable portion of their requirements. Yet it is an interesting fact that a few of the nations ordinarily classed among the "Have Nots," are well supplied with either sulfur or pyrites. Spain, Portugal, Greece, and Norway have large reserves of pyrites, and 40 years ago Italy was the world's chief source of elemental sulfur.

Since France is close to the inexhaustable supplies of Spanish pyrites, and Great Britain controls the seas, the Allies are assured adequate supplies of sulfur, and can probably prevent Germany from obtaining sulfur through her main ports. On the other hand, as long as the Rome-Berlin Axis endures, and Stalin remains Hitler's friend, Germany may be able to obtain sufficient sulfur from Italy and Russia to meet her needs, provided, of course, she has the cash to purchase it.

The United States, however, not only possesses immense reserves of pyrites, but the sulfur deposits of Louisiana and Texas are the greatest yet discovered, and the annual output from these fields eclipses that of all other nations combined.

When sulfur burns, it combines with the oxygen of the air to form sulfur dioxide, a stifling, choking gas, the odor of which is familiar to those who have fumigated their homes by means of sulfur candles. Sulfur dioxide is capable of combining with a further quantity of oxygen, but it requires a little "urging." Therefore a third party, known in chemistry as a "catalyst," is employed to introduce this additional atom of oxygen into the compound. The product thus formed is known as sulfur trioxide which, in turn, readily combines with

TABLE II
Production of Sulfuric Acid, 1937

Table compiled from figures of the U. S. Department of Commerce, and the "Chemical Trade Journal")

France	6.86 %
Germany	12.78 "
Italy	6.56 "
Japan	15.60 "
Russia	*7.53 "
United Kingdom	6.86 "
United States	31.00 "
All other countries	12.81 "
TOTAL	100.00 %

*Production of 1936

water to form the useful sulfuric acid.

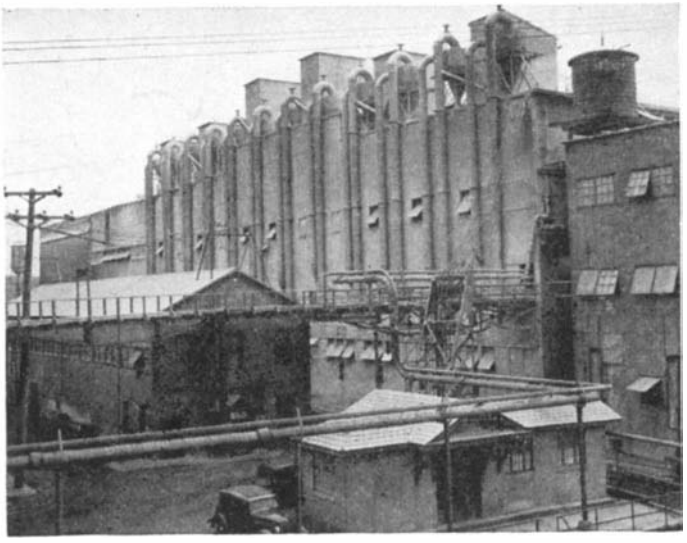
Most of the sulfuric acid is manufactured in immense lead chambers, but the pure concentrated product is made in more compact plants. While most of the sulfuric acid plants have been built for the prime purpose of manufacturing this chemical, others have been erected to recover this acid as a by-product. And this brings us to a strange story of how our annual output of acid was *unwillingly* increased by 1,000,000 tons.

Many metal-bearing ores contain rather high percentages of sulfur; and in roasting or smelting such material to recover the metal values, immense volumes of sulfur dioxide were released into the atmosphere. Now sulfur dioxide is a rather heavy gas and quite toxic to vegetation. It gradually settled down on farms and ranches, even though they were miles away from the smelters, and caused grave damage to crops. The blame was traced to the smelters, and injunctions were secured whereby their owners were given the choice of either collecting the noxious sulfur dioxide or closing down the plants. They chose the first course and, although it involved heavy expenditures, they erected immense plants and turned the waste gases into sulfuric acid. Instead of proving an added expense or liability, the acid collected more than paid for itself, so that in some instances it is hard to say which should now be considered the main product—metal or sulfuric acid.

Under normal conditions, the production of this acid is a better index to a nation's prosperity than its output of steel and agricultural commodities, for sulfuric acid not only contributes liberally towards the production of these basic materials, but it plays an almost indispensable part in the manufacture of the innumerable things which are in such demand when times are good. As an example, the year 1928 probably represented the peak of post-war prosperity; and we produced in that year 7,225,000 tons of sulfuric acid. But, in 1932 when we were in the depths of the greatest financial depression of all time, our output of this acid dropped to 4,401,000 tons, a decrease of about 40 percent.

The fertilizer industry is the greatest consumer of sulfuric acid, and the larger fertilizer plants usually have an acid factory as part of their equipment. In 1938, this industry required over 2,000,000 tons of sulfuric acid and it was by no means being operated at capacity, or tonnage would be greater.

The next largest consumer of sulfuric acid is the petroleum industry. This acid is practically indispensable in the refining of oil, kerosine, and gasoline; yet here again, no trace of free acid is allowed in the finished products as it would soon ruin the delicate mechanism of the carbureter and score the cylinders of our automobiles. In 1938, 1,120,000 tons of sulfuric acid were consumed by different parts of the petroleum industry.



Fertilizer is made in this plant, of which only a part is shown, by treating phosphate rock with strong sulfuric acid

The next greatest demand for sulfuric acid comes from the metallurgical industries. Our huge output of metal products would be impossible without its aid. Mining operations could not be carried on as extensively or cheaply without the help of the high explosives which sulfuric acid is instrumental in producing; and after the various metals are separated from their ores, sulfuric acid is employed in ridding the surfaces of scale before these metals can be fabricated into such finished products as wire, bars, sheets, pipe, and tubing. This acid plays an important rôle in the manufacture of electrolytic copper, galvanized iron, and nearly all types of plated metal. If we had deprived the metal industries of the 850,000 tons of sulfuric acid consumed in 1938, business would have been at least partially paralyzed.

Until comparatively recent times, sulfuric acid was instrumental in producing many of the other important acids used in the arts and industries. Although we have discovered other means of producing these acids, the demand for sulfuric acid shows no tendency to decrease, for new uses are constantly developing elsewhere. It is the main power behind the chemical industry. The consumption of this acid for chemical and medicinal purposes in 1938 amounted to 790,000 tons.

Without sulfuric acid, the movie industry would be prostrated until development of some substitute to take its place in the production of the millions of miles of photographic films required. The manufacture of one type of rayon would cease, and the candid camera would be relegated to the attic. In 1938, 310,000 tons of sulfuric acid were employed in the manufacture of rayon and cellulose films.

In the home, sulfuric acid has been instrumental in producing the heating plant, and the steel work, the steam or hot water pipes, so necessary in this system. Sparkling clearness of faucet water is probably due to a compound of sulfuric acid, (alum), which is introduced at the filtration plant to precipitate or throw out suspended impurities. This same acid has had a hand in the manufacture of keen edged razor blades, and is responsible in part for the chromium plated fixtures of the bath room.

Soap, made by the so-called "English process," and shoe polish, whether black or white, have probably been manufactured by the aid of this chemical.

Without sulfuric acid there would be no family car. Practically every part of the modern automobile, (with the exception of the glass), has been manufactured by the aid of this chemical. The steel of the body, as well as the numerous metal parts, must be "pickled" in sulfuric acid before the finish is applied. The nitro-cellulose lacquer is produced through its agency, and the chromium plating also involves its use. Even the upholstery, whether it be of wool or artificial leather, has been produced by the aid of sulfuric acid or its derivatives.

We owe our thanks to sulfuric acid for the enamel-ware in the kitchen, certain ornaments in the living room, many of our paints and pigments, and for numerous dyes which impart beauty to the textiles used throughout the home. The cans on the pantry shelf have been manufactured by the aid of the acid.

Devoutly do we hope that American-made sulfuric acid need only serve our peace-time wants, but this nation's watchword is "Preparedness" and, therefore, our resources for producing this acid are being mobilized to meet any emergency. The output of sulfur has already been increased, new deposits of pyrites are being exploited, new trade routes established, and new acid plants erected. This "Chemical Giant" of our constructive industries must be groomed to defend and preserve these industries should war be thrust upon us.

INDUSTRIAL TRENDS

Competition for Swedish Steel

TROUBLE in Scandinavia has upset other industries than those using wood pulp — paper and rayon producers. Cutting off of Swedish steel from world markets has given the razor blade industry a rude shock. Practically all so-called wafer blades are made of Swedish steel regardless of brand name.

Steel imports for blades run several thousand tons annually, and while this is a small item as steel tonnages run, the product is a premium one. Now, for the first time in history, American steel producers have a chance to capture this market, if they can do it. One concern has been working several years to develop a suitable competitor for the Swedish product and is now in production. Another slowly gets underway.

While almost anything can happen in the European situation, day-to-day news promises no prompt resumption of imports. Couple this with the lack of any substantial inventions in the hands of manufacturers and it spells an eventful dependence upon domestic mills—with quality in the balance.

England and Germany have been large producers and exporters of blades to world markets. Lick the steel problem and much of this business should gravitate to American manufacturers.

Prefabrication Boosts Plywood

WHEN the prefabricated house turns the corner, it will be found that plywood, not steel, is the favored structural material. Plywood has high strength, light weight, insulating properties, and handles with ease. These qualities spell thin walls and partitions, with savings in weight and cost, and ease in shipment. Steel, while providing high strength, has been abandoned by most prefabricators because of weight, lack of insulating properties, and the need for paint protection to prevent corrosion.

Chiefly responsible for the greater interest in plywood is the advent of the phenol formaldehyde resin binder, which holds the laminations of wood together, and makes the product suitable for exterior use. The resin bond is indestructible and is anathema to fungi and termites. Panels so bonded and kept under water for two years show no sign of separation even when the wood itself becomes waterlogged.

The prefabricated house is still coy about making a stage appearance, but the possibilities are much better today than they were four years ago when there was so much chatter about it. Out in front is a concern which offers all-factory made houses in nine standard sizes, but so skilfully designed as to afford a much wider style variety. About 500 were sold and erected last year; this year, with a lower priced model, production may be doubled. Merchandising covers more than a dozen states and the company operates at a profit. This sums up to being a business and not an experiment. It shows what can be done.

Trailing this concern are several smaller ones, but none which meets so completely all the definitions of prefabrication. Some employ partial factory fabrication; others limit their operations to local developments. Most advocates of steel have shifted over to production and sale of framing and panels for industrial rather than housing use.

Prefabrication has had many obstacles to overcome and there are several hurdles yet to take. Early design was unattractive, costs offered very little, if any, advantage over orthodox construction, and strong resistance was met from every element in the building trades from labor on up through supply firms and contractors, to engineers, architects, financiers and public agents, short of the Government. Design is now pleasing, costs favor factory work, but there is still sabotage. This is unlikely to be banished until the force of public demand sweeps it out of existence.

Approach to the problem has also delayed maturation of prefabrication. Most experimenters have been persons seeking new outlets for old materials. Thus, steel producers struggled to get steel houses on the market, while plumbing and electrical supply concerns hastened to find a box suitable to encompass their products. Only by consideration of housing and prefabrication needs first, and then selecting materials to do the job, has the barrier to success been broken.

Proof of this is found in the experience of companies. The top flight prefabricator, for example, spent eight years discarding pre-conceptions. Having tried metals, plywood was adopted, and it is not applied in typical building manner, but skin-stressed a lá airplane. That is, plywood panels are bonded to the frame with resins to make them load-carrying members. Likewise, standard heating equipment was found unsuited and new types developed.

Manufacturers who are actually in production declare that prefabrication has outgrown the "nut and bolt" stage of development, that further preoccupation with technical matters will not accelerate the low-priced housing movement. While much remains to be done, basic problems of construction, they say, have been solved with enough practicability to warrant placing major emphasis upon business building with more attention to consumer taste, merchandising, and wide promotion.

This attitude is reflected in the statement of one producer, who says: "The automobile is our chief competitor. When we can offer the consumer as attractive a piece of merchandise. with equally definite figures of first cost and upkeep, then we'll begin to have a business. The country isn't breathlessly awaiting the prefabricated house. It must be sold."

If prefabrication continues gains of the past two years what will it mean in material sales? A great expansion in the use of plywood; a scramble to design and place on the market more compact and economical plumbing, heating, air conditioning, and electrical fixtures, in which activity wide awake, small companies can play an important rôle. It will mean also an expanding market for all household effects which go to make up a livable home.

When mass production means thousands instead of hundreds of new homes, it will pay to try to find something superior to plywood for walls. A really low cost plastic is wanted for panels, or, perhaps, something fashioned from farm products or wastes via the chemurgic road.

—*Philip H. Smith*

Insect Quarantine

Pacific Plane Service Provides Passage for Insect Pests . . . Hawaiian Farms Threatened . . . Midway and Canton Islands Have Pest Control Stations

THE United States may have to face an invasion which all the big guns of our Army and Navy cannot repel. The foe is an army of insects. While transpacific plane service brought this country into rapid communication with the Orient, it also brought a threat of devastation. Plane service, smashing the barriers of time for man, has been quite impartial about man's enemy, the insect.

In the old days, the slower journeys by steamer and sailing vessel were tough on insects with the urge to travel, for the usual insect's life cycle is so brief that few could last out long ocean voyages on ships.

Occasionally, however, insects did manage to survive trips, and the farmers of Hawaii saw and suffered from the destruction caused by the pests. Planters of sugar cane, Hawaii's most important crop, early came to know the need for insect quarantine. They organized and created an experiment station, staffed by agriculturists expert in battling the diseases of sugar cane and insect pests.

Through the knowledge of these entomologists, Hawaii's sugar industry learned how to cope with insect enemies, to liberate in infested fields natural parasites to prey upon the pests, to re-establish nature's balance, and to defeat the invading hordes. But it learned also how difficult it was to bring insect allies from far countries to the Islands — for the time interval for the voyage was as much a bar to parasites as to pests.

WHEN Pan American Airways laid out its route for Clippers to and from the Orient, the scientists of the Hawaiian Sugar Planters' Association urged that quarantine measures be adopted. With the permission and cooperation of PAA officials, a quarantine station was set up on Midway Island. An entomologist was sent to inspect, search, and spray all planes arriving at that island. Experience has proved that the defense was sound.

In the course of a recent 10-month period, 66 planes were searched at Midway. More than 1200 insects were found to have died before arrival. But the search yielded nearly 1100 live ones which were promptly placed in the scientists' poison bottle. It seemed that danger from the Orient was definitely halted.

But the threat has reappeared in another quarter. Pan American has surveyed a route from Auckland, New Zealand, to San Francisco, via New Caledonia, Canton Island, and Honolulu. The first regularly scheduled flight will follow approval of the route by the Aeronautical Commission at Washington and is expected to take off this year. Forewarned by experience on the Orient run, Pan American Airways, together with the Hawaiian Sugar Planters' Association, have already taken steps to set up a second quarantine station on Canton Island for the new route.

The reason for selecting Canton, an uninhabited atoll nine miles long and half as wide, is not apparent at first glance; but it is a sound choice. Canton is the intermediate landing point for Clippers flying between New Caledonia, a potential plague spot of the South Pacific, and Honolulu, with its 154,476 population. Canton, however, has no human population, little vegetation, and few insects. Hence, it becomes an ideal spot for a protective quarantine control. By the time the Pan American Clippers are ready to begin their flights, the HSPA bug man, already appointed, will be on hand with his sprays, and any insect stowaways heading for Honolulu will be summarily executed at Canton.

The same speed which enables insect pests to survive long trips in planes, permits importation of insect parasites (in special cages, as shown above) to fight them

SANDIA MAN

Artifacts Found in Basal Layers of a Cave in New Mexico Give Evidence of Earliest Known Man in America . . . But Just Who Was That Man?

By FRANK C. HIBBEN
Museum of Anthropology, The University of New Mexico, Albuquerque

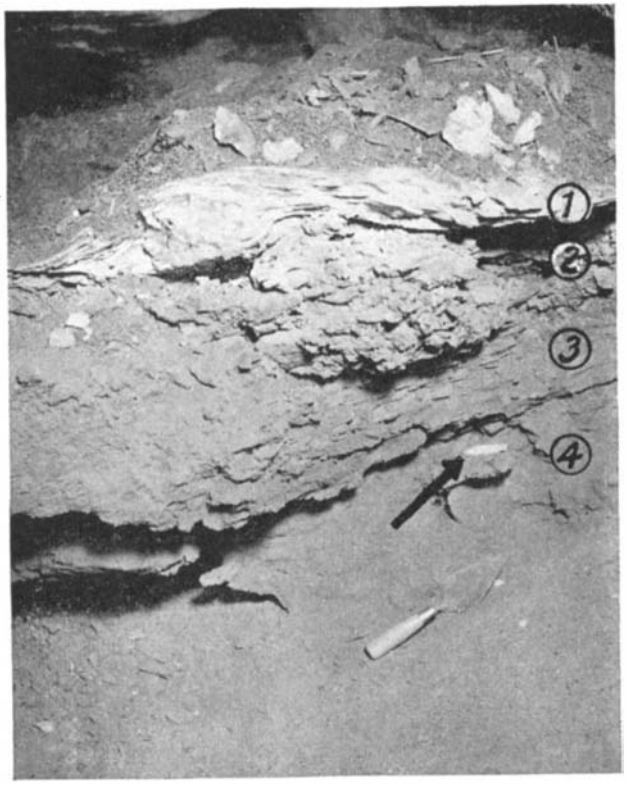
THE archeological bird, which always flies backward because it doesn't care where it is going but wants to see where it has been, is again on the wing. A recent discovery in a New Mexico cave has pushed back the history of the first Americans still further into a shadowy past.

Both North and South America have long been forced to take seats in the background whenever the question of the antiquity of man has arisen. Our predecessors of Europe who killed the mastodon and grappled with the cave bear are well known, and every grammar school child is familiar with their appearance and their tools. The New World, however, has not been able to boast of 50,000- or 100,000-year-old ancestors with hairy skins and protruding jaws. Instead, we on this side of the Atlantic have to be content with a moderate background of antiquity and with human beginnings derived second hand from the Old World by means of migrations across the Bering Straits.

It is for this reason that the discovery of a cave habitat of ancient hunters in New Mexico has been followed with much interest by anthropologists. These early Americans give promise of being the earliest inhabitants yet discovered in North or South America and comparable in age with some of the European oldsters.

In the Sandia Mountains, near Albuquerque, New Mexico, three years ago some archeologists were crawling through a limestone cave of unusual length. In the dust and debris of the cave floor one of them scuffed up a bit of bone — a piece long and curved and sharp on one end. This was the claw of a giant sloth which had ambled over these limestone hills some 10,000 to 20,000 years ago. Since this initial discovery, the Sandia Cave has been the scene of much activity. Flickering torches and acetylene lanterns have sent shadows dancing in gloomy corridors where the sloth laired in by-gone ages. The chambers and passages of the cave have reverberated with the clang of the sledge and pick and the rattle of wheel barrows.

Gradually there has come to light a human story which could be pieced together from evidence gathered during the last three years in this cavern home. Here there was a fire hearth with the blackened fragments of a camel jaw beside it, though many thousands of years have elapsed since the camel, which originally evolved in the New World, was native to the Southwest. Dart points were scattered among the broken bones of the animals which had been killed, perhaps, with these same points. Scrapers and knives of flint and bone splinters broken for the marrow gave evidence of Sandia hunters and their domestic life. A cave man of ancient America gradually took form.



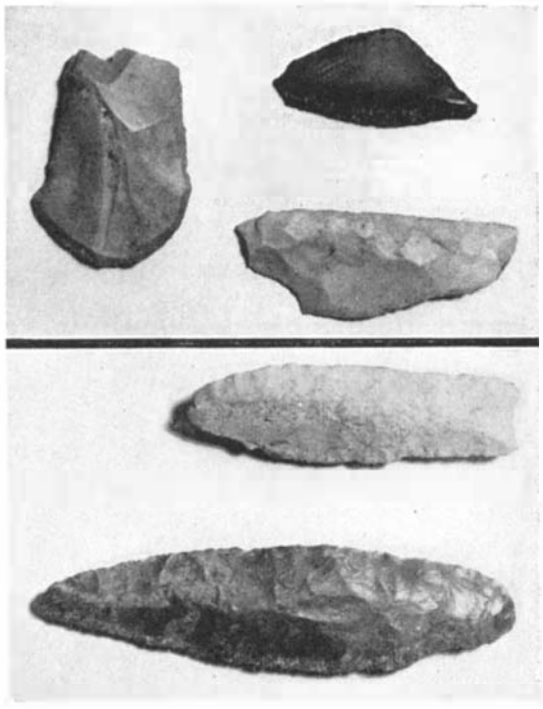
A vertical section of the deposits in the Sandia Cave. Numbered layers indicate: *1*, the crust that sealed in the deposits below. *2*, Folsom breccia. *3*, yellow ochre. *4*, the Sandia layer (note point found in place)

This, in itself, is not remarkable, for evidences of a very early type of American who had hunted now extinct mammals and who lived during the rainy period just after the last glaciation have been found before. Of these, one of the most famous is the so-called Folsom Man, named from the little town of Folsom, New Mexico. Folsom Man was a hunter who ranged up and down the foothills of the Rocky Mountains hunting a peculiar type of bison or buffalo now long extinct. This type of man left traces of his passing in a distinctive type of javelin point which looks like a short bayonet with a groove running up either side. These Folsom points have been found from Saskatchewan to Texas and for the last decade have been considered as indicating the earliest known human evidence in the New World.

AT first it was thought that the Sandia evidence was only another phase of the Folsom, a variation perhaps, or another tribe. Results of the latest digging has, however, given conclusive evidence of a group of men who hunted the green hills of New Mexico long before even Folsom Man. These were contemporaries of the mammoth and the mastodon, and of the American horse and the camel and the savage predators who preyed upon them. Evidence of these earlier animals is not founded on guesswork or even on clues, but is based on the science of stratigraphy. Stratigraphic evidence is derived from the long-known fact that he who is first gets in on the ground floor. Thus, if we dug in New York, we would find the relics of the Gay Nineties buried in the city dump below the more modern remains of our own era. We would correctly conclude that the battered remains of the horse car represented an earlier vehicle than the automobile which lay above it. The joker in the stratigraphy is, of course, in the difficulty of finding remains which overlie one another. If, instead, the deposits are side by side, no matter how primitive or advanced one

or the other might be, it is difficult to establish the precedence of one over the other conclusively.

The Sandia Cave, happily, is well stratified. On the top surface throughout the cave is a heavy deposit of dust, bat guano, and broken fragments fallen from the roof. Mingled with this dust at the front of the cave are fragments of pottery, baskets, and yucca sandals of the Pueblo era. Below the uppermost layer of dust is a crust of stalagmitic material some three to six inches thick (marked *1* in the photograph). This records a period when the cave was wet and when water containing calcium carbonate in solution dripped from the ceiling and spread out over the cave floor in a sheet which was deposited as the water evaporated. Under ordinary conditions only a fraction of an inch of this material is formed in a century. More important than its possibilities of indicating age in the cave, it was effective in sealing in the deposits below it, and thus prevented any mixture of recent material with the ancient which lies beneath. Thus the remains of extinct mammals and the cultures which accompany them have been completely enclosed and unaffected by disturbing influences until the sledge and the pick of the archeologists broke through.



Above: **Stone scrapers and gravers of Sandia man, also javelin points.** ***At left:*** **A Folsom point, the darker object, not the brighter one, found embedded in a matrix near a bone of a camel—proving their contemporaneity**

THE geological epoch just prior to our own is called the Pleistocene. This time was characterized by the formation of great sheets of ice in Continental glacier form in both North America and Europe. The fauna of the Pleistocene is extremely distinctive, insomuch as most of the species then extant are now extinct. Wet periods accompanying these glacial times made great changes in areas now dry. The mammoth grazed amidst plenty on slopes which are now barren and rocky. The stalagmitic crust in the Sandia Cave is evidence of one of these wet periods when the hill above the cave was deluged with rains and snows now unknown there. All material below this crust is Pleistocene in date. No mammal bone or fragment of Pueblo culture occurs below this level.

Immediately beneath the calcium carbonate capping of the cave lies a thick layer — the one marked *2* — of debris, dirt, and bone fragments consolidated into a homogeneous mass by the same material as the capping above. This consolidated material is a great flat hasty pudding in which are mixed ingredients which were lying around on the cave floor in the late Pleistocene. There are fragments of bone and teeth representing the garbage piles of beasts and men. Pieces of rock of all sizes are covered with dust blown or carried in from the cave entrance. Chips of flint, scrapers, and points are consolidated in this material as though liquid cement had been poured over the whole to make sure none moved from the positions they had assumed during the Pleistocene. Most interesting is the fact that the projectile points in this material are true Folsom type. Evidently the Folsom bison hunters occasionally used the cave when on trips in the vicinity, and lost or left them there.

Beneath the Folsom layer lies a thick deposit (marked *3*) of yellow ochre stratified in laminae and evidently water-laid. This, then, represents a second or earlier wet period in the cave's history. At this time the drip and trickle of the cave waters were not disturbed by any inhabitants or visitors. The sloth shunned the mud and slime of the cave floor, and so did man as well, for there is no indication in the ochre layer of any disturbance or any casually dropped implement or bone.

Below the ochre and between it and the solid limestone of the cave floor are the most important deposits of the cavern (marked *4*). These were accumulated during a dry period, the first in the varied history of this abode. In these lowest levels there was again evidence of grisly meals, bone fragments, fires, and flint implements. These latter are javelin points entirely different from the later Folsom variety. They are notched from one side, forming a single shoulder in a manner very similar to flint points of the Paleolithic or Old Stone Age of Europe. That the Sandia points may be comparable with some of the earliest implements of Europe is a distinct possibility.

European remains of the Paleolithic variety were made mainly by types of men having certain primitive characteristics. They walked with a stoop-shouldered, bent-kneed gait. Their heads were fastened on their necks far forward, like those of a gorilla, and their jowls protruded while their foreheads receded. Such a type of man as these has been eagerly sought for in the New World since scientific endeavor in Europe began. So far, there has been no success. First, Folsom Man and now Sandia Man, seemed to give promise of being this American link. The probable truth is that even such an oldster of the last of the ice age as Sandia Man would look no worse if we saw him on the street than some of the least attractive of our politicians. Yet, in order to satisfy a perfectly natural as well as scientific curiosity, we would like a look at Sandia Man's bones — if only he has left one of his dead in a corner of the cave, and if the rats have spared him sufficiently so that we can see his outline. Such a discovery would solve one of the most pressing of the queries concerning the mystery of the first Americans. That Sandia Man lived, loved, hunted, and died in the time of the mammoth and the sloth we now know. Perhaps the as yet unexcavated portions of the cave will answer the questions of his appearance.

●

¶ *Readers will note that, in the case just described, the evidence calling for Pleistocene antiquity is based on stratigraphic grounds. In all too many of the instances where claims of high antiquity were made these were based on finding human artifacts associated with bones of animals that lived in Pleistocene times — and nobody yet knows how much longer toward or even into our own era.*—The Editor.

Is Atomic Energy Nearer?

Physicists Talk Down Some Fabulous Claims . . . But New Findings May Alter the Picture . . . Prediction Probably Unsafe . . Immediate Development Unlikely

By ROY H. COPPERUD
University of Minnesota

EYES of the scientific world — and of a good part of the lay population, too — widened the first week in May at the startling news that work of a 28-year-old physicist at the University of Minnesota in isolating the explosive uranium isotope, U-235, had been corroborated, marking a significant advance toward shackling atomic energy.

The physicist is Dr. Alfred O. C. Nier, who modestly expressed dismay at extravagant reports which blossomed on front pages everywhere, to the effect that the incalculable forces of the atom were on the verge of being pressed into the service of mankind.

There were fabulous predictions that this discovery made feasible bombs of unheard-of strength, that five or ten pounds of U-235 would propel a vessel around the world for an indefinite time without refueling — in short, that economic foundations of the world were about to crumble.

The fact of the matter, he insists, is that many a knotty problem remains to be solved before any useful harnessing can take place. Chief among these is extraction of U-235 in vastly greater quantities than is possible now.

Yet authorities in the field concede that the discovery is a stride of unprecedented importance toward opening up a new and virtually limitless source of power. Dr. Nier himself admits that large-scale extraction "is surely within the range of possibility."

It was the work of Dr. John R. Dunning at Columbia University in New York, aided by Dr. E. T. Booth and Dr. Aristid V. Grosse, that clinched the findings of Dr. Nier. The New York physicists, subjecting Dr. Nier's infinitesimal samples of U-235 to a slow neutron bombardment, confirmed successful isolation of the isotope, and demonstrated its explosive properties.

For about a year previous to last February, when Dr. Nier first accomplished the separation, it was known that uranium would blow up if bombarded with slow neutrons, releasing immense energy. Discovery of this fact was made by two Germans, Dr. Otto Hahn and Dr. Lise Meitner, in Berlin.

The explosions, however, were incomplete, and the results baffling. Baffling, that is, until a theory was advanced by Prof. Niels Bohr, Nobel prize winner at the University of Copenhagen, and Dr. John A. Wheeler of Princeton University, that U-235, one of the three isotopes which constitute uranium, was responsible.

This was only a hypothesis, albeit a good one, until Dr. Nier blazed the trail in separating U-235 from its brother isotopes, U-234 and U-238. Sieving them out in a mass spectrometer, he obtained quantities sufficient for testing. These were sent on platinum collecting plates to Columbia.

WHAT happens in the bombardment is that slow neutrons crack U-235 atoms as a baseball bat would crack a walnut, splitting them in two. Accompanying the explosion is a terrific release of energy. Particularly significant is the fact that, in a quantity of U-235, the process is cumulative, for the smash sets free other neutrons, which in turn attack other atoms. Once begun, the process will continue automatically — a "chain reaction."

When natural uranium was first bombarded, the explosions did not continue in this fashion because of the great preponderance of U-238. The stray neutrons which would keep the action going in pure U-235 collided with atoms of U-238, which are unaffected by the slow barrage that shatters U-235. Consequently, there was an effect of smothering. Even with pure U-235, a considerable amount would be required, for many of the neutrons fly off harmlessly into the air.

Dr. Nier estimates that one pound of U-235 would generate as much force as the combustion of 2,000,000 pounds of coal, or that its detonating energy would be equivalent to that of 20,000,000 pounds of high explosives.

All of which sounds vastly encouraging [and just at present in some aspects a bit alarming.—Ed.]—except that the greatest amount of the isotope that he has yet been able to produce is less than a microscopic 1/100,000,000 of an ounce.

It was formerly believed that U-235 made up only one part in 1000 of natural uranium. The occurrence of the explosive isotope is actually far more frequent than that, however, for Dr. Nier's instruments showed a proportion of one U-235 atom to every 139 of U-238, another of the trio. Thus natural uranium contains seven times more of U-235 than had been supposed.

Dr. Nier's separation work was duplicated by Dr. K. H. Kingdon and Dr. H. C. Pollock of the General Electric Company's laboratories, and their samples produced the same result in the Columbia cyclotron as those isolated at the University of Minnesota.

Rumors said that the discovery had set all available researchers in Germany at work in the Kaiser Wilhelm Institute at Berlin to seek a means of economically extracting U-235 in commercially usable amounts. Large deposits of uranium are found in Germany, also in Canada, the Belgian Congo, England, and Colorado.

Dr. Nier estimates that, even with any reasonably economical means of extracting U-235 in large quantities, the cost per unit of energy produced would equal that of coal. "So you see," he observed, "it would not mean getting power for nothing." Despite the extraction cost, the great amount of energy concentrated in a small volume would make it invaluable for airplanes, for example, or any other apparatus where weight of fuel is a consideration.

The Minnesota scientist considers it hardly likely that the mass spectrometer, the device he used to separate the uranium isotopes, can be adapted to mass production. It is more probable that some chemical means of separation would turn the trick. But as to any such method, researchers are still at sea. Dr. Nier emphasized further that, once extraction is accomplished, the problems of handling and chaining the atomic force safely might occupy scientists for years.

This is the abbreviated story of what may well prove to be one of the great crests of scientific achievement. True, researchers are cautious about advancing ambitious claims, and Dr. Nier himself believes that remaining obstacles to chaining atomic power will persist far into the misty future. But only ten years ago it was considered impossible to separate the isotopes of any element whatever, and now it is being done commercially with hydrogen.

BROWSING with the Editor

THROUGH THE SCIENCE LITERATURE OF THE WORLD

SYPHILIS IN U. S.—The annual attack rate of syphilis per 100,000 people in the United States in 1935 was 796, compared with 47 in Great Britain (clinics only), 20 in Denmark, and seven in Sweden. —*The Journal of the American Medical Association, 114,* 1321 (April 6, 1940).

SA

CELESTIAL MECHANICS.—The mathematical theories of the celestial motions are of a complexity almost beyond conception, and the length of some of the calculations involved is appalling. Single formulas that fill dozens of printed quarto pages, series expansions in which hundreds of terms must be used, and single calculations that require years to accomplish, are not unusual in celestial mechanics.—Edgar W. Woolard, *National Mathematics Magazine.* (January 1940).

SA

DON'T BLAME THE RAZOR.—The average man, "cussin'" his razor blade roundly, doesn't realize that each hair's-breadth of blade edge has to cut 100 hairs in a once-over shave; or 200, twice-over.—E. J. Casselman, Mellon Institute of Industrial Research.

SA

OIL PAYS.—Nearly one twelfth of all the carload freight revenue of American railroads in 1939 was paid for the transportation of petroleum products.—Interstate Commerce Commission.

SA

AUTOMOTIVE COSTS.—The typical wage-earning, car-owning family spends $197.74 annually to operate its car for business and pleasure.—U. S. Bureau of Labor Statistics.

SA

INSULATION SAVES.—United States Government tests on identical houses, one insulated and one not insulated, showed a fuel cost for the insulated house 44.75 percent lower than that for the non-insulated.—National Warm Air Heating and Air Conditioning Association, 11 West 42nd Street, New York.

SA

WAR AND PAPER.—American paper makers regularly import from Scandinavian countries more than one fifth of the pulp they need, with Sweden leading among suppliers.—*Science Service,* (April 11, 1940).

SA

LONG RAYS WEAK.—Suggestions that long, invisible infra-red radiation could be used to pierce fog have been refuted by experiments.—J. A. Sanderson, U. S. Naval Research Laboratory, Washington, D. C.

SA

INSECT ENEMIES.—Throughout the world, there exist nearly 500 plants that are carnivores, or insect eaters.—Brooklyn Botanical Garden, Brooklyn, New York.

SA

"HYPODERMIC."—Oil squirted at high pressure from tiny holes, such as those in Diesel injectors, often penetrates the flesh of workers. Though the oil penetrates to a considerable depth, the worker is not immediately aware of his injury.—Dr. G. Failla, Memorial Hospital, New York.

BETTER SHOOTING.—During the recent war between Finland and Russia, the average number of shots fired for each airplane destroyed was 54, contrasted to 11,000 shells needed to bring down each airplane at the beginning of the World War and 6000 shells at the end of that War.—*The Illustrated London News,* (April 13, 1940).

SA

SPARKLESS.—To prevent generation of static sparks by belting, one powder manufacturing company keeps belts in a moist condition by frequent applications of 50 percent glycerol and 50 percent water.—*News Edition,* American Chemical Society, *18,* 355 (April 25, 1940).

SA

PETROLEUM RESEARCH.—The growth of research in the petroleum industry has been more rapid than in most industries, having expanded 639 percent in 11 years and having risen from seventh largest to second largest. For every 10,000 wage earners in the petroleum refining industry there are 563 research workers—almost twice as many as in the chemical industry which is reported to have the next highest concentration.—*News Edition,* American Chemical Society, *18,* 347, (April 25, 1940).

SA

PROVED SUPERIORITY.—The aluminum mirror coating of the 100-inch telescope at the Mount Wilson Observatory lasted five years and was recently renewed. Silver coatings, formerly used on telescope mirrors, lasted only a few months.—*Publications of the Astronomical Society of the Pacific, 52,* 145, (April 1940).

SA

OIL UNLIMITED.—It seems altogether likely that nature is continually producing more oil underground, perhaps at a faster rate than gas pressure or pump stroke can bring it to the earth's surface. —Dr. Gustav Egloff, Universal Oil Products Company, Chicago, Illinois.

SA

CHINCHILLA FUR.—Eleven chinchillas were brought from South America 17 years ago. Though difficult to breed in the United States, the original group has grown to 3500, 2000 of which are located in the home chinchilla ranch in California, while the remainder are scattered throughout the country.—Trane Company, La Crosse, Wisconsin.

SA

FAT PEOPLE.—The old belief that women can withstand cold better than men has been proved correct by calorimetric measurements made on nude men and women at the Cornell University Medical College. It was shown that, if men were by nature provided with a layer of fat tissue about one sixth of an inch thick, they would be on a par with women in heat retention.—National Academy of Sciences, *Abstracts,* Annual Meeting, 1940.

SA

HEAT DEATHS.—In 1939 more persons died from heat stroke indoors than out. The exact percentages were 67.1 percent in the home; 22 percent in factories; and 10.9 percent in public places. The reason is simple. Both the very young and the very old—most susceptible to heat—spend more of their time indoors than do others.—National Warm Air Heating and Air Conditioning Association, 11 West 42nd Street, New York.

Bleak Black Ball Of Rock

After Ten Years the Planet Pluto's Mass Has Been Determined . . . Denser, Darker, More Massive than Was Expected . . . Laborious Computations

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

A PROBLEM which looked as if it might remain unsolved for many years has been cleared up recently by Professor Brouwer of Yale—who reported his results at the last meeting of the Astronomical Society. Ever since Pluto was discovered, attempts have been made to find its mass—and previously with no success.

The problem is simple enough in principle, though very complicated and laborious in detail. The attraction of Pluto upon the other planets modifies, or "perturbs" their orbits, by an amount proportional to the attracting force, and hence to the mass of Pluto itself—which can be found, if we can determine from observation the actual magnitude of these perturbations. Given precise information about the orbits of Pluto and any other planet—say Neptune—the calculation of the perturbations can be made by standard methods—none of them simple, because the problem is inherently complicated mathematically. There are two main lines of attack—the "general" method, which derives formulas from which the perturbations can be calculated at any time, and the "special" which determines their effects only for a given interval of time.

The first is enormously laborious, especially when, as in the present case, the orbits are eccentric, inclined, and come relatively near one another. When the results have been obtained, they are applicable almost indefinitely. Hence these methods alone are of value for the Moon, the satellites of Jupiter, and the inner planets, which have already been observed over hundreds or thousands of revolutions.

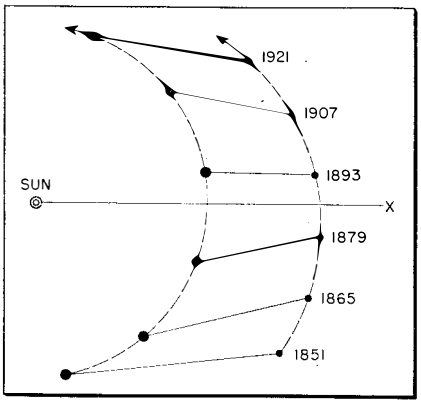
The second method calculates step by step, giving accurate values over the interval of time covered by the computations, but tells us nothing about the future until the calculations have been extended to cover it. For two or three revolutions, or less, this second process costs less work than the first.

The two methods follow entirely different mathematical paths—diverging at the start and meeting only at the finish—so that, when both have been applied to the same case, they afford a very complete check upon one another.

The perturbations of Neptune, for example (except those due to the undiscovered Pluto) were calculated by Newcomb 40 years ago. A recalculation by the second method has just been made by Brouwer, using modern "punched-card" calculating machines, which save a great deal of time and money. The results of the two methods agree excellently, over 160 years, except for a regularly recurring deviation in longitude, of maximum amount 0″.15 with a period of 12.8 years, exactly that in which Jupiter catches up with Neptune. A term of this period appears in Newcomb's tables, and it is clear that, despite the great care taken by this distinguished investigator and his assistants, some numerical error must have crept into its coefficient. Recalculations are being made by the first method.

THE perturbations due to Pluto can be calculated, just as well as for any other planet, but when the attempt is made to use them to find Pluto's mass, a new complication arises.

We must find, from the observations of Neptune, not only these perturbations, but the size and shape of its orbit. If Neptune had been observed all around its orbit for several revolutions, like Jupiter and Saturn, we could determine the orbit almost independently of the perturbations, since these would be different in successive revolutions, and almost average out. But Neptune was discovered in 1846, and has been only a little more than half-way round the Sun since then. Consequently, when its motion is perturbed by Pluto, it is possible to find another orbit, such that a planet moving in it, and not subject to Pluto's attraction, would simulate very closely the motion of Neptune in its real orbit, disturbed by Pluto. The motions of the real and fictitious planets would diverge in the unobserved parts of the orbit—but this leaves us no wiser, though our grandchildren will be. The existing orbits of Neptune, calculated, without taking account of Pluto, so as to fit the observations as closely as possible, are of this "fictitious" type, and it is only from the differences between the observed positions of the planet and those calculated from these adjusted orbits that we can find out how much influence Pluto really exerts.



Positions of Neptune and Pluto, projected on plane of Neptune's orbit

This matter was thoroughly discussed, a few years ago, by the late E. W. Brown. He concluded that it was not at present possible to obtain a reliable determination of Pluto's mass, either from observations of Neptune, for the reasons aforesaid, or of Uranus, which is too far from Pluto.

Brown, however, considered only the longitudes of the planets. The latitudes—measured, if we will, from the mean orbit plane—usually suffer much smaller perturbations—since all the planets move in nearly the same plane. But Pluto's orbit has the high inclination of 17 degrees to the ecliptic, or 15½ degrees to Neptune's orbit, and this puts it far out of the general plane of the system.

The situation is illustrated in the sketches. The first represents the positions of Neptune and Pluto during the interval of observation as projected on the plane of Neptune's orbit. The planets were in conjunction in 1892, at a distance of 19 astronomical units, and have been closer together than the average over the whole time.

The second sketch represents the planets as seen from afar perpendicular to the plane of Neptune's orbit, along the line *Sun-X* in the first. From this point Neptune would appear to oscillate back and forth in a straight line passing through the Sun, while Pluto, during the interval of observation, was continuously on the south side of the orbit plane.

The attraction of Pluto on Neptune throughout this interval tended to pull Neptune away from the Sun, as is evident from the first sketch, but, as has been explained, the principal influence of this will be to alter the calculated elements of Neptune's orbit. But the component of attraction at right angles to the plane of Neptune's orbit tends to pull it out of the plane. No adjustment of the assumed orbital elements can do much to help this, for, in the absence of perturbations, the orbit must be exactly plane. (The actions of the other planets can be accurately computed and allowed for—after which they may be ignored, and only Pluto considered.)

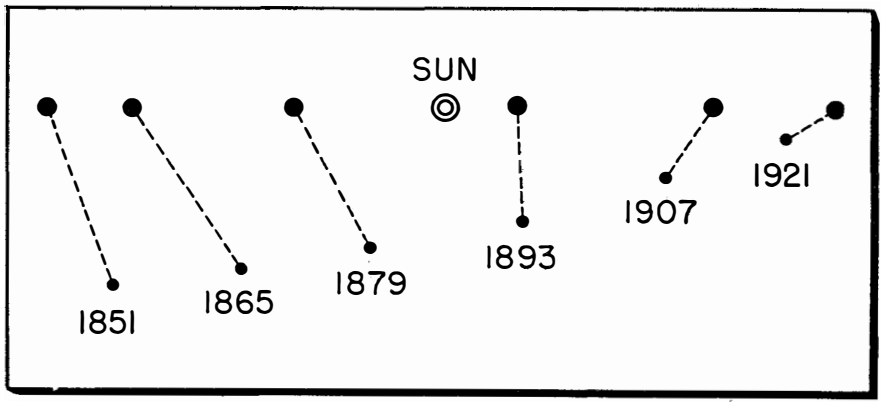
After making the best adjustment of the calculated plane that we can, we may expect to find Pluto south of this plane at the beginning of the observations, north of it in the middle, and south again at the end. This is exactly what Dr. Brouwer has found, after making just such calculations. In 1850, Neptune was 0″.5 south of the calculated position, in 1900, 0″.2 north of it, and, in 1936, 0″.4 south. Though there are some fluctuating errors in the observations—as is inevitable—the general trend is unquestionable.

MEASURABLE effects of the attraction of Pluto on Neptune have thus been found. From these Brouwer finds that the mass of Pluto is 1/400,000 that of the Sun, or 83 percent of the Earth's, with a probable error of eight percent.

The perturbations in longitude, between 1846 and 1936, are almost completely obscured by the adjustment of the orbit. But two earlier observations of Neptune exist: Lalande, in 1795, while cataloguing faint stars, made two observations of the planet supposing it to be a star. These agree well with one another, and give a residual deviation of 10″ in longitude from the orbit adjusted without regard to Pluto. If perturbations by Pluto, with the mass determined from the latitudes, are taken into account this discordance disappears. By itself, this deserves no great weight, as Lalande's observations were not of high accuracy; but the agreement of the two determinations is satisfactory.

Dr. Brouwer is investigating Uranus by similar methods. Here the attraction of the Sun is greater, and that of Pluto less; but it will be of much interest to learn what can be derived, especially from the latitudes, but it is improbable that the results will compare in accuracy with those already derived from Neptune.

The mass of Pluto thus takes its place in the list of known data for the solar system. It is surprisingly great—equal, within the limits of error, to that of Venus, which is 1/410,000 of the Sun's. It is not the actual value which is surprising—we have no excuse for any anticipations on the mere knowledge that a trans-Neptunian planet exists. But the faintness of Pluto suggests a much smaller value.



Neptune and Pluto, projected on a plane perpendicular to Neptune's orbit

If Venus could be put at Pluto's average distance from the Sun and Earth at opposition, a simple calculation shows that it would appear as a star of visual magnitude 11.8. The measured value for Pluto, reduced to the same standard conditions, is 14.7. Hence Pluto reflects only seven percent as much light as Venus would if put in his place. If of the same size as Venus, his reflecting power, or albedo, must be correspondingly small. Now the albedo of Venus has the high value 0.59, but, even so, that of Pluto comes out only 0.04. This is so very low that the planet's surface would be called dark gray, or almost black (not brown, for Baade's observations show that, unlike the Moon, the light which it reflects is of the same color as direct sunlight).

The Moon itself reflects seven percent of the incident light. If it were not for the weakening of the light of the half-moon by the shadows of the innumerable roughnesses on its surface, this value (which represents the average for light reflected in all directions) would be raised to 10 or 12 percent. We see Pluto at the full phase: hence it may be concluded that, if it is of the same size as Venus, the average reflecting power of its surface is probably between 30 and 40 percent of the average for the Moon.

This is clearly not impossible, for the darkest spots on the Moon are made darker than the average; but it is about at the limit of plausibility.

We cannot well escape the difficulty by assuming that Pluto is smaller than Venus, though of the same mass, for this would make it denser, and Venus, with a mean density 4.9 times that of water, is denser than any other planet except the Earth.

TO assume that Pluto was twice as dense as Venus would be going wild —making its mean density greater than that of the core of the Earth, composed of metal under enormous pressure. But even this would raise the calculated albedo only to 0.06.

There seems to be no escape, therefore, from the conclusion that the surface of Pluto is almost black. This is the more remarkable because Pluto, like Venus or the Earth, ought to be able to retain an extensive atmosphere. It is reasonable to suppose that, like these planets, Pluto lost any hydrogen which its atmosphere contained early in its career. But an atmosphere which contained water-vapor like the Earth's, or carbon dioxide like that of Venus, would, at the very low temperature of Pluto, send these substances down in permanent snow. Nitrogen and the inert gases would remain to form a permanent atmosphere, even at this temperature; but, if this atmosphere were of any considerable extent, it would scatter enough light on its own account—like the sky—to make Pluto look much brighter and bluer than it is. It appears, then, that Pluto is an atmosphereless ball of black rock.

All this depends on Brouwer's determination of the mass; but the evidence for this is so strong that it altogether outweighs considerations based upon the supposed improbability of conditions which certainly do not appear to be physically impossible.

Neptune's satellite, sometimes called Triton, is of very nearly the same brightness as Pluto—or, at least, it would be if the two bodies could be observed at the same distance, which will happen about 1989, when Pluto is in perihelion. The satellite's mass has been determined by Nicholson, van Maanen and Willis by observing the small oscillation of Neptune's position about the center of gravity of the system as the satellite describes its orbit. They find a value about one twelfth of the Earth's mass, or one tenth of Pluto's. Allowing for a slightly lower density, we may estimate that Triton has about half the diameter of Pluto, and four times its albedo. The difference between the two bodies is surprising, and illustrates the danger of guessing at the mass of a planet or satellite from its brightness. — *Princeton, May 4, 1940.*

SEEING WITH ELECTRICITY

New Electron Microscopes Now Being Developed Far Outdo High-Powered Optical Microscopes . . . Reveal a World Hitherto Unseen by Man

By JEAN HARRINGTON

IN this age of super-movies, super-telescopes, super-cyclotrons, and super-whatnots, we are apt to pass over lightly the news that a super-microscope has just been built. But such news has just popped out of New Jersey, following within a year two similar announcements from Canada and Germany; and to anyone interested in the progress of science, it sounds a good deal more important than the latest super-movie.

The electron microscope already has become a powerful and a practical instrument. With it, science can explore

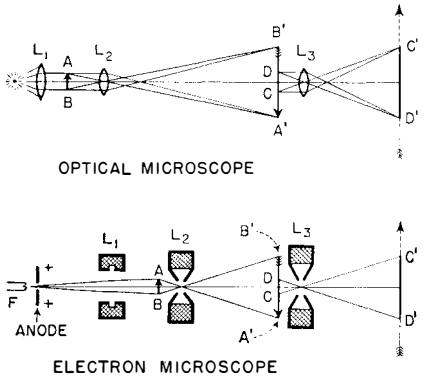


Figure 1: **A comparison of the optical and electron microscopes. The one does its ray bending with glass, the other with magnetism from the coils L_1, L_2, L_3, explained in text**

a new world of things infinitely small—disease viruses, for example, which have never before been seen or photographed—and this may lead to important medical discoveries.

We are all of us familiar with the ordinary optical microscope. Perhaps we have used it in the laboratory to see the teeming life in a drop of pond water, or to study the fragile nerve endings in the tissue of a frog's leg. The upper part of Figure 1 shows how such a microscope works. The object or specimen—suppose it is our drop of pond water—is represented by the short arrow *AB*. It is brightly illuminated; light from the lamp is concentrated on it by the lens L_1. The lens L_2 bends the light from the object and focuses it to produce an enlarged, inverted image of the water drop at *A'B'*. Then the lens L_3 takes light from any part (such as the section *CD*) of the first image—a single amoeba, perhaps, swimming sluggishly in the drop—and re-focuses it to give us a still more enlarged image at *C'D'*. This is what we see if we peer through the eyepiece of the microscope, or what we can photograph if we care to put a film there.

The electron microscope shown in the lower part of the same figure is arranged and behaves quite similarly. It has illumination, three lenses, and two magnified images in cascade. But, instead of light for illumination, it uses streams of electrons from the hot filament or cathode at *F*; and in place of glass lenses, three magnetic coils, by curving the electron paths, do the focusing. A more detailed discussion of the instrument will be found later in the article.

The analogy between the two microscopes follows the close analogy between light and electricity. Visible light, we know, is a wave motion, one of a large family of electro-magnetic vibrations ranging from radio waves to the gamma rays from radioactive materials. Figure 2 shows where visible light ranks in this family. From the broadcast and short-wave radio bands, down through the infra-red or heat rays, from the red to the violet of our sunlight spectrum, down through the ultra-violet and the X-rays, the wavelength steadily decreases; when we come to gamma rays, we have waves less than a billionth of a centimeter long. For convenience, these short wavelengths are measured in angstrom units, an angstrom being a hundred-millionth of a centimeter, or 1/250,000,000 of an inch. The visible spectrum ranges approximately from 3900 to 7600 angstroms.

WE usually think of an electric current as a stream of electrified particles rather than as a train of vibrations or waves. The electrons flowing in our telephone and lighting circuits we picture as tiny bundles of negative charge. Yet the curious thing about them is that under certain circumstances they behave as if they were waves instead of particles. In 1924, De Broglie showed that, in theory at least, a moving electron should have a definite wavelength associated with it, and his theory was proved true by experiment some three years later. It was shown that electrons, like light, can be reflected or refracted at surfaces, and are subject to familiar interference and diffraction phenomena in which different electron streams add or subtract to form patterns of light and shade. (Parenthetically, just as electrons act sometimes like waves, light waves on occasion behave like particles—a beautiful if somewhat confusing example of the harmony and inter-relationships of nature.)

The De Broglie wavelength of a moving electron depends only upon its velocity, decreasing as the speed increases. A "one-volt" electron—that is, an electron accelerated by a potential difference of one volt—travels at nearly 370 miles per second, and has a wavelength of about 12 angstroms. A "million-volt electron," whizzing along at more than 175,000 miles per second, has a wavelength of about a hundredth of an angstrom. How this range compares with that of light is shown in Figure 2.

This comparison leads to the essential advantage of the electron microscope over the optical variety. The ability of any kind of microscope to show clearly minute objects is sharply limited by the wavelength of the illumination it uses. It has been found in practice that this limit is approximately half the value of that wavelength. In other words, you can't distinguish objects or details of objects the dimensions of which are less than half of the particular wavelength

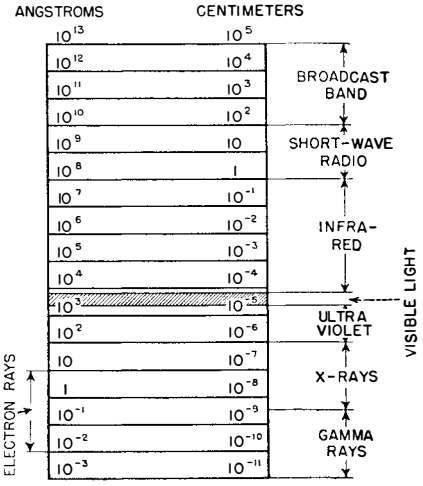


Figure 2: **Comparison of wavelengths of the family of electromagnetic waves and of electron rays**

you choose for illumination. Obviously, then, the shorter the wavelength, the smaller the details you can observe.

The reason for this is to be found in the phenomenon of diffraction. Without going into a full explanation, which belongs in a book on optics*, suffice it to say that diffraction is a special case of interference of waves, and is caused by wave trains bending around corners or the edges of opaque objects. Although the phenomenon is universal, we don't ordinarily notice it, for the effects are negligible when the object is large and the wavelength small. But in microscope work, where specimens and wavelengths are the same order of magnitude, diffraction rears an ugly head. There its effect is one of diffusion and blurring. A sharp line in the specimen appears in the image as a broad one, flanked on either side by bands of dark and light. A point reproduces in the image as a disk surrounded by dark and light concentric circles. These are known as "diffraction patterns."

When you see a circular diffraction pattern in a microscope, you know a particle is present; but different sized particles may have identical patterns, and you can deduce nothing about the actual magnitude and shape of the particles. Or, if two particles in the specimen are less than a half wavelength apart, their diffraction patterns overlap in the image and you cannot distinguish them as two separate points. The size of the diffraction pattern does, however, decrease as the wavelength decreases; so it happens that, with short-wave illumination, there is less overlapping of patterns and therefore greater clarity in the image.

THE resolving power of any microscope is the shortest distance two points of a specimen can actually be separated and still appear as two distinct points in the image. We have already said that this shortest distance cannot be less than the half wavelength of illumination. Thus, with visible light of 4000 angstroms, you cannot get a clear, detailed image of anything much smaller than 2000 angstroms or .00002 centimeters (1/125,000 inch) in diameter. With ultra-violet light you may get down as far as 1000 angstroms. But now, with high speed, short-wave electrons, it has become possible to observe objects and details of objects smaller than 100 angstroms in diameter — that is, about 1/2,500,000 of an inch.

A good example of the electron microscope's power is Figure 3, a photograph of the carbon grains in ordinary lampblack. The individual grains are completely invisible in the most high-powered light microscope or even in an ultra-violet microscope. At best, these microscopes show the patch of lampblack only as an irregular, solid, black blob. But illuminate the patch with short-wave electrons, and it resolves itself into a myriad of particles, some of them as small as 30 angstroms in diameter—about 1/8,000,000 of an inch! This photograph was made with the new University of Toronto super-microscope, by James Hillier, one of its designers. The total magnification is 100,000. This, however, was reached in several stages; and here a word about magnifications:

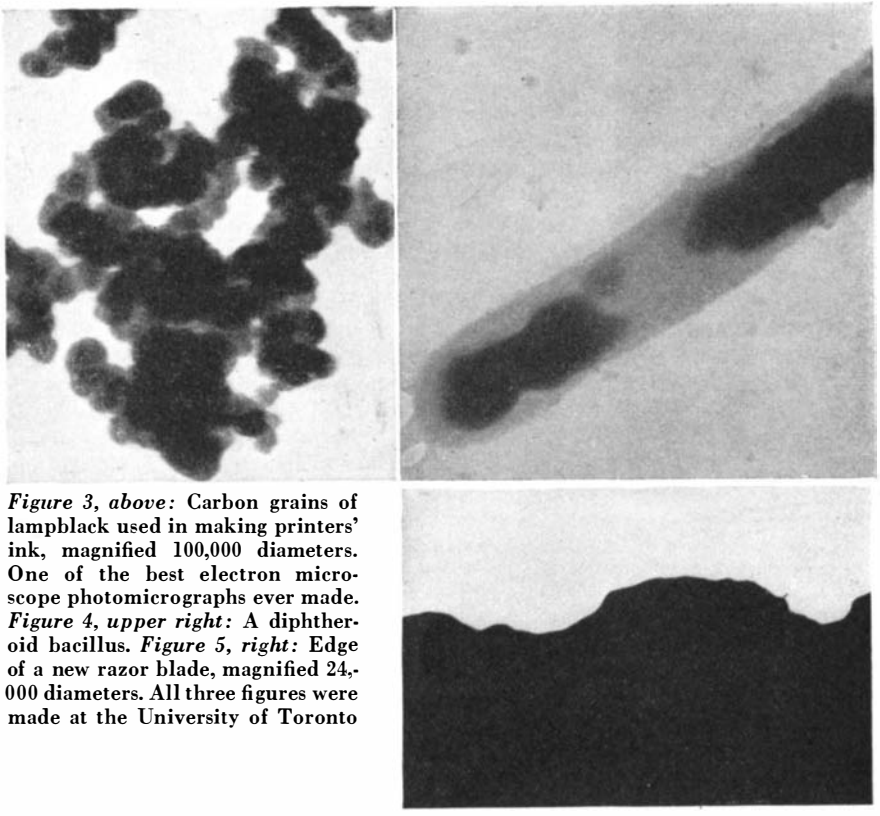


Figure 3, above: Carbon grains of lampblack used in making printers' ink, magnified 100,000 diameters. One of the best electron microscope photomicrographs ever made. *Figure 4, upper right:* A diphtheroid bacillus. *Figure 5, right:* Edge of a new razor blade, magnified 24,000 diameters. All three figures were made at the University of Toronto

In order to be distinguishable on the photographic plate, the smallest details of the final image must be several times larger than the chemical grains that make up the film. These are about .001 centimeter in diameter. If the smallest detail of Figure 3 is 30 angstroms (.0000003 cm.) it must therefore be magnified some 10,000 times (up to .003 cm.) if it is to appear on the film at all.

But, in order to be visible to the unaided eye, objects must be at least as large as .02 cm.—about 1/125 of an inch. Therefore, the .003 cm. detail of the microscope photograph must be enlarged up to .02 cm. — a magnification of 6.7 times. This is done by enlarging the microscope picture by ordinary darkroom methods.

The total *useful* magnification is then 10,000 x 6.7, or 67,000; this *represents the total enlargement necessary to make the smallest detail visible to the unaided eye.* Further magnification only makes the picture a more convenient size for study. In some cases it is possible to accomplish the whole useful magnification with the electron microscope, but for technical reasons it is easier to keep its magnifying power under 20,000 and supplement it with optical enlargement.

Figure 4 is a diphtheroid bacillus, also photographed by Hillier with the Toronto instrument. The bacillus, magnified 35,000 times, is about to divide in reproduction, as shown by the slight constriction of its waistline. Such a photograph is again utterly beyond the scope of even the best optical microscopes. An enormous number of other organic and inorganic minutiae—bacteria, viruses, crystal structures, colloidal particles and the like—fall within a size range of from 1000 down to 10 angstroms, or 1/250,000 inch down to 1/25,000,000 inch, and it is in this range that the electron microscope has already proved itself so valuable.

IT may well be asked why X-rays or gamma rays, with wavelengths as small or smaller than electrons', could not be used for the same purpose. The answer is that no one has ever been able to devise a lens that would focus them. Though they belong to the same family of electromagnetic vibrations as light, they are too short-wave to be refracted appreciably by glass, as is light. (It is true that X-rays are very useful in examining the minute intricacies of crystal structure, but the method is entirely different from microscope technique.)

The electron microscope is less than a decade old, for its development, which has recently reached practical fruition, began only a few years after the proof in 1927 that electrons have wave properties. The first steps were experiments showing that an electron beam can be

* For example, Valasek's "Elements of Optics"—*Ed.*

focused by a magnetic or electrostatic field, providing the field is symmetric around the axis of the beam. The curving of electron paths in such fields is analogous to the bending or refraction of light rays as they pass through glass; and the field enclosed by a charged hollow cylinder or a solenoidal magnetic coil is thus analogous to a glass lens.

The first electron microscope having

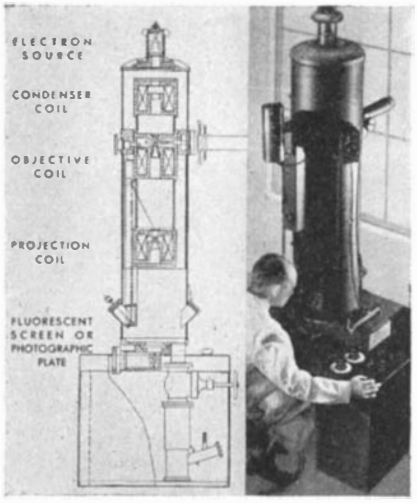


Figure 6: **The electron microscope at the RCA laboratories. Electrons from top are converged by condenser coil, traverse specimen (introduced through an air lock) above objective coil. This coil magnifies image to 100 diameters. Projection coil re-magnifies this image 250 diameters. The image is observed through two diagonal side-windows**

magnetic fields as lenses was begun in Germany in 1931 by Knoll and Ruska. Not until 1934 was it perfected enough by Ruska to show a definite superiority over optical microscopes. Since that time various physicists have been toiling to remove still more of the kinks and further improve the design and performance of the instrument. The most notable achievements to date are the three magnetic super-microscopes completed since the spring of 1939—one in Canada, one in Germany, and the latest in the United States.

Figures 3, 4, and 5 were taken by the Canadian instrument and give hints of the new world into which the electron microscope affords view. Figure 3, showing a resolving power better than 30 angstroms and a useful magnification of 67,000 diameters, is one of the best electron microscope photograph so far published. Designed by Hillier and Prebus under the direction of Prof. E. F. Burton of the University of Toronto, the Canadian instrument uses lenses of a radically new design.

Last fall the pioneering Ruska and his co-worker, von Borries, developed for a German research institute a microscope with a resolving limit of 50 angstroms, magnifying up to 56,000 times. Little word has been heard of its progress since then, but it is capable of excellent work.

The third and latest super-microscope has just been completed in the Camden laboratories of RCA, an important American center for studies in electron optics (a field which applies to radio and television as well as microscopes). Intended largely for commercial use, the instrument has been developed under the direction of Dr. V. K. Zworykin. Its designer is Dr. L. Marton, another pioneer in electron microscopy, and the first to apply it to the study of biological specimens. This instrument, although it does not differ from the others in its fundamental principles, incorporates a number of new features of design and construction. The limit of resolution which can be obtained is at least 50 angstroms.

LOOKING back now at the lower part of Figure 1, let us trace the path of the electron beam through the electron microscope more in detail. The whole instrument is enclosed with air-tight fittings and pumped free of any gas which might interfere with the passage of electrons. In this high vacuum, the cathode, *F*, and anode behave something like a radio or thermionic tube. The cathode—a metal filament or coated metal plate—is the source of the beam, emitting electrons as it is heated by an electric current. The anode is a metal plate kept at a high positive potential—perhaps 50,000 volts—which attracts the electrons and accelerates them to a high speed. A tiny hole in the anode lets through a narrow beam of these 50,000-volt electrons (wavelength: .055 angstroms). The magnetic lens shown in cross-section at L_1 concentrates the spreading beam into parallel rays that fall on the object at *AB*.

The object—suppose it is the diphtheroid bacillus of Figure 4—has to be supported somehow, and its support must be so thin that it doesn't interfere with the passage of the electron beam. A collodion film 150 angstroms thick (about three five-millionths of an inch) is a common choice, corresponding in function with the glass slides used for ordinary microscopic specimens.

As the beam falls on the specimen at *AB* in the lower part of Figure 1, some of the electrons are absorbed and some are scattered, in proportion to the thickness or density or other properties of the various parts. The transmitted electrons correspond to light of varying intensity reflected into your camera by an object you are photographing; these are what produce the areas of light and shade on the film, and constitute a negative of the final picture.

The transmitted electrons pass on through the magnetic lens L_2 to form a somewhat magnified image of the bacillus at *A'B'*. In the early stages of the microscope, this was the final image and the one that was photographed. But, as the instrument was improved, another magnetic lens (L_3) was added to give still further magnification.

The final image at *C'D'* is usually photographed, but under certain circumstances can be seen visually. If a fluorescent screen is placed at *C'D'* the electrons impinging on it cause it to glow in the pattern of the image. This can be observed through a viewing window cut in the wall of the microscope. By watching this picture, and moving the specimen, it is possible to search for interesting organisms or structures. If one of sufficient interest is found, it may be photographically recorded for closer scrutiny by merely lifting the fluorescent screen out of the path of the electrons, so as to allow them to fall directly on the photographic plate. However, since .02 cm. is the limiting size of objects seen visually, and if the fluorescent screen is used, the microscope must accomplish the whole useful magnification without any supplementary optical enlargement to clarify details.

It is quite possible to use the cathode itself as a specimen, and let it take a picture of itself with the electrons it emits as it is heated in a vacuum. In this case, no object is put between the cathode and the photographic plate. A similar optical example would be to photograph the hot filament of an electric bulb with an ordinary microscope, using the light of the bulb for illumination. Very valuable studies of the surface structure of various cathode metals

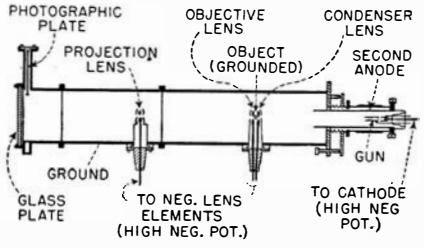
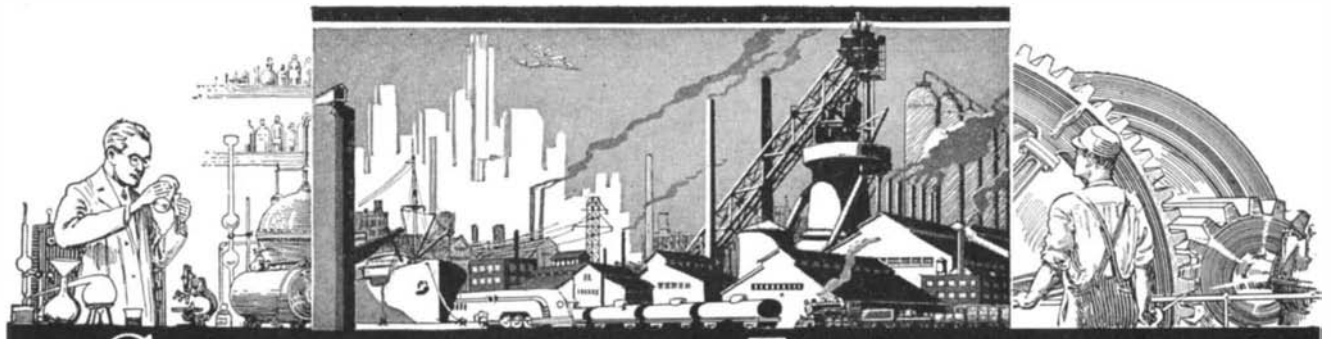


Figure 7: **An electron microscope which uses electrostatic fields instead of magnetism to bend its rays**

have already been carried out, with series of electron microscope pictures showing how the structure changes as the cathode is heated to different temperatures.

It has been stated that either magnetic or electrostatic fields may be used as lenses. Thus far we have chiefly discussed the magnetic model, which is at present the type most used for high magnification studies of specimens which do not themselves emit electrons. The electrostatic microscope has not in the past received as much attention in spite of the fact that it was first developed (by Brüche and Johannson) about the same time as Knoll and Ruska began working

(*Please turn to page* 32)



SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

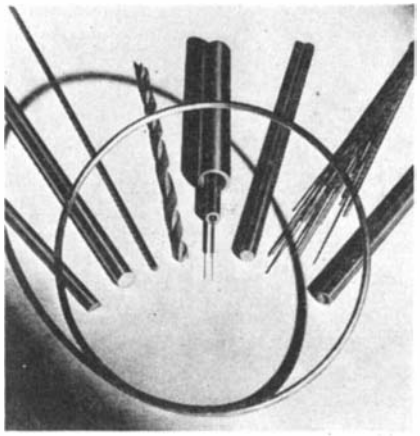
Contributing Editor
ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

Coal and Kilowatts

WHILE three to five pounds of coal were required to generate one kilowatt hour of electric power 20 years ago, points out M. W. Smith, vice president of the Westinghouse Electric & Manufacturing Company, improvements in generators, turbines, boilers, condensers, and stokers have increased efficiency until today the coal consumption of some of the new high-pressure, high-temperature steam turbine generating stations is less than one pound per kilowatt hour. "Other means of power generation," he added, "are now being considered which show the theoretical possibility of cutting in half even this low value of fuel consumption."

Carboloy Extrusion Process

CARBOLOY cemented carbide now can be produced in the form of tubing, spirals, and round or shaped bars by means of an extrusion process, it was announced recently by Carboloy Company, Inc. Available in lengths up to 20 inches and within a diameter range of from .015 to 3/8 of an inch outside diameter, these rods, spirals, and tubes are considered a distinct innovation compared with previous practice. Formerly such parts were available only within an extremely limited size range and it was necessary to perform a large part of the shaping operation manually. With the new process now employed, the Carboloy parts are formed directly into the shapes desired, eliminating most of the customary hand forming operations.



Carboloy in many shapes

To those familiar with the limitations ordinarily encountered in working cemented carbides, the Carboloy tubing now produced is of especial interest. This can be made as small as .060" outside diameter by .030" inside diameter, leaving a wall thickness of .015".

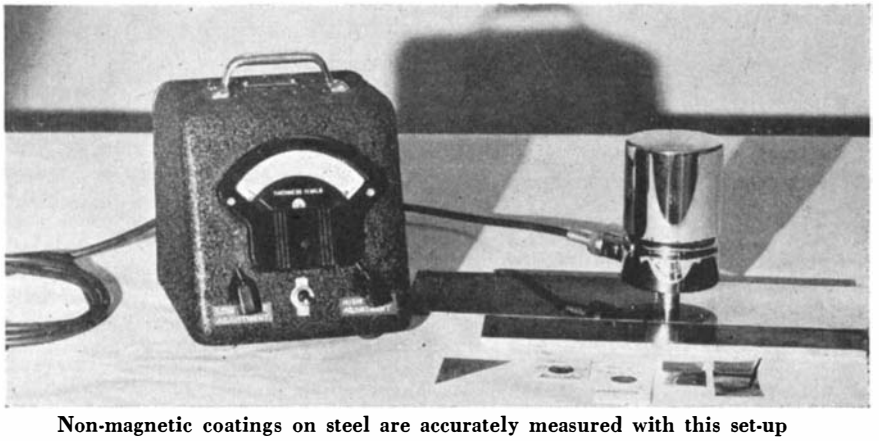
The limitations have been overcome by the development of a new process of extrusion. By this process the dry powder is mixed with a plasticising medium and can then be formed by extrusion or molding into almost any shape.

Particularly interesting is a supplementary process, by means of which Carboloy rods, and so on, can be bent to various shapes. The 5-inch diameter ring illustrated was produced through this process. It consists of a round rod curved to form a ring, with the ends joined together.

Gage Measures Lacquer and Thin Paper

AN electric thickness gage, designed by General Electric engineers, has a full-scale range from 0 to 0.0007 for measuring non-magnetic coatings on steel and can measure coatings of lacquer only 0.0001 of an inch thick, such as that used in the canning industry on the thin sheet-iron of the cans.

Thin paper, as used in the manufacture of capacitors, and even thin electroplatings on steel can also be measured. The gage will measure a deposit of 0.0001 of an inch thickness on ordinary commercial tin-plated flat sheet stock to a plus or minus 25 percent accuracy, and heavier coatings are measured to a much greater degree of accuracy. To obtain the correct gage response, the material to be measured must be backed with magnetic material to serve as the magnetic-flux return for the gage.



Non-magnetic coatings on steel are accurately measured with this set-up

Prevents Shock in Surgical Operations

SAFER surgical operations and speedier recovery from them, especially for debilitated patients, seem promised by a new treatment for preventing dangerous shock during and after operations. The treatment, using a synthetic adrenal gland hormone, was developed by Dr. David Perla, of Montefiore Hospital. Striking benefits in 14 cases at this hospital are reported by Dr. Perla, who said that the treatment will shortly be adopted in two other New York City hospitals.

The patients treated at Montefiore were what would be considered poor surgical risks because serious chronic illnesses such as cancer and tuberculosis had weakened them so that they would have little strength to withstand an operation. With the new treatment, patients are prepared for opera-

tion by being given quantities of salt solution and carefully prepared doses of desoxycorticosterone acetate. This chemical is the synthetic vital hormone of the adrenal glands. Earlier studies have shown that these glands play a significant rôle in the body's fight against intoxications, poisons, shock, and infections. The adrenal cortical hormone, Dr. Perla explained, influences the transfer of water from tissues to cells and the level of salt in tissues and cells. Disturbance of this glandular balance, which frequently occurs in an exhausting operation, leads to collapse.—*Science Service.*

SCOOP

TANKS between the rails from which railroad locomotives scoop up water without coming to a stop were first used in 1872.

Fade-Proof Interior Finish

THE Wood Conversion Company has just announced Kolor-Fast Nu-Wood as an improvement in insulating interior finish. This new product is the first of its type for which fade-proof qualities are claimed. These claims are based on severe tests by nationally recognized laboratories, which tests have established the light-fast qualities.

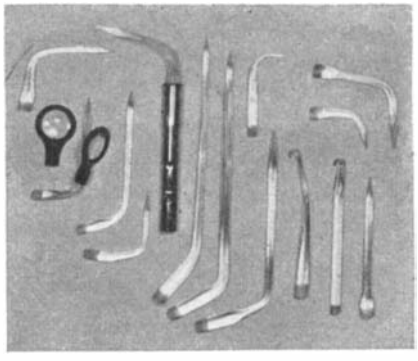
Nu-Wood Kolor-Fast is available in tile and plank in variegated and tan colors. Nu-Wood Kolor-Fast Board is available in tan. The colors are richer and clearer than before. The over-all colors are slightly lighter, giving the material a higher light reflection value in keeping with the modern tendency in interior decoration.

Heretofore, all insulating interior finish board materials have been subject to oxidization which resulted, over a period of years, in darkening of the material.

Rod-Lights for Industry

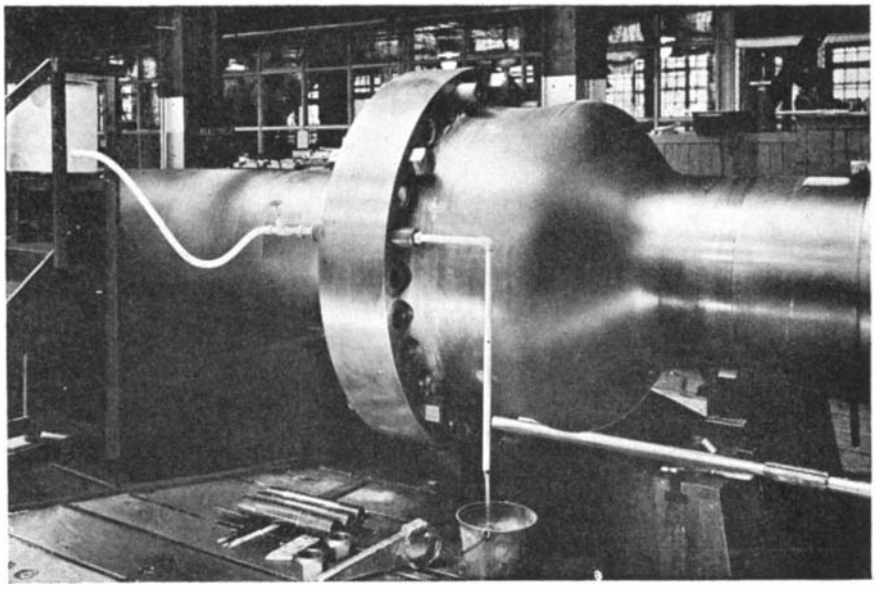
SEEMINGLY there is no end to the light transmitting uses of Lucite. Sometime ago we discussed in these pages new flash lights for medical examinations which used Lucite rods to carry the light into such close spaces as a patient's throat. An accompanying illustration shows a number of new forms of Lucite flash lights developed by Dr. D. L. Weiss for wide use in industry and repair work.

Dr. Weiss's development makes use of a small fountain-pen-size flash light, or a handle of the same shape connected to a small transformer which, in turn, is plugged into an alternating current socket.



Light-conducting rods of various shapes used in flashlight (center)

Various types of this new unit, called Ang-Lite, are being used in many manufacturing operations to examine assembly of complicated apparatus. The light travels down the Lucite rod and is thrown off in a bright spot at the tip. Instrument makers and repair men can examine with these units parts of their equipment difficult to get at. One type, having a rubber-mounted magnifying glass, throws a light directly on textiles, printing, or other surfaces to be examined. Other forms of these rods, fluted spirally in order to throw a glow of light throughout their length, are used for mixing operations or to observe chemicals in a mixture. In the photographic darkroom Lucite rods of proper color may be used not only as working lights but also as a means of stirring the photographic baths and throwing a glow of light directly on negatives and prints that are being developed.



Alcohol, cooled by dry-ice to 40 degrees below zero, Fahrenheit, is used for shrinking the bolts in this water-power coupling assembly so that they may easily be removed from their carefully fitted holes. The assembly shown set up in the shop of Allis-Chalmers Manufacturing Company, is a huge coupling for connecting the water wheel and generator shafts of one of the three 30,000 kva generator units for Chickamauga Dam. The tank containing the dry-ice and alcohol may be seen at the left. In assembling such couplings, the bolts are first shrunk by placing them in a box containing dry ice

New World's Record Pressures

NEW world's record high pressures, as much as 3,500,000 pounds per square inch, have been achieved by Dr. P. W. Bridgman in Harvard's Physics Laboratories through use of nests of high pressure vessels in which inside apparatus receives outside support at critical parts.

A piece of tool alloy, Carboloy, composed of tungsten carbide and cobalt, was subjected to a compressive stress of between 2,800,000 and 3,500,000 pounds per square inch, without fracture. Carboloy's crushing strength under normal conditions is not more than 1,000,000 pounds per square inch.

Dr. Bridgman, in reporting his results to the *Physical Review*, also made known that under such extreme pressures, carbon in the form of a thin plate of crystal graphite is not converted to diamond at room temperature. There had been hope that pressure alone might cause the formation of diamond out of this form of carbon. "It is probable that no pressure, however high, will accomplish the conversion at room temperature," Dr. Bridgman now concludes.

A striking effect of the extreme high pressures on Carboloy was that, although under normal conditions it is highly brittle and breaks with practically no plastic deformation, under the confining pressures used by Dr. Bridgman the piston of this tough material was plastically and permanently shortened by 5.5 percent with no perceptible cracks.—*Science Service.*

Paint-Receptive Aluminum

UNTREATED surfaces of aluminum and its alloys possess no natural affinity for paint, lacquer, or enamel coatings. Ordinarily such finishes will not adhere permanently. Use of aluminum has, therefore, been limited to those products on which no coating is desired.

In the Metal Finishing Laboratories of the Pyrene Manufacturing Company a simple process has been developed for the treatment of aluminum so that it will take these finishes. This process, which has proved so satisfactory under ordinary plant production conditions and whose flexibility is demonstrated by its successful use on a wide variety of parts such as microphones, transmitters, instrument panels, switch parts, has been named the Pylumin process.

Pylumin powder is a mixture of several chemicals which, when dissolved in boiling water, forms a solution that reacts quickly upon aluminum, converting the surface into a non-metallic film of complex basic oxides, thereby forming a coating which is highly resistant to corrosion and also serves as a

Official photograph, U. S. Navy

Grumman *Sky Rocket*, designed for operation from naval aircraft carriers

base for paint, lacquer, or enamel finishes. Pyluminized metal is of a uniform gray to black color, depending on the composition of the metal treated, and is velvety in texture.

The Pyluminizing operation involves only the simple immersion of parts in a heated solution in a steel tank. The processing action is fast, requiring only three to ten minutes immersion in the boiling Pylumin solution.

First Tests of The Grumman "Sky Rocket"

THE construction of the Grumman *Sky Rocket*—the XF5F-I, to call it by its Navy designation—was undertaken by the Navy Department well before the war broke out in Europe, when it became apparent that high performance fighters with long range and endurance would be required to accompany heavy bombing airplanes on long flights. The European war confirmed the Navy's viewpoint. Long-range bombers operate best if supported by fighters of equal endurance.

The XF5F-I is a carrier-fighter and has the control, maneuverability, and relatively small dimensions necessary for operation from the deck of an aircraft carrier. Although it is equipped with two Wright engines of 1200 horsepower each, it has a gross weight of only 9000 pounds, and a span of only 40 feet. The square wing tips and the square tail surfaces are intended to increase production possibilities without detracting from aerodynamic efficiency.

Although the new ship has been released for sale to the French Air Commission, definite information regarding performance is lacking. Take-off occurs in about seven seconds. In one of the tests the *Sky Rocket* flew about 100 yards in advance of a standard pursuit and suddenly began a steep climb which the older craft was unable to duplicate. Climb was said to be 4500 feet a minute without full power. Top speed is reported to be 450 miles per hour, a figure which is at least plausible. It is noteworthy that the two Curtiss controllable-pitch propellers of 10 feet diameter rotate in opposite directions. We have often in these columns pointed out the desirability of twin engined propellers turning in opposite directions. Both control and stability, and the aerodynamic efficiency, are improved thereby. Altogether, there is no doubt that the new machine will be a worthy and gratifying addition to the air equipment of the Allies.—*A. K.*

A Plea For Many Small Landing Fields

IN a recent speech, Robert Hinckley, Chairman of the Civil Aeronautics Authority, deplored the short length of time that the private owner keeps his ship before reselling it. Four out of five of the men who buy private planes sell them within a period of two and one half years, and do not buy other planes. One third of such owners actually dispose of their craft in one year without purchasing another. This is a deplorable situation and in sharp contrast to the case of the automobile, where a man who has once owned a car will mortgage his home if there is no other way of buying a new one. Mr. Hinckley thought that the situation was due to a combination of several factors, possibly too many log books and inspections, possibly too few small airports and landing fields.

The lack of small landing fields is indeed a very important reason. At least so thinks Jerome Lederer, well-known Chief Engineer of Aero Insurance Underwriters. We cannot resist quoting part of what Mr. Lederer had to say at the North Central Regional Planning Conference: "At present the private pilot may be likened to the owner of a little sailboat in a stormy area with very few harbors to run to for safety. Only the more venturesome will dare to risk a sail along the forbidding shore . . . If only there were small inlets along the shore, not necessarily large harbors, these less venturesome folks would try coastwise sailing too, and have more fun. Likewise, the private pilot does not want large airports. Small landing fields located at frequent intervals in every direction would furnish much greater incentive than now exists to make cross-country flights. These fields would furnish men much more chance of getting down safely if bad weather were encountered, besides giving the private pilot greater opportunities to use his airplane."

La Guardia Airport has been criticized for charging large landing fees. We believe that the authorities of this Airport are perfectly right in so doing. Promiscuous use of the transcontinental airports would make air-traffic control difficult and increase hazards. What is needed is a nation-wide movement for a multiplicity of small fields, and every reader who can in some manner encourage the construction of such fields will be a welcome ally to the cause of private flying.—*A. K.*

The First Central Air Terminal

IN a personal interview with Floyd Del Brown, architect and President of the Bethlehem Engineering Corporation, we obtained details of the new central air terminal which is being constructed on the site of that famous and friendly old hotel, the Belmont, just across the way from Grand Central Station, New York City. The terminal is a splendid example of what American brains, business men, architects, and engineers working together can do in combining functional design with desirable sober beauty.

The artist's drawing of the new terminal building shows its dignity and beauty. Five companies will have their offices and passenger facilities within the one structure—T. W. A., United, American, Eastern Air, and Pan American. The building cost will be $1,500,000, on a piece of land estimated at some $5,000,000. Tenancy will be for a period of 10 years; the air transport industry is growing so rapidly that a structure twice as big as Grand Central Station may then become necessary.

In the new building there will be a basement for garage purposes and another basement completely fitted as a passenger terminal. On the first floor there will be a motion-picture theater and stores, with the mezzanine used for ticket reservations and so on. The second floor will be the main departure terminal. The third and fourth floors will house the offices of the five airline companies.

The main hall will be three stories high,

New York's central air terminal

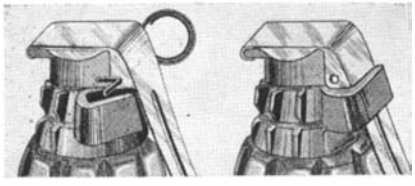
160 feet in length, and 100 feet in width. There will be six platforms side by side, with hydraulic platforms for raising the passenger buses. Passenger coaches will discharge passengers at the incoming terminal, proceed to the garage for minor attention, and will then roll on to the hydraulic lifts and be raised to the departure platforms. A minimum amount of attention will be required as doors and elevators will all operate automatically. The whole will constitute a remarkable system of "uniflow," as the engineers call it in steam-engine design. Not only will there be a minimum loss of time and a minimum expenditure in handling coaches, but there will be avoided the sorry spectacle of airline coaches parked along the street near some small and insufficiently equipped ticket office as at present.

The building, which runs from 42nd to 41st Streets, will have its bus exit on 41st Street. With but three blocks of city traffic, the coaches will then be at the entrance to the Third Avenue Long Island Tunnel. Then Queens Boulevard and La Guardia Airport will be within easy reach. It is estimated that no more than 20 minutes will be required for the entire trip.—*A. K.*

Hand Grenade Safety

THE layman will not think of humanitarianism in connection with a hand grenade. Yet that is the essence of a new locking device for hand grenades developed by Norwalk Lock Company, Division of Segal Lock & Hardware Company, Inc.

Often a soldier has occasion to pull the pin from his hand grenade many seconds



or perhaps minutes before he may need it — in a charge against enemy trenches, for example. Should he then find that the trench already has been mopped up, he must dispose of the hand grenade somehow, for the minute he releases his grip on the metal handle, the firing pin snaps over and in five seconds the grenade explodes. Only too often have soldiers been blown to bits by their own hand grenades.

The new development consists of a metal collar around the neck of the grenade. A projecting arm is so bent that a slight turn of the collar with the thumb of the hand holding the grenade pushes this arm around to hold the detonating cap holder in cocked position. A number of fins on the collar provide a positive grip for the thumb.

Twins More Likely to Older Parents

IF you are an expectant father, your chances for having twins instead of one son or daughter are greater with each year of your age, it is revealed by a statistical study conducted by the National Institute of Health and reported to *Human Biology* by Drs. J. Yerushalmy and S. E. Sheerar.

Older mothers are more likely to give birth to twins than are younger women. And twin births occur with much greater frequency in families already large than they do as first or second births.

But the fact that older fathers are more likely to have twins cannot be explained by the fact that older women are more likely to have older husbands. When only the births to young mothers are considered, there is still a steady increase in the proportion of twin births to total deliveries with advancing age in the father.

The influence of age in father and mother and order of birth, although showing up clearly when all twin births are considered, seems to apply principally to the births of non-identical twins, those resulting from a double ovulation rather than the dividing of a single egg cell. — *Science Service.*

PULLMANS

AN average of approximately 32,000 persons sleep every night in Pullman berths on American railroad trains.

The Pittsburgh of Old Palestine

IN our January issue, Director Nelson Glueck, of the American School of Oriental Research, Jerusalem, described excavations at an arm of the Red Sea, which had brought to light a buried city with a smelter in which King Solomon refined his copper. A second season of excavations at the same site has revealed that there was a much more extensive system of similar refineries than had previously been expected. Indeed, practically the entire town of Ezion-geber proves to have been a phenomenal factory site, of a nature unparalleled in the history of the ancient Near East, according to the same archeologist writing in *American Journal of Archeology.*

Flower Watering Gage

A NEW and inexpensive device for determining the amount of moisture required by potted plants and by seedlings in seed flats has been introduced by Fabaco Company, Inc. Known as the "Soil-Rite" watering gage, it is placed in pots or flats deeply enough so that its point is in close proximity to the roots, thus registering the degree of dryness or moisture at that depth on a scale. Acting as the "voice" of the plants, this gage takes the guesswork out of watering, a problem that has been the death of many a plant. A

Soil-moisture indicator

chart lists some of the more popular desert plants, those requiring moist soil, and those that do well only when the soil is wet, so that one knows the moisture requirements of the more common plants and will not under-water or over-water them. — *C. F. Greeves-Carpenter.*

New Ships for Merchant Marine

IN May there was launched at the Newport News Dry Dock and Shipbuilding Company, the steamship *President Jackson,* first of a new series of ships being constructed for American President Lines Round-World Service. Other Presidents to be honored by this series will be Adams, Monroe, Jackson, Van Buren, Polk, Hayes, and Garfield.

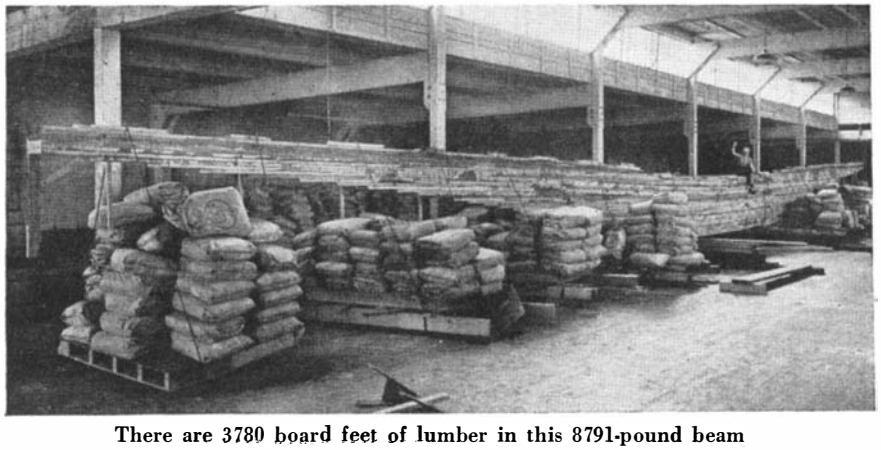
These new ships will be of 9300 tons gross, 492 feet long, 69.5 feet beam, and have a speed of 16.5 knots.

Largest Wooden Beam

AN accompanying illustration shows the largest laminated wooden beam ever built. This beam owes its existence to Laux Self-Bonding Glue with which it was fabricated in the plant of the Speedwall Company in Seattle.

Regular two by ten's of a maximum length of 20 feet made up the laminations in this beam which contains a total of 3780 board feet of lumber. Of the self-bonding casein glue, 118 pounds were necessary, while only enough nails were required to insure adhesion while the glue was setting.

The beam is 110 feet long, 10 inches deep



There are 3780 board feet of lumber in this 8791-pound beam

at the ends, and 52 inches at the center. Weighing 8791 pounds, it is capable of supporting a roof load of 65 pounds per square foot of roof. In our illustration, the beam is being tested under a load of 650 pounds per lineal foot.

FIREPROOF

THROW all the cigarette butts and lighted matches you want to on a new awning and it never burns. It is woven of fiber glass yarn. Besides being fire-proof, it is rot-proof and will not mildew.

Mending Cement

A LATEX cement, which is being sold under the name Liquid Thread, mends fabrics, paper, leather, or leatherette, and adheres to such non-porous materials as glass. Used on fabrics, it provides a heat-proof and water-proof mend, and is said to be unaffected by washing and ironing. Liquid Thread is made by Paste Elastic Manufacturing Corporation.

It may be used for joining or binding rugs and, when applied as a coating, it imparts anti-skid qualities to rugs, telephone bases, and similar objects. It also finds use as a general adhesive in the office, home, and school.

A Problem for the Resourceful Inventor

THE skin prevents the escape of body fluids. Its thickness varies in different parts of the body. It is freely movable in some places and tight in others, and the creases mark where it is bound down. It has minute ridges which improve the grip on the palm and sole and marvelously afford the only permanent and absolute means of personal identification with finger prints.

With all our modern ingenuity in creating machinery and fabrics, we cannot create a tough yet highly elastic one that will withstand heat and cold, wet and drought, microbes, and the wear and tear through the years and yet make its own repairs and even assemble in summer a protective pigment against the sun's rays. The skin is a regulator of body temperature, an excretory organ, and the largest and most versatile of our sense organs. The skin helps to form the ear drum, it covers the eye ball, from it originate the teeth, and in it are millions of tiny glands. Finally, when sunlight or ultra-violet is shed on it, the ergosterol in the skin produces vitamin D.—*Journal of the American Medical Association.*

Roses Treated with Gas from Apples

ARTIFICIAL autumn can be brought to rose bushes, causing them to shed their leaves in a few days, by locking them up in the same room with apples, it has been discovered at Oregon State College by J. A. Milbrath, Elmer Hansen, and Prof. Henry Hartman.

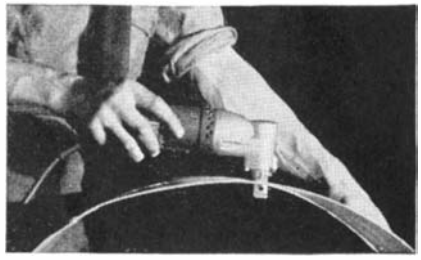
Ordinarily such defoliation would be undesirable, but when large numbers of field-grown rose bushes are being prepared for shipment to market it is necessary to rid them of their leaves, to cut down water loss

through evaporation. Hand plucking is tedious and expensive — a thorny job at best.

By putting the bushes in a tightly closed, moderately heated room, with one bushel of apples to every 300 or 400 cubic feet of space, they can be caused to shed their leaves in about four days. The apples produce this effect because they give off small quantities of ethylene, which is also a common constituent of natural gas.—*Science Service.*

Metal Nibbler

PORTABILITY, speed, and power are characteristics of a new portable nibbler with which all types of sheet metal products may be cut into odd shapes for fitting. This new Thor nibbler cuts panels,



sheets, or tubes up to 18 gage in steel and up to 15 gage in aluminum. It follows line or contour accurately, cuts plain or corrugated stock and will cut tubes as small as 1½ inches in diameter. Operated with one hand, it will not distort the sheet and makes inside cuts easily.

This nibbler is equipped with a universal motor in standard voltages of 110 or 220 volts. Full load input is 200 watts.

Window Cleaning Compound

MEETING the growing demand for a solvent suitable for use in the manufacture of window cleaning compounds, U. S. Industrial Chemicals, Inc., has developed a new concentrated solvent blend that can be diluted with water to make a finished liquid cleaner.

In placing this solvent on the market, U.S.I. has made it possible for manufacturers of cleaners to offer a highly effective product.

All that is needed to manufacture the finished compound is to dilute the new solvent with water. The final compound may contain from 15 to 50 percent by volume of the solvent, as desired. Even the 15 percent mixture is safe for storage in cold weather.

The 50 percent dilution, it should be noted, will affect paint, varnish, and lacquer, and will soften celluloid (such as eye-glass frames). The 15 percent compound, however, may be used safely on such surfaces and is an excellent polish for eye-glasses.

Naval Construction

LAUNCHING of the battleships *North Carolina* and *Washington*, early in June of this year, marked the first launching of a battleship by the United States since the early twenties. Both of these ships should be ready for shakedown trials within another year. The keels of three other battleships—*South Dakota, Indiana,* and *Massa-*

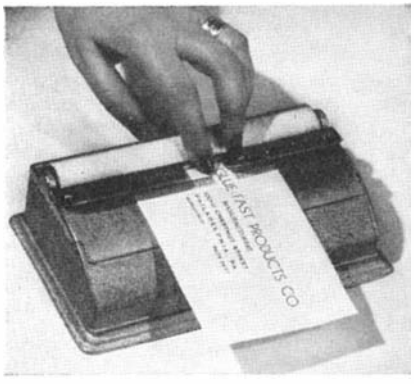
chusetts—were laid in 1939, and the keel of a fourth, the *Alabama*, was laid in February 1940. Two others, the *Iowa* and *New Jersey*, have been let on contract to the New York Navy Yard and the Philadelphia Navy Yard, respectively, and their keels will probably be laid shortly, now that the *North Carolina* and *Washington* are off the ways.

As of March 1, 1940, progress of other naval construction in navy yards and private yards was as follows:

Two aircraft carriers were under construction, one of which, the *Wasp*, has since been placed in service. Contracts have been let for six light cruisers, for one of which the keel was to be laid late in March. Fourteen submarines have been ordered, of which two were launched, two were scheduled for launching in March, and the keels had not been laid for three. Keels had been laid for all except two of 27 destroyers. Nine of these have been launched and two others were scheduled for launching early in March. Keels have been laid on most of the remaining ships comprising tenders, mine sweepers, a repair ship, a mine layer, submarine chasers, and a large number of motor torpedo boats. Of these, two DD tenders, a fleet tug, a submarine chaser, and two motor torpedo boats had been launched.

Label Gluing Machine

SHIPPING rooms of factories, stores and business offices are faced with one slow but always messy job—that of pasting shipping labels on packages. Pre-gummed labels are not only difficult to handle but are expensive. The Glue-Fast Equipment Company, Inc., has worked out a simple gluing machine which operates like many well-known moisteners but which makes



unnecessary the pre-gumming of labels. This machine covers the surface of the label with a thin film of glue.

The operator of this machine uses only one hand to slide the label under the guide bar. Pulled across the roller, the label is gummed so that it can immediately be spread on the package and there is no necessity for wiping off excess glue—there is no excess.

Leather Electro-Plating

THE fad of electro-plating babies' shoes to preserve them, and the manufacture of certain kinds of metallic decorative leather, make the following formula of interest to many of our readers.

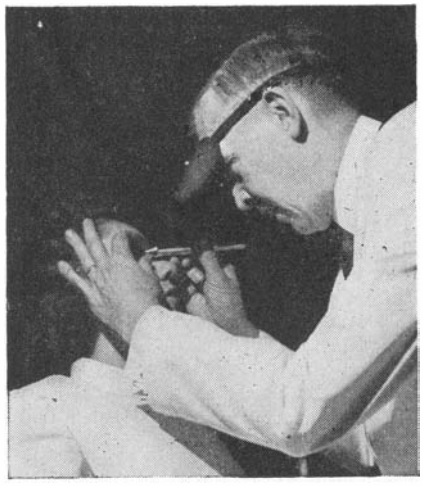
All leather to be plated must first be carefully cleaned to remove oils, greases, and the like and then dried and coated with

orange shellac to make it waterproof. An additional coat of shellac or an air-drying varnish is then put on the surface and sprayed or brushed with copper or bronze powder while still tacky in order to make it conduct electricity. Once this has fully dried, the leather is electro-plated in the usual manner in an acid copper solution. Following the copper plating the leather is rinsed, scraped, brushed, or buffed and is then oxidized or plated with the final coating of metal.

This process can be used on wood, plaster, flowers, and other such objects, according to the magazine *Metal Industry.*

New Magnet for Medical Use

A NEW magnet for the removal of metal fragments from the eyes and surface wounds has been devised by the General Electric Research Laboratory in Schenectady. Though not designed to replace the



powerful electromagnets in this field, the new instrument is more powerful and more easily handled than earlier permanent magnets used for the purpose. Sintered alnico, an alloy of aluminum, nickel, cobalt, iron, and copper, is used with a high-permeability insert of nickel-iron to collect the flux at the point. The magnet is light in weight.

RUBBER

THE 1940 rubber requirements of one popular make of automobile would make a single monster tire 346 miles in diameter and 80 miles wide.

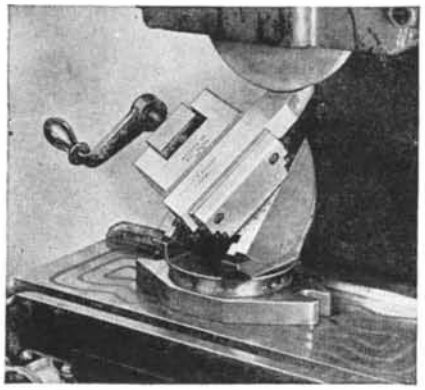
Airplane Armor Plate

WALTER Winchell in his Sunday-night broadcasts has often made the statement that American fighting planes are as efficient as any made in the world today with the single exception that the pilot has no armor-plate protection. The Jessop Steel Company recently reported that they have just completed shipment on a large number of sets of armor plate to be installed in the cockpits of combat planes. These pieces are so placed as to afford protection to fire from below and from the rear. The armor plate for this order was specially heat-treated to procure maximum ballistic resistance to penetration. Consequently, the

gage is comparatively thin and the weight reduced to a minimum while giving protection against machine-gun bullets and shell splinters.

Universal Angle Vise

A NEW type of universal vise for use in connection with milling, grinding, and drilling operations permits easy production of even complicated compound angles. The vise is adjustable in three planes. Graduated scales are provided in each plane so that



the vise may be set up for a complicated angle operation as easily and quickly as for a simple angle.

A special feature of this new vise is its accuracy and ability to handle heavy cuts. The vertical member is built like a cradle; it rocks in a solid base. All-steel construction gives added strength and makes the vise light and easily portable. It may be moved from one machine to another for successive operations without disturbing the work. This vise may also be used as a gage in checking the accuracy of angles which have already been produced.

To Protect Rusted Fences

RUSTED fences present a difficult painting problem. First of all, it is practically impossible to remove the rust and prepare the surface for ordinary types of paints. Furthermore, the links "chafe" the touching pieces of wire and cause the paint to crack and chip away. A new product, Fence-Bond, made by the Skybryte Company, solves these problems.

Fence-Bond is a factory-mixed, ready-to-use aluminum paint specifically designed for painting rusted fences. The factory mixing is said to result in a more uniform dispersion and a more silvery, lustrous surface that will protect the fence despite rust that may be present before the repainting. Chafing and cracking are prevented because the paint remains plastic enough to take up all movement from expansion and contraction or other causes.

Kidney Extract for Gastric Ulcer

HOPE for stomach ulcer patients appeared in a discovery announced at the recent meeting of the Federation of American Societies for Experimental Biology. For these patients there will be the new hormone urogastrone, obtained from kidney excretions. First trials on 10 normal persons showed that this hormone can stop the

formation of acid by the stomach, Drs. A. C. Ivy, E. Wiezcorowski, and J. S. Gray, of Northwestern University Medical School, reported. At present, ulcer patients must take alkaline powders to neutralize the acid in their stomachs so that it will not irritate the ulcers and cause bleeding.

The new hormone will be injected under the skin. Such injections at present cause swelling and reddening. Dr. Ivy and associates hope shortly to overcome this feature by further purification of the hormone, after which it will be ready for use in treating ulcer patients. The hormone treatment, by checking the acid in the stomach, will give the ulcer a chance to heal.—*Science Service.*

AGAR

IN dried form a grayish, light, stringy solid, agar is made solely in Japan because the harvesting of the seaweed from which it is made, and the processing, require much hand labor, which is cheap in that country. Should the supply be interrupted, all manner of research institutions would be handicapped, for it is used almost invariably as a culture medium in research involving germs.

MACHINE POST OFFICE

A COIN-OPERATED post office, called the Mailomat, has been intriguing commuters and others—with letters to mail at the last minute—in both of New York's great railway terminals. This machine is, in reality, a self-service post office, for if the letter is dropped in with a coin the machine prepays postage and postmarks the letter. No stamps are necessary and it is not necessary to run the mail collected from this box through the cancelling machine at the post office. The Mailomat is manufactured by Pitney-Bowes Postage Meter Company.

OFF WITH PEANUT SKINS—CHEMICALLY

BEFORE peanuts can be used as a food, the unpalatable reddish-brown skin which closely covers the nut must be removed. This has been a problem in the manufacture of peanut products. Home economists in the Department of Agriculture now have developed a commercially practical way to remove the skins with low weight loss and no splitting, and still have a nut high in quality. The shelled nuts are dipped in a 1 percent hot lye (sodium hydroxide) solution for about eight seconds—just long enough to moisten the skins. They are then dipped immediately into a cold, 1 percent solution of hydrochloric acid to reset the dissolved pigment in the skins and thus keep it from staining the nuts. The nuts are then rinsed in cold water and the skins easily removed by hand. The nuts are dried at room temperature before storage.

Peanuts skinned in this way retain their smoothness and gloss and keep much longer than those blanched either with hot air or hot water. The weight loss is low — 3 to 6 percent as compared with around 18 percent for the usual commercial hot-air treatment.

SEEING WITH ELECTRICITY

(*Continued from page* 22)

on magnetic lenses. The principle of this type of instrument is shown in Figure 7, a diagram of an electrostatic electron microscope now under construction in the Camden laboratories of RCA. Here radially symmetric electrostatic fields between suitably shaped apertures serve as lenses. While the actual construction of the instrument is quite different from that of the microscope described, the operation is quite similar. These electrostatic lenses now appear to be capable of the same high magnification as the magnetic lenses, but the ultimate resolution that can be obtained with them has yet to be determined.

We could hardly leave the subject of the electron microscope without giving at least a sketchy account of some of the difficulties which beset it. Any microscope, optical or otherwise, is allergic to certain "bugs" in the works, some of them inherent in the illumination itself, and most of them leading to distortions and aberrations of the image.

Among these is diffraction, which we have already mentioned, explaining how it limits the resolving power and tends to blur the image. But present-day electron microscopes still have a long way to go before they attain their theoretical resolving limit of half the wavelength of the electron. Even so, the fact that, for a given specimen, diffraction effects decrease with wavelength, gives the electron microscope an advantage over the optical instrument. As large a part of that theoretical advantage as can be exploited practically is being sought for use.

Figure 5 is an electron microscope photograph of the edge of a new razor blade, magnified 24,000 times. The section of blade pictured is .00003 cm. (about 1/83,000 inch) across—a distance within the scope of good optical microscopes. But, had the latter been used, diffraction would have blurred the indentations of the edge, and the picture would lack the detail and exquisite clarity of line given by electrons.

With present electron lenses, a number of errors other than diffraction are of great importance, and keep the resolving limit far above its lowest theoretical value. Distortions of the image result if the electric or magnetic field lenses are not perfectly symmetrical or constant; if the accelerating potential varies even by a volt or two; or if the velocity of the electrons is slowed too much by passing through the specimen and its mounting. Once again, each of these electron lens errors has an analogue in optical lenses: spherical aberration, chromatic aberration, astigmatism and so on.

The proper mounting of all types of biological and physical specimens also presents a problem which is at present far from being solved. The men working on it have been successful in mounting a number of types of bacteria, colloidal particles, and other physical specimens, but the extension of the list and the interpretation of the images is more difficult. However, when one considers that, after a century of work, the corresponding problems of light microscopy are far from complete solution, the development of the super-microscope and its associated technique appear almost phenomenal,

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

OPTIMUM is the word to characterize the Richest-Field Telescope, which affords a optimum broad view of the heavens.

"I enclose a photograph (Figure 1) of a 6", short-focus reflecting telescope made for me by two friends, W. F. Gale in the chair," writes G. H. Hoskins, of Ewarra, Brewongle, New South Wales, Australia. "My interest was aroused by a chapter on 'The Richest-Field Telescope,' in your book, 'Amateur Telescope Making—Advanced.'

"The telescope is 30" long over-all, focal

Figure 1: RFT made in Australia

length is 24", mirror is 6" diameter, Ramsden eyepiece, magnification 19 diameters, field of view 2°.

"It struck me, when suggesting its construction, that the design could be made more comfortable to use, hence a leather-covered pad was attached to the base, so that the telescope could sit easily on a rather bony knee—it also helps to take up vibration. The eyepiece is just at the right height when one is sitting in a chair. A door handle is attached to the tube, to allow safe carrying, but it also gives a remarkably steady hold when observing—the telescope is steadier than a binocular. Another part of the apparatus, and a most useful one, is the alt-azimuth mounting shown. This is extraordinarily good.

"I have used telescopes, up to 18", but in none of them have I seen such comprehensive and beautiful views of the heavens. As a comet seeker it would be hard to find its equal and, for ease of use, I know of no other unmounted telescope to approach it. All thanks to 'ATMA.'"

Thanks mainly to S. L. Walkden, father of the RFT.—*Ed.*

ENDLESS and largely futile has been the age-old debate between exponents of the refracting telescope and those of the reflector. After years of near ostracism by American amateur telescope makers, the refractor is now in the social swim, thanks largely to J. R. Haviland's lengthy and detailed treatise in "ATMA." An amateur whom we shall designate as X, because he prefers to be anonymous, has completed a 7½" refractor (Figure 2) and says he enjoyed the job, also likes the telescope.

X says he feared to begin the 7½" objective lens as his maiden refractor job but, after a talk with J. R. Haviland, he felt encouraged to wade in. The 8" flat required in testing the objective, good to a quarter wave, was successfully completed in 150 hours. Then came the actual objective. "It definitely was not difficult," states X. "The edge testing jig and spherometer described by D. Everett Taylor, in the February, 1940, Scientific American is the thing. However, I found the three-ball jig recommended in 'ATMA' by Haviland was good. Using a Starrett gage on the Taylor equipment, it was necessary only to take a little care and use patience to get the crown and flint to radius and the edges within the limit of accuracy of the gage. This eliminated the bugbear of centering.

"To avoid scratches I ground glass blanks to the same radius as each curve and used these to break in the pitch laps. Figuring was rather baffling until I tried Ellison's stunt of putting a heated flannel pad in the center of the back of the flint to indicate definitely what a hill should look like, then varying lap and stroke accordingly. To save making King's test for convexes I drew on my flat-making experiences and interpreted the fringes against the concave; for this the concave should be a true surface with a clean edge. I finished No. 1 surface one fringe off, and No. 2 about three off, but this was cemented to the concave.

"The objective required about 225 hours of actual work. It is second grade Jena and of course has some striae (a pair of guaranteed discs would have cost probably five times as much.) Strange to say, it is difficult to trace any irregularities to the striae in actual performance, though in the collimation tests they stood out like a sore thumb. Under test on the stars the glass is quite satisfactory. There is much less scattered light in the field than in my reflector. The planets and, particularly, the Moon's detail, stand up much better under high power."

John R. Haviland, author of the chapter on objective lens making, in "ATMA," states that he has tested this objective against his 10" flat, and that it tests first-class and has a beautiful polish. The anonymity of X is not of his own choosing, it isn't due to shyness, and the G-men aren't after him! Your scribe will forward to him private letters from readers, if addressed in care of this department.

William R. Harlow, 328 Fisher Hall, Oxford, Ohio, states that he made a 7¾" objective lens, working from Haviland's chapter in "ATMA," which he praises, the job lasting from November to May. "The biconvex crown part was easy," he says, "but I had trouble with the back surface of the flint. The unit was quite a bit over-corrected and had to be separated by about 0.1". The definition of the image then was somewhat spoiled by the light reflected back and forth between the surfaces. All in all, the lens is all right," Harlow continues, "but I will stay with smaller ones after this."

A 3" is usually about the best size objective for a maiden job, (at least one previous reflector having been made). One man followed this by a 4½", then a 6", obtained good results from all, and has used nothing but these refractors for the past several years.

SILVERING isn't extinct, by any means, even though aluminizing today seems superior. From C. S. Walton, 5975 W. 44th Ave., Wheatridge, Colo., we recently received word that a method of silvering described in *The Philosophical Magazine* (London), December, 1938, pages 953-970, had been successful in his hands and that he believed it had advantages over the more familiar method. On the basis of its origins, also of Walton's praises, we asked him to describe it, which he does as follows.

"My attention was directed to an article on silvering, in *The Philosophical Magazine*, December, 1938, written by B. Dasannacharya and Amar Chand Seth, of the Hindu University, Benares, India, which seemed to offer improvements over the familiar Brashear method. Trial met with success, so I pass the method and my experiences along.

"Clean and prepare the mirrors according to the methods stated in 'ATM.'

"Prepare two sets of solutions based on 1 gram of silver nitrate in 2½ oz. water, ½ gram potassium hydroxide in 1 oz. water, and 6 cc. regular sugar reducing solution for each 175 square centimeters of area,

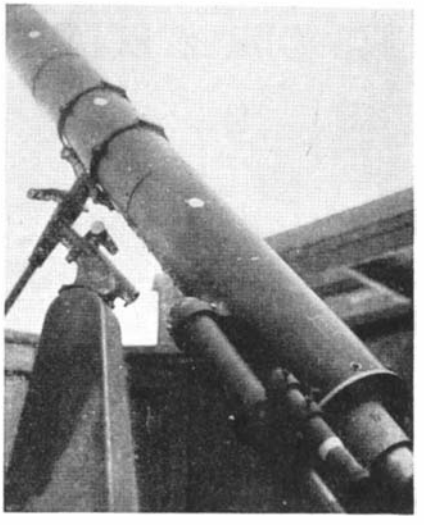


Figure 2: The anonymous refractor

including a dish, if any. An 8" mirror, for example, having 314 sq cm. of area, with a band around it, would be silvered by preparing two solutions, each made of 2 grams silver nitrate in 5 oz. of water, 1 gram potassium hydroxide in 2 oz. water, and 12 cc. reducing solution. The water happens to be an amount that will cover an 8" mirror properly. The two gentlemen of Benares state that the concentration is not important, but that the relation of silver nitrate to area is. They found one gram to 525 sq. cm. to be the best, but with prolonged depositing time I did not get a sufficiently heavy coat and preferred one gram to 175 to 200 sq. cm. Other chemicals are, of course, always maintained in the usual ratio to the silver nitrate. Two applications on the basis described will produce a heavy coat.

"Clear the silver nitrate solutions with ammonia, as usual; add potassium hydroxide solution *slowly*, stirring constantly; clear again with ammonia, very carefully. The solutions clear decisively and there will be no turbidity, sediment or black suspended matter left. They therefore need no filtering.

"Forget the reserve nitrate solution and the instructions to have silver in excess. The authors state that the worker should just clear with ammonia each time, and that, in the second clearing, a slight ammonia excess (a drop or two) may be desirable since the coats will be more free from spots and action will be retarded to a convenient rate. Further, they say that temperature is of little importance. I can subscribe to the workability of all this.

"The solution on the mirror, to which reducing solution has previously been added, will turn clear brown, then opaque black, then gray, and finally, if left on 10 or 15 minutes, will clear to some extent, and will not form a lot of black muck as it does when using the more familiar methods. Pouring off solutions about the time they turn gray seems to be the dividing line between a bright surface and too much white bloom. The wet coat may be washed with mild soap and water to remove bloom and sediment—with reasonable care, of course.

"While I use two applications, I do not deliberately strive for as thick a coat as results, because thin coats seem brighter and have less bloom, and after five years' experience with various coats on a 10½" and 12" mirrors, plus a lot of use of the 20" Alvan Clark refractor at Chamberlain Observatory, entirely on faint variables and novae which frequently were beyond reach of even the 20", I have concluded that something is wrong with the dictum, 'a thick coat is better in every way'. However, double coats produce fewer pinholes for me, which soothes my feelings. Moderately thin coats and thick coats reach about the same minimum star magnitudes in my reflectors, and their performance is exactly proportionate to the 20" refractor in that respect.

"In sum, I consider that the improvements in silvering made in India not only save chemicals, but that the process works clean and precise as compared with the one described in the Bureau of Standards circular quoted in 'ATM'."

FOR the alt-azimuth mounting a wrinkle usually attributed to the Earl of Crawford, and described by S. L. Walkden, of

London, provides a fairly good rough working substitute for the drive clock used on equatorial mountings. Figure 3 is self-explanatory. Walkden writes: "The scheme can be made to work pretty well for looking southward within about four or five hours of

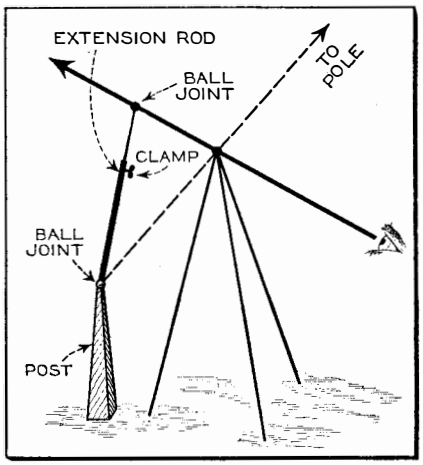


Figure 3: **An old alt-azimuth kink**

the meridian and up to about 60° North Declination. It generally works suitably enough for about an hour's observation. If the eye end of the telescope is slightly overweighted, a cord may be substituted for the extension rod."

IN "ATMA" Everest describes the use of kerosene in place of water for mirror grinding, since the cooling caused by evaporation of water causes temperature effects well worth taking note of in advanced mirror making. W. A. Mason, 1303 Lakeview Avenue, Lorain, Ohio, says he has tried instead some carbon tetrachloride, also "Prestone" anti-freeze, diluted about 1 to 1, and believes these are better than kerosene—though he states that he has used them on only one mirror, hence does not wish to make this claim dogmatically. He also diluted "Prestone" anti-freeze 1 to 1 with rouge and thought it kept the rouge mixture on the lap better than water, also retarding evaporation. Mason is the author of a chapter in "ATMA" (p. 361).

"Prestone" anti-freeze used in automobile radiators, and known to everybody, has an ethylene glycol base and suffers practically no loss by evaporation. In a 1 to 1 mixture of "Prestone" anti-freeze and water, the evaporation, at ordinary temperatures, would be approximately one half that of water alone.

YOU invited some friends over to spend the evening looking at the stars through your telescope. They came—whereupon everything clouded up. The friends hung around through an awkward two hours, giving you the dog-eye, as if it were your fault, and you felt like a plugged nickel. Then they went home—whereupon all the stars came out.

It hasn't happened to you?

This total depravity of inanimate objects does not catch W. L. Chamberlain, 519 Liberty Street, Meriden, Connecticut, napping. He keeps in reserve a dummy telescope made of cardboard tubing, equipped with indirect lighting and an "eyepiece"—a sort of peep-show—and into this he slips various mounted astronomical pictures, half-tones and drawings from here and there. And he says his friends actually think these look better than the reality!

Well, when you consider that these would be mainly exceptional pictures, corresponding to rare views of the heavens taken with large telescopes; also that most persons who have studied or read no astronomy at all are disappointed when they see the stars through a telescope, because in seeing they see only with their eyes while the amateur astronomer "sees" also with the intellect, then these cut-and-dried pictures probably do look better than reality to your friends, who no doubt would be too polite to say so. Of course, one could show such pictures to the visitor even without a dummy telescope, yet there is just enough of the kid in most of us to fall in readily enough with some such guise, just as we do with scenery at a play. This saves the evening when guests look reproachful.

Chamberlain wasn't, however, the first amateur to try this stunt. Holden's biography of Sir William Herschel contains a letter from Sir William to his daughter Carolina, dated July 1782, in which is revealed how Herschel tried it on King George III and his Queen when they came to look through his telescope (George III became a good amateur astromoner later on, even though as a King we Yankees think he wasn't so hot). "When the evening appeared to be totally unpromising," Herschel wrote, "I proposed an artificial Saturn as an object. I had beforehand prepared this little piece, as I guessed by the appearance of the weather in the afternoon we should have no stars to look at. This being accepted with great pleasure, I had the lamps lighted up, which illuminated the picture of a Saturn cut out in pasteboard at the bottom of the garden wall. The effect was fine, and so natural that the best astronomer might have been deceived. Their royal highnesses and other ladies seemed to be much pleased with the artifice."

CONVENTIONS of amateur astronomers will be held Friday-Sunday, July 5-7, at Buhl Planetarium, Federal and West Ohio Sts., Pittsburgh, Pa., by the Amateur Astronomers Association of Pittsburgh, H. Clinton Kyle, General Chairman; also Saturday, August 10, at Stellafane, near Springfield, Vt., Roy J. Lyon, Secretary. All are welcome to both gatherings.

NEWTELLIAN is the name given by John M. Pierce, 11 Harvard St., Springfield, Vt., to a reflector having a small diagonal just outside the incoming beam of rays, which he has described in one of his hobbygraphs.

ADVANCED optical design sharks will be interested in a 13-page article on "The Design of Wide-aperture Photographic Objectives," by R. Kingslake, of the Eastman Kodak Co., in last January's *Journal of Applied Physics* (175 Fifth Ave., New York). Trends is the main thread in this.

FROM *The Journal of the Royal Astronomical Society of Canada,* 198 College St., Toronto, Ont., can be obtained, for a quarter, a practical booklet on "The Small Observatory and its Design," by Brydon, who contributed to same journal in 1939 an article describing "Two Inexpensive Drives for Small Telescopes," one drive being especially interesting. Same cost.

Conducted by JACOB DESCHIN, A.R.P.S.

Making The Most of Your Vacation Shots

THIS piece may seem to be more appropriate at the end of the vacation months, when we have all gathered what vacation pictures we are going to be able to make this season. However, though it may seem like putting the cart before the horse—discussing print-making before we have shot the negatives—this department would like to submit that many a picture would be much improved if the final print were kept in mind even as one is shooting the original subject.

The illustrations reproduced here are the work of Miss B. S. Shannon, a member of the London Terrace Camera Club (New York) and represent two of a large number of negatives she made during a trip to Mexico, that land of limitless picture opportunities. The sermon that Miss Shannon's pictures suggest for this month is that a single negative may often yield more than one picture, even though a print from the full negative may itself be worthy.

Figure 1

Miss Shannon uses a negative format longer in relation to its width than most amateurs are accustomed to work with; as a result, they cannot be enlarged, without cropping, to the usual 5 by 7, 8 by 10, and 11 by 14-inch formats the standard printing papers call for. One of the best examples in her collection is Figure 1, which depicts two moods in a single scene: the busy market-place in the street and the tranquility and dignity of the church on the hill above. Although the two moods might appear to clash, together they present the characteristic flavor or "mood ensemble" that we have come to associate with Mexico. As it stands, the picture has definite charm and undeniable appeal. It is very well worth while. We like it.

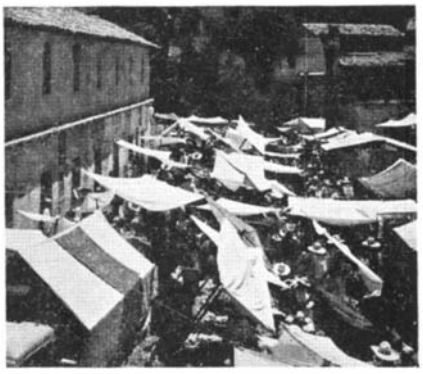


Figure 2

However, the negative does lend itself to dismemberment, as Figures 2 and 3 will illustrate. In Figure 2 the concentration is on the market-place; in Figure 3 the church and sunlit rooftops occupy the full picture.

Not all negatives, of course, are so easily separated into two or more pictures. In many cases it is difficult to get even one good picture out of a negative which has been shot without any sense of composition or appreciation of the fact that a picture must have a point of interest and an arrangement in which the various elements are pleasingly balanced.

Another type of negative in which a certain effect was desired but which fell flat because of one circumstance or another, is shown in Figure 4. The goal of the photographer was to shape the three persons (plus the baby) into some story-telling picture, but things did not work out as desired. The baby probably became upset for some

Figure 3

Figure 4

reason, and the mother and boy had their attention diverted. The only saving feature of the picture is the smiling worker leaning on a shovel. By judicious cropping, an interesting picture was salvaged from an apparent failure.

Despite all precautions you may take and all the care put into the making of a negative, pictures in which persons are included,

Figure 5

and particularly where they are shot candidwise, often will prove disappointing. But do the best you can, always keeping in mind that negatives do not have to be printed just as they are exposed but may frequently be "edited," as our movie colleagues have it, to produce at least one picture from a piece of the negative, even though the larger portion of it may be worthless. Sometimes, too, we are obliged, by reason of the angle of view encompassed by the lens, to include more than we desire. Again we do the best we can and keep in mind that when we come to making the enlargement later we can take what we want and let the rest go.

Prepared Solutions *vs* Mixing Your Own

THE question often arises as to whether it is better to buy developing solutions already made up or to mix one's own solutions. Louis H. Lanctot, A. R. P. S., of the Center Photo Stores, Inc. (New York), recently commented on this subject as follows:

"The only advantage of mixing one's own solutions," he said, "is that it is a little cheaper. Sometimes, too, there arises the need for a special formula to do some particular work and having a stock of chemicals on hand makes it very convenient. But on the whole there are good reasons why the photographer should purchase his solutions. The manufacturer mixes the chemicals in large quantities and this reduces any errors in weighing. Again, the mixing operation is carried out in a scientific manner under the supervision of trained chemists and there is no chance for the solution to go wrong. The small additional amount expended on a prepared solution is the price you pay for a chemical engineer to help you, as well as insurance that your solution will work satisfactorily."

Stainless Equipment in Amateur Darkrooms

THE qualities of stainless steel that have made it indispensable to industry also are responsible for its growing popularity in photography, writes George J. Sherwin, well-known amateur photographer, in a recent communication to this department. Its resistance to chemical action, its cleanness, and its great strength are, in fact, qualities ideally suited to the requirements of photographic work. Profession-

In the darkroom—stainless steel tanks, tray, film driers, and so on

als soon discovered that equipment made of this metal was both convenient and economical, requiring but little care and no replacement. The amateur, as usual, was not far behind the professional. He too clamored for tanks and trays made of the metal that neither tarnishes nor corrodes — that lasts a lifetime. That he knew what

Print washer with stainless frame

he wanted is evident from the great amount of stainless-steel equipment to be found in the average amateur darkroom today.

One of the better known applications of stainless steel to photography can be found in film developing equipment such as the "Nikor" developing tank. The tank probably has to take as much punishment as any other article in the darkroom and therefore must be made of a material that combines many virtues. It must be impervious to the corrosive action of the developer; even if only a slight reaction takes place, fogging or other spoilage of the negative may occur. Then, too, the tank must have a hard, non-porous surface so that it will not retain deposits which, by contaminating the solution, might also cause spoilage. The stainless steel tank, smooth and non-corrosive, fully meets these requirements. Moreover, its great strength is another valuable characteristic.

In addition to fulfilling all these demands of photography, stainless-steel equipment offers other advantages in the way of convenience and economy. Its heat conductivity is favorable because a stainless container tends to keep the liquid in it at a constant temperature, free from rapid fluctuations. It is easy to keep meticulously clean simply by rinsing out. Economy, too, is an angle that the amateur is not likely to overlook. Stainless steel practically lasts forever because of its high tensile strength and corrosion-resisting characteristics.

Many new darkroom accessories of stainless steel are now available. Stirring rods, trays, negative driers, print washers, and thermometers represent only a few of them. One of the most popular is the new type print washer shown in the illustration. It utilizes an entirely different principle which insures both rapid and thorough washing by running fresh water over the prints which are held between its absorbent book-like leaves.

That stainless steel is taking over the American darkroom seems to be an incontestable fact. Some amateurs have even

completely lined their darkroom sinks with it, hiring a local tinsmith to do the job. But for the present, however, most amateurs are content to take advantage of the many conventional items now available.

Re Flat Prints

A CURE for those curling prints most of us keep complaining about is offered by John H. Cornwall. He says it took him all of his 18 years in photography to discover it, but believes he has the solution now. After washing the prints thoroughly, he immerses the prints in the following bath:

Glycerin	12%
Alcohol	5%
Water	83%

He recommends this after-rinse particularly in the case of prints that are to be ferrotyped. Upon drying, the prints fall off the tins flat and without any signs of the corrugations and non-glossy circles that make ferrotyping such a chore and exasperation for some workers.

WHAT'S NEW
In Photographic Equipment

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

KODAK PORTABLE MINIATURE ENLARGER ($42.50 to $60 with lens): Designed for 35mm camera users who lack darkroom or who travel. Packs and dismantles readily in airplane-luggage type case measuring 13½x 13½x6½ inches. Can be unpacked and set up ready for use in few minutes in any improvised darkroom. Enlargements from 2½ to 9 diameters on baseboard; still greater enlargements by projection to floor or wall. Enlarger head may be rotated 90 degrees to right or left. Scale graduated in degrees indicates angle off vertical. Combines diffuse and condenser illumination by employing No. 113, 50-watt, 115-volt Mazda Photo Enlarger Lamp in conjunction with triple-lens condensing system. Lenses available: Kodak 50mm Projection Anastigmat *f*/6.3 in lens tube, fixed diaphragm; Kodak 2-inch Projection Anastigmat *f*/4.5, adjustable diaphragm stopping down to *f*/22: Kodak Projection Ektar *f*/4.5, adjustable diaphragm and click stops to *f*/22, latter lens designated for color-separation work as well as black and white. Baseboard 13 by 13 inches, takes printing paper up to 8 x 10 inches. Carryall case has three extra compartments, one with hinged cover and cloth lining, providing storage space for additional equipment.

FEDCO BANTAM SPOTLITE ($7.95 less lamp; lamp, 85¢): Miniature type spotlight using 100-watt T8 projector bulb, 115-v. Beam range adjustable from small spot to full flood. Small, compact, lightweight. Made of die-cast aluminum. Completely ventilated. Adjustable handles and knobs of non-heat conducting plastic. Micrometer type focusing. New type 3-inch Fresnel heat-resisting lens. Short focal length of lens permits wide variation of beam width. Op-

erates on 3200 degree Kelvin, making it adaptable to color shots as well as black and white. Chrome-plated, non-tarnishing focusing reflector. Has built-in standard tripod socket. American made.

HAYNES SALON MICRO-MATTE: Enlarging paper with same silver-loaded emulsion as Haynes Salon, but with the coating placed directly on a fine-grain paper base. Designed especially for portraiture and precise rendering of delicate detail.

CHROMO - UNISOL DEVELOPER TONERS ($1.75): Develops and tones prints in one operation. Prints are dried in usual manner, either on ferrotype plates or drum dryer. Choice of sepia, blue, green, and magenta.

PRINCETON PRECISION GLASS FILTERS (85 cents to $1.50): Made from dyed-in-the-mass glass. Said to be "absolutely flat, meaning that there are no bumps or hollows in the surface, not even to 1/1000th part of an inch." Available in following colors: Yellow 1, 2, and 3; Red 1 and 2; Green 1 and 2; Ultra-violet, Orange, and Infra-Red. Sizes 19 to 42mm.

GEM PORSO-GLAZE (25 cents): In white or black. For waterproofing and coating. Used as surface preservative on darkroom trays and tanks and other darkroom items that are prone to rust, chipping, and cracking.

DU PONT SUPERIOR 1, 2, 3: Three new Du-Pont 35mm films. Superior 1 intended for outdoor use. Extremely fine grain; long scale; specially color-sensitized for exposure by daylight. Areas of sky register as printable densities without use of filter. Speed about same as Superior Pan formerly supplied for miniature cameras. Superior 2: twice as fast as Superior 1. For use outdoors in cameras having slower lenses, regardless of weather conditions, and indoors for scenes and portraits with controlled lighting. Color response corrected for incandescent light source. Grain size finer than old type Superior Pan. Superior 3: high-speed film intended primarily for interior use where lighting is not controlled. Color sensitivity takes advantage of tungsten illumination. Grain size about same as former Superior Pan. Forced development increases effective speed of film, making exposures possible at Mazda rating of 100 Weston.

POCKET-PACK BULB KIT: Holds six G. E. Synchropress No. 5 Midget Photoflash bulbs. Made of heavy cardboard about size of ordinary tobacco tin. Bulbs held apart in perforated cardboard belt which slides into heavier protective cardboard sleeve.

SOLAR SLIDING LENS BOARD ($4.75): Mounts three lenses of different focal lengths permitting instant placement of any lens into optical center of enlarger. Sliding unit measures 9¼ by 2¾ inches with ⅝-inch lens clearance at back. Mounts directly to lens board receptacle of enlarger. Will take lenses from 3 to 7¼ inch focal length. Fits all Solar enlargers except Junior Model.

CAMERA ANGLES ROUND TABLE

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

Q. A certain studio turns out portraits with a bronze tone, which gives the subjects in the portrait a very pretty flesh tone and is subsequently easier to color. Will you please tell me if this tone is achieved by toning? If so, will you please give me a formula and also the type of paper most suitable for this kind of work.—G. G.

A. The photographer in question undoubtedly uses a gold toner. Agfa Flemish Gold Toner is a prepared product that appears to be generally liked. A good formula is the Nelson Gold Toning Bath (Kodak T-21). A variety of tones may be achieved with these toners and you will have to do some experimenting to obtain exactly the bronze tone you refer to. Chloride or chlorobromide papers, preferably white, may be used.

Q. Some months ago I bought a miniature camera with a fast lens. The other day I discovered two small marks about the size of a pin point; they appear to be pits on the front lens. Can you tell me what effect this will have on negatives made by this camera? I have noticed no defects on the ones I have made. I photographed a sheet of newspaper and there was no diffusion in any part of the print. Is such a test of any value?—G. E. A.

A. The only test of lens performance that is at all useful to the photographic worker is the negative made with it. Therefore, if your negatives look satisfactory, the pits you speak of apparently have no effect and you may continue to use this lens in full confidence. The newspaper test is a very good one because, containing sharp details over the entire surface as it does, defects are easily noticeable. To satisfy yourself completely, we would suggest that you make good sized enlargements from these newspaper negatives and study the resulting prints.

Q. Recently I cemented in Canada balsam a tricolor gelatin filter set in 40mm glass circles. The red filter is almost perfect, the green filter is very slightly hazy, and the blue filter turned out to be useless as the diffusion increased to a point where it gives a double image. I have made two sets of these filters with the same gelatin, balsam, and glass and the order of diffusion is remarkably identical. What do you think could be my trouble?—R. M.

A. The difficulty may lie in one or more of the following factors: the quality of the glass may not be good (it should be plate glass of selected quality); the balsam may not be of a good grade; the cementing or the binding of the gelatin between the glasses may not have been properly done; the bound filter may not have been allowed to dry long enough (it may sometimes take as long as 10 days). If you will check over these various possibilities, you will probably find the answer to your trouble.

Q. My camera uses 127 film and I have a developing tank for it which uses eight ounces of solution at a time. 1. Do you know of any developer in concentrated form on the market which is prepared for only eight ounces for tank use? If not, do you know any formula for a developer suitable for tank use, which could easily be prepared for only eight ounces at a time? 2. Approximately how many rolls of 127 films will a quart of acid hypo fix, using D-76 developer and leaving films 15 minutes in hypo? 3. Does the exposure or the developing determine the contrast for the resulting prints? In other words, will each exposure on a roll have a different contrast or will they all have the same contrast?—B. Y.

A. 1. The smallest volume in which concentrated developer solution is available for fine grain work such as you require is 16 ounces. Panthermic 777 is available in eight ounces but only in dry form. Any developer formula can be scaled down for an eight-ounce solution. It is simply a matter of dividing the larger volume stated in the formula. 2. We do not have the exact figures, but the general attitude of workers is that, since hypo is so very cheap, why not use it liberally to insure proper fixation? On this basis we would say that up to five or six rolls for each eight-ounce volume should be the maximum. 3. Exposure determines the gradation of tone, development time determines the contrast; the longer the development time the greater the contrast, the shorter the period the weaker the contrast. The degree of contrast will be the same throughout the roll.

OUR BOOK CORNER

THE Book Department of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

THE SCIENCE OF PSYCHOLOGY

By Raymond H. Wheeler, University of Kansas

PSYCHOLOGY being a word popularly having wide connotation, readers may wish to study the more limited but more substantial part of this total connotation which is recognized as psychology in university courses. A readable work, whether regarded as a textbook or otherwise. (436 pages, 5½ by 8½ inches, 78 illustrations.) — $2.85 postpaid. — *A. G. I.*

FEARSOME CRITTERS

By Henry H. Tryon

"AMERICA," says the author's preface, "has grown so rapidly that much true folk-lore was born, lived, and died with no chance of ever becoming a part of our permanent records." But what visitor to our backwoods, what hunter or angler visiting our hinterlands hasn't heard of "The Side-Hill Gouger," "The Hodag," "The Filla-ma-loo Bird," "The Axe-Handle Hound," and many, many others while resting weary limbs beside the evening fire? Here they are, the legends of America, mostly fabricated by husky hewers of pine forests from shrouds of early morning river mists, back in the days when America was young. A thoroughly delightful compilation of the myths of our woods, fields, and streams. (68 pages, 6 by 9 inches, 31 line drawings.)—$2.10 postpaid.

—*A. D. R., IV.*

EXCURSIONS IN SCIENCE

Edited by Neil B. Reynolds and Ellis L. Manning

TALKS — 36 of them — given on the General Electric Science Forum radio program by different scientists and engineers, ranging from astronomy to physiology and atomic physics to archeology, are set forth in this book in relatively simple language; entertaining and readable. (307 pages, 5½ by 8 inches, unillustrated.) — $2.60 postpaid. — *A. G. I.*

CHEMICAL SPECTROSCOPY

By Wallace R. Brode, Professor of Chemistry, Ohio State University.

READERS of this magazine who have been disappointed by the dearth of good general treatises on chemical spectroscopy should find their want fulfilled by this new work. Compact with information are its chapters on atomic and molecular spectra; emission spectra and apparatus; qualitative analysis; spectrum tables and standard samples; quantitative analysis; resonance and chemical structure; absorption spectra, apparatus and methods; infra-red and Raman spectra; theory and description of color; laboratory experiments; theory and practice of (related) photography; equipment and arrangement of a spectographic laboratory; bibliography and references. The last 120 pages are filled with tables: persistent lines by wavelengths and elements; principal lines by wavelengths and elements (70 pages); spark spectrum of air; principal lines by elements (discharge spectra); Fraunhofer lines in the Sun's spectrum; conversion tables; iron spectrum charts with line positions of other elements. In this book, emphasis is on the practical rather than on theory. It has received flattering reviews in professional journals. (494 pages, 6 by 9 inches, numerous illustrations).—$6.10 postpaid.—*A. G. I.*

AEROSPHERE

Edited by Glenn D. Angle

THIS book presents an up-to-date statement of the main characteristics of the world's aircraft engines, indexed according to nationality. The main characteristics and specifications of almost all well-known engines are presented, with suitable illustrations of each engine. Similar summarized information is presented for airplanes, although in less detailed form. An important section gives records, directories of schools, various governmental bodies, flying statistics, and so on. The last section of the book includes an aircraft directory listing manufacturers of planes, engines, and accessories. The whole constitutes an excellent work of reference with obvious utility for all those having contact with the aircraft industry or wishing to keep up-to-date regarding this industry. (1420 pages.) —$16.00 postpaid.—*A. K.*

PHOTOGRAPHING IN COLOR

By Paul Outerbridge, Jr.

AN acknowledged master of color technique has written a thoroughly practical guide for perplexed color photographers, both rank beginners and those more

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

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

advanced. To the amateur photographer, Mr. Outerbridge is known chiefly through exhibitions of his color work in photographic salons, where his prints always excite the greatest admiration. This book contains the fruits of many years of practical work in the field of color photography, his personal selection of medium being Carbro, and is written in a style that is easy to read, using language that is clearly understandable. One of the most attractive features of the book is the inclusion of 16 full-page, four-color reproductions of his work. The text, which is divided into two parts, discusses the relationship of color to photography, cameras and camera equipment, lighting and exposure, composition and picture material, and the use of color transparencies. The second part of the book is concerned with the laboratory set-up for color work and making separation negatives and full color prints by various processes. (204 pages, 8½ by 12 inches, 16 full color illustrations.)—$4.95 postpaid.—*J. D.*

THE CHEMIST AT WORK

By Roy I. Grady, John W. Chittus, Professors of Chemistry at the College of Wooster, and many others

YOUTHS who think they would like to become chemists wonder just what it would be like to be one—what kind of daily life they would lead. There are many specializing varieties of chemists and in this book about 50 varieties have contributed chapters telling what their work really is like. For example, plant chemists, nutrition chemists, soil chemists, government chemists, chemistry teachers, lubrication chemists, woman chemists, and so on and on in wide variety. A high-school youth, after reading this book, would pretty surely know the answer and not just guess vaguely, perhaps mainly emotionally, at it. Non-technical, of course. (455 pages, 5 by 8 inches, illustrated.)—$3.10 postpaid.—*A. G. I.*

CAMERA, TAKE THE STAND

By Asa S. Herzog and A. J. Ezickson

EXCITING as a detective story, yet factual in content, is this comprehensive running story of the uses to which photography is put by law enforcement officers. In finger-print work, in recording details of the scene of the crime, in identifying firearms and bullets, and in many other ways, photography aids in the work of criminologists. The authors have based their text on actual cases and have used a large number of illustrations taken directly from evidence files. They discuss the means as well as the end product; how the photographic work is done and how the resulting pictures are used. (194 pages, 6¼ by 9¼, a large number of photographs and drawings.)—$3.10 postpaid.—*A. P. P.*

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE

SIXTH edition of a volume that has become famous in the field of arc welding. There seems to be nothing in that field not covered in detail in this volume of 1117 pages, either in discussions or diagrams, and often both. (6 by 9 inches, several thousand illustrations, limp leatheret.)—$1.50 in U. S. A., $2.00 elsewhere, postpaid. —*F. D. M.*

and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department, which welcomes correspondence from readers.*

Gun Collector's Philosophy

SOME men are, by avocation, carpenters, fly-tyers, mechanics, horticulturists, while others delegate such specialized tasks to professionals and invest their leisure in various pursuits. It's all a matter of personal preference, and so it is in gun collecting. The collector, or his agent, may acquire magnificent specimens through contact with legitimate, trustworthy, antique dealers, through museums, or by attending auctions. For these he may pay large or small sums, and more often than not the arms which find honored places in his gun room have been cleaned, reconditioned, and prepared for display.

Not so with Major Lenox R. Lohr, President of National Broadcasting Company. His gun collecting philosophy begins with

Major Lohr . . . and guns

the personal discovery of a specimen, tucked away in some dark cranny of a junk yard, an attic, an old barn, or other casual source, and ends with the investment of a prodigious amount of elbow grease expended in cleaning, refurbishing, and repairing the firearm in an effort to restore it to as near its original status as possible. Somewhere in between these extremes there has occurred a bit of keen, good-natured bargaining which ended in payment of from one to four dollars for the desired specimen, for, says Major Lohr, "Contrary to popular belief, you don't need a wallet-full of money to begin a firearms collection." As proof of the Major's contention, every rifle, revolver, pistol, and shotgun in his collection is in working order, is capable of firing the load originally designed for it, and his largest investment in any single piece has been $4.

Major Lohr's collection of U. S. military rifles, thoroughly reconditioned in his own workshop, has provided him with many hours of pleasant relaxation, knowledge of the details of varied constructions, and the satisfaction of having proved that anyone can pursue the hobby of gun collecting for an insignificant expenditure. In fact, the Major points out, an old gun, purchased for a dollar or two, thoroughly cleaned and repaired, pays dividends on the investment by being of greater value to someone and by increasing the collector's knowledge of the history and mechanics of firearms through the research, study, and effort expended in restoring it. Many an American lad, he says, has earned spending money through harder labor than is involved by subscribing to his philosophy of gun collecting.

Outstanding among the Major's firearms is a group of American military rifles which depict the evolution of the breech loader. Included are: a Springfield muzzle loader of 1837, converted from a flintlock; an 1840 North gun with rising breech for separate loading of powder and ball; a Burnside rifle for separate ball and powder, with percussion cap and tapered breech seal; a Starr rifle of 1858, built for paper cartridge, the end of which had to be bitten off to expose powder to percussion cap; an 1859 Sharp's rifle, with percussion cap equipped with clipper to cut the end of the paper cartridge; an 1861 Ballard rifle, for rim fire fixed cartridges; a Spencer breech loading repeater of 1865.

Are Fish Color-Blind?

IT'S an old but ever new discussion as to whether fish are color blind, yet Dr. Frank A. Brown, Jr., assistant professor of zoology at Northwestern University, recently conducted a series of experiments which would appear to have settled this antique argument. It seems the good Doctor caught some bass in an Illinois lake, put them in large, white enameled basins, and proceeded to feed them with pipettes, or common medicine droppers, which had been covered with adhesive tape tinted in various colors. The joke was on the fish, however, for from one pipette only did they obtain food. All others were electrically wired so that the bass received a mild shock as he nosed into it.

But now came the convincing part of the demonstration. Different fish were trained to obtain food from different colored pipettes. When the bass had completed their "training period," the experiment began. A deliberate attempt was made to confuse the "trained" bass by offering them pipettes in new and unfamiliar colors, and various tints and shades of the colors to which they had become accustomed, but it didn't work. Dr. Brown's bass were unerringly able to select the pipette from which they had been taught to expect food, even to picking out the "soup's-on" pipette from a confusing series of grays. Red, it seems, is the most

distinct color a bass sees, followed by green. yellow, black, blue, with black and blue appearing more nearly similar than any other colors. Despite the results of Dr. Brown's experiments, there will be many anglers who insist fish cannot distinguish colors and that the use of multi-colored lures is merely an attempt to beguile the fisherman, not fish. What do you think?

Duck Stamps for 1940

THE 1940 "Duck Stamp," which must be purchased for $1 by all migratory waterfowl hunters over 16 years of age, will be available to the public at all 1st and 2nd class post offices July 1. This year's design, by Francis L. Jaques, shows a brace of black ducks flying down wind over a marsh area, with wild rice in the background. The Bureau of Biological Survey receives 90 percent of the money from Duck Stamp sales to supplement other funds for purchase and maintenance of waterfowl refuges, and the remaining 10 percent is used for printing and distributing stamps, administrative purposes of the Migratory Bird Hunting Stamp Act, and for other Federal activities relative to migratory bird conservation.

Technology in Rod Making

LAST month we delved briefly into rod making, mentioning some of the early artisans who were pioneers in the six-strip construction so largely in vogue today. With 12 million American anglers wetting lines in streams, lakes, and oceans, however, some of the former handwork on rods must now be done by machinery in order to meet the tremendous demand. By no means should this be construed to indicate that the niceties of skilled workmanship have been lost through technological advances.

To the contrary, at the South Bend Bait Company factory, for example, specially designed machines, so true in operation that variations of .001 of an inch are unknown, convert the split sections of bamboo into perfect triangles. By a gradual taper from one end to the other, which later governs the action of the finished rod, it is possible to produce segments which not only are minutely uniform, but which pass micrometric inspection. Some conception of the exactitude of this machinery may be gained by realization that in some rods 12 pieces of cane are used instead of six, thereby producing a rod within a rod. Likewise, the South Bend Bait Company constructs what is known as a "Triplebuilt" rod from 18 laminated segments of cane, and even goes further to produce their Cross "Bow Stave" big game fishing rod, shaped from more than 40 flat strips of outside bamboo enamel, laminated and glued under pressure.

But the important point to remember is that these sections, or "sticks" as they are known to the tackle trade, must remain in seasoning vaults at least 1½ to 2 years before they are finally fashioned into a rod. Only after this seasoning period can such hand operations as straightening, cleaning, balancing be done. Each section must be finished to pre-determined calibrations, checked every 2½ inches on the circumference of the rod. Is it any easier now to understand why a fine rod cannot be turned out in a day?

Pot-Shots
AT THINGS NEW

FOX, SAVAGE, AND STEVENS 1940 catalogs are off the press and each presents an array of guns to delight the hand and eye of the most critical and fastidious gunner. They're all there, from the ever-reliable little Stevens .22 single-shot to the Fox FE Grade, double-barrel shotgun in all its breath-taking beauty and symmetry. To mention but a few innovations incorporated in the 1940 products, Fox Model B, made in 12, 16, and 20 gages last season, is also available this year in .410 bore, chambered

Savage . . . Fox . . . Stevens

for 3-inch shells in 26-inch barrels. This light-weight, popular priced, hammerless double met such enthusiastic acceptance when brought out last year that additional barrel lengths may now be had. The 16- and 20-gage guns come with 26- and 28-inch tubes, while the 12-gager may be obtained with 20-inch barrels.

In the Savage line, new rifle for 1940 is Model 602, similar in design to the "3-way" Model 6, except it is chambered for .22 shorts only. As an automatic, it will handle .22 short regular or hi-speed cartridges with lubricated bullets; as bolt action repeater or as single shot, it takes any .22 short cartridges. The 99-H Carbine, with 22-inch barrel, is now chambered for the .300 Savage cartridge, as well as for the .250-3000, .30-30 and .303, but with 20-inch barrel for last three. Model 99-RS is now regularly equipped with Redfield No. 70 adjustable rear peep sight, folding leaf middle and gold bead front sight, has ⅞-inch combination adjustable leather sling and carrying strap with quick release swivels. Model 40 Super-Sporter has checkered, capped, full pistol grip, checkered fore-end. Models 23-AA, 23-B, C, and D come equipped with ⅞-inch sling loops, are likewise checkered on grip and fore-end. In automatic shotguns, Models 720-P, 726-P, and 740-P have as standard equipment new Aero-Dyne Super Poly Choke built integral with barrel and Bev-L-Blok front sight.

Model 762 is Stevens' new 1940 offering. Comparable in design to popular Model 76, which handles .22 L.R. cartridge, the new gun is also automatic, but is chambered for .22 shorts. The No. 620 repeating scattergun in 12, 16, and 20 gages has been redesigned to eliminate upper tang from frame and to provide streamlined frame and stock, which now has full capped, checkered pistol grip. Same gun, but known as 620-P, comes with new Aero-Dyne Super Poly Choke built integral with barrel. Stevens .22 caliber repeaters and automatics are drilled and tapped for Weaver 'scope sights, eliminating factory fitting process. Public reaction to use of the plastic, Tenite, on Model 530-M shotgun for stock and fore-end has been so satisfactory that No. 22-410, over-and-

under combination rifle and shotgun will be similarly equipped later this year. We discussed use of Tenite in December, 1939, issue (Vol. 161, No. 6) and have severely tested our own Tenite-stocked Model 530-M. It not only "shoots sweet," but also can "stand the gaff." The Fox-Savage-Stevens parade of guns is on, and catalogs are available. Which will you have?

AMERICAN OPTICAL COMPANY offers relief to fishermen from dazzling sun by filtering out reflected glare rays through their new AO Polaroid Day Glasses, which help to locate fish before they locate you. With better vision and ability to see the big ones strike, it's easier to set the hook. Skeet shooters, too, should find AO Polaroid glasses of great benefit.

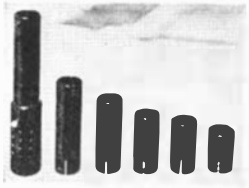
FROM INQUIRIES we've had, there must have been something very alluring about Smith & Wesson's new .22 cal. target re-

volver, "Model K-22 Masterpiece." Here's a picture which will prove it has "oomph"; we still have a few K-22 folders.

MOHAWK PRODUCTS COMPANY has borrowed a leaf from Galileo and developed a telescopic peep sight as an improvement over standard peep disks on receiver and tang sights. Combining two precision ground plano-convex lenses, one of flint, the other of crown glass, Mohawk has achieved a telescopic effect with a field which is bright and free from the blur often found to some degree in peep disk use. Total length of Peep 'Scope at normal focus is just under one inch; thread diameter of shank is 7/32 with 40 thread, or .218-40, which fits all standard peep disk holes except Marble, but which does fit the Marble-Goss. Diameter of object lens is 8mm and that of ocular lens is 4mm. Width of field varies according to distance which 'scope is mounted from eye. Based on a 100-yard range, with 'scope four inches from eye, field is about 12 feet, increasing until, with 'scope two inches from eye, field is about 25 feet. C. B. Mitchell, of Mohawk Products, tells us that every lens is rigidly tested and that with normal eyes, or fairly well corrected eyes, and with 'scope set at full magnification on distant object, newsprint can be easily read at 24 inches with same focus. "This," he says, "means the front sight shows up very clearly, while distant objects are twice as plain as with the unaided eye."

W. R. WEAVER COMPANY, makers of 'scope sights for target and hunting rifles, as well as that Weaver IX shotgun 'scope of benefit to so many scattergun shooters, announces their new Weaver-Choke, developed to (1) eliminate "blown" patterns; (2) reduce recoil; (3) adapt one gun to 20 to 70 yard shooting. Choke has series of baffles in bore to catch and divert through numerous vents gases which are released before shot leaves gun muzzle, thereby reducing pressure on shot column and minimizing muzzle blast. This, in turn, cuts down disturbance to shot, which, directed by the choke, continues forward, resulting in even and uniform patterns. Reduction of recoil is also accomplished through baffle rings and gas vents. High velocity powder gases strike baffles, giving forward thrust, which reduces recoil.

Weaver-Choke is made of strong aluminum alloy, weighs no more than section of barrel removed, won't change handling or balance of gun, is finished with special process which gives bore a diamond-like



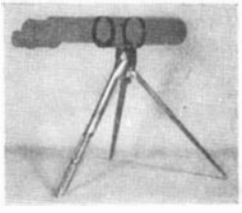
A group of Weaver-Chokes. Tallest one is full choke in baffle tube

hardness and perfect surface for passage of shot. The six chokes, which may be changed in a few seconds, were designed as to length, shape, taper, constriction after exhaustive tests for following individual purposes:

Extra Full Choke—extremely close patterns averaging 85 percent for long range shooting, even to ducks at 70 yards, if shooter does his part. Full Choke—shoots about 75 percent, or same as standard, full-choke gun. For ducks to 60 yards, long shots at doves, desert quail to 50 yards. ¾ Choke—small game at 40 to possible 45 yards. For ducks from blind, western quail, Bobwhite, rabbits. ½ Choke—fairly wide shot spread; dependable small game killing to 35 yards. Bobwhite, rabbits, doves, and all shooting where range is not extreme. ¼ Choke—wide pattern for wooded, brushy country where shooting is fast, close, and range not over 30 yards. Skeet or scatter—designed expressly for skeet with wide, even pattern and full coverage on 30-inch circle at 20 yards. For single ball or slug loads.

Weaver-Choke is now ready in 12 gage; available in other gages in July; is adaptable to all autoloading, pump, and single barrel shotguns, either plain or ribbed; can be attached by any good gunsmith or at Weaver factory.

SCOPE POINTER COMPANY offers new 1½-pound aluminum alloy folding tripod, with machine parts of steel and brass, guaranteed to support 75 pounds. Scope remains attached to cradle, which is fastened to tripod by large, single thumbscrew; may be instantly set to any angle of offset; is controlled rapidly, accurately at ground level



Scope pointer tripod, showing the cradle that holds the scope, and rear leg with controls

by two revolving drums, integral with rear leg of tripod. Rotation of upper drum directs horizontal adjustment, while lower drum swings scope vertically. Legs are adjustable to any angle, have 12-inch spread at ground level, allow more elbow room in prone position. Compactness when folded, centralization of controls, adaptability to any type optical equipment are additional appeals.

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., L.L.B., Sc.D.
New York Bar
Editor, Scientific American

AFFIRMATION

THE decision establishing a radically new principle for computing profits in suits for copyright infringement discussed on this page under the heading of "Apportionment" in the January, 1940, issue of Scientific American has been affirmed by the United States Supreme Court. In affirming the decision the Supreme Court held that in computing an award of profits against an infringer of a copyright there may be an apportionment so as to give to the owner of the copyright only that part of the profits found to be attributable to the use of the copyrighted material.

The copyright statute provides that an infringer of a copyright shall be liable to pay to the copyright proprietor such damages as the copyright proprietor may have suffered or "all the profits which the infringer shall have made from such infringement." Prior to the present decision the courts have generally construed this provision of the law as entitling the copyright proprietor to recover from the infringer all of the profits resulting from the sale or production of an infringing work even though some of the profits might properly be attributable to factors other than copyright infringement.

In the present case the Court found that a motion picture produced by the defendant infringed a copyrighted play owned by the plaintiff. The total profits realized by the infringer were found to be a little more than half a million dollars. The infringer introduced the testimony of experts showing that the plot and story contributed in but a small measure to the production and success of the motion picture The experts testified that the main factors in producing the large profits were the popular actors, the artistic scenery, and the expert producers and directors. This testimony was apparently not rebutted by the copyright proprietor and accordingly was accepted by the Court as indicating the approximate contributions made to the success of the moving picture by the copyrighted material on the one hand and by the infringer on the other hand. As a result the Court awarded only 25 percent of the total profits realized by the infringer to the copyright proprietor.

In reaching its decision the Supreme Court pointed out that it had been the custom for many years in patent infringement suits to apportion the profits in accordance with the approximate proportions resulting from the infringement and from extraneous contributions made by the infringer. The court concluded that there was no reason why the same principle should not also be applied to suits for infringement of a copyright.

The section of the copyright law providing that the infringer shall be liable to pay "all the profits which the infringer shall have made from such infringement" was held to mean that only the profits resulting from the use of the infringing material shall be paid to the proprietor and that profits resulting from extraneous matters were not payable to the copyright proprietor. The Court held that "when such an apportionment has been fairly made, the copyright proprietor receives all the profits which have been gained through the use of the infringing material and that is all that the statute authorizes and equity sanctions."

FTC INJUNCTION

THE Federal Trade Commission for many years has had power to restrain unfair methods of competition in commerce. More recently, the Commission has been given power to restrain unfair or deceptive acts or practices in commerce. In the usual proceedings the Commission issues a complaint against a party who is charged with using unfair methods of competition or unfair or deceptive acts or practices. If, after testimony has been taken, the Commission finds that the party is guilty, it issues an order requiring him to cease and desist the unfair or deceptive acts or practices.

Naturally, considerable time must elapse between the serving of the complaint and issuance of the order to cease and desist because the party complained of must be given an opportunity to file an answer, testimony must be taken, and due consideration must be given to the testimony. In the meantime the party may continue the practices complained of. In certain instances the continuance of the act complained of prior to the issuance of the order will be extremely detrimental to the public interest and under an amendment to the Federal Trade Commission Act the Commission has been given power to apply to a Federal Court for an injunction to restrain the wrongful act.

The ammendment to the law provides that where it appears that it would be in the interest of the public, the Commission, pending the issuance of a Complaint, may apply to a district court of the United States to enjoin the dissemination of any false advertisement and that upon a proper showing a temporary injunction shall be granted without a bond. This is an extraordinary remedy since the party is restrained from committing the acts complained of prior to an adjudication of the issues by the Federal Trade Commission. Naturally it is only resorted to under unusual circumstances where the public interest is involved.

An example of a proceeding under this section of the law is found in a recent case in which an injunction was granted to restrain false advertising in the sale of cosmetics through a puzzle promotional scheme. It was charged by the Commission that a company selling cosmetics initiated its sales by means of a puzzle contest for which a prize of $50 would be paid for a successful solution. When a contestant sent in a solution it was alleged by the commission that he was notified that his entry had passed a preliminary check-up and was before the final judges. If a payment of $3 was submitted by the contestant he was advised that he would receive five dollars worth of cosmetics and if a so-called "promptness prize blank" was returned within a designated time there would be a chance to win a cash prize in the amount of $1250 and an automobile.

The Commission charged that the entire plan was devised for the purpose of selling cosmetics which were of inferior quality for which the purchaser would have no use and which could not be resold without loss. The Commission also charged that the defendant corporation was a reincarnation of a former corporation which promoted the identical sort of sales scheme and which had dissolved in a short time to be succeeded by another corporation, all for the purpose of avoiding the provisions of the federal laws and evading the Federal Trade Commission. Under the circumstances the Commission argued that to protect the public interest it was necessary to enjoin the company at once, prior to the issuance of a complaint. The Court sustained the contention of the Commission and restrained the company from circulating the advertising relating to the sale of cosmetics through a puzzle promotional scheme.

EMANCIPATION

A SUIT charging unfair competition was brought by the author of an outstanding play dealing with the life of Abraham Lincoln against the producer of a moving-picture drama also based on the life of Abraham Lincoln.

The suit in question was unusual in that it did not charge plagiarism or copyright infringement but was based solely on the theory that the author had dispelled the public apathy with regard to the life of Abraham Lincoln and had caused a recrudescense of lively interest in his life and under the circumstances the moving-picture producer should not profit by this renewal of public interest, especially since the producer had previously expressed the belief that the American public had lost interest in Lincoln.

The Court pointed out that historical facts such as the facts dealing with the life of Lincoln were in the public domain and were available to anyone. Since anyone had the right to use and refer to these facts the Court concluded that the production of a motion-picture play based upon the story of Abraham Lincoln's life did not constitute unfair competition.

In reaching its decision the court made the following statement:

"Countless decisions defining unfair competition preclude any favorable consideration for plaintiff's claim. Since the source of their material belongs to public domain, no exclusive right to the use thereof can be acquired even though they were the first to discover its value as a medium to awaken public interest."

SCIENTIFIC AMERICAN ADVERTISERS
July · 1940

Advertising Manager
A. P. PECK
New York City

Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.
BLANCHARD-NICHOLS
Los Angeles and San Francisco

Eastern Advertising Representatives
JOHN P. CANDIA
HERBERT E. HAYDEN
24 West 40th Street,
New York, New York

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D. MUNN, President I. SHELDON TILNEY, Vice Pres. JOHN P. DAVIS, Sec.-Treas.

EDITORIAL STAFF . ORSON D. MUNN, EDITOR

ALBERT G. INGALLS
F. D. McHUGH
PROFESSOR HENRY NORRIS RUSSELL
A. P. PECK
A. M. TILNEY
PROFESSOR ALEXANDER KLEMIN

CONTRIBUTING EDITORS

A. E. BUCHANAN, Jr., Director of Research, Remington Arms Company.

L. WARRINGTON CHUBB, Director of Research Laboratories, Westinghouse Electric and Manufacturing Company.

JACOB DESCHIN, A. R. P. S., Amateur Photography.

CHURCHILL EISENHART, Department of Mathematics, University of Wisconsin. Statistician, Wisconsin Agricultural Station.

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

WILLIAM E. GREGORY, Professor of Vertebrate Paleontology, Columbia University.

LEON A. HAUSMAN, Professor of Zoology, New Jersey College for Women.

WALDEMAR KAEMPFFERT, *New York Times.*

D. H. KILLEFFER, Chemical Engineer.

IRVING LANGMUIR, Associate Director, Research Laboratory of the General Electric Company, Schenectady.

M. LUCKIESH, Director, Lighting Research Laboratory, Incandescent Lamp Dept. of General Electric Company, Nela Park, Cleveland.

D. T. MacDOUGAL, Associate in Plant Biology, Carnegie Institute of Washington.

ROY W. MINER, American Museum of Natural History.

RUSSELL W. PORTER, Associate in Optics and Instrument Design, California Institute of Technology.

W. D. PULESTON, Captain, United States Navy.

A. D. RATHBONE, IV, Firearms.

J. B. RHINE, Associate Professor of Psychology, Duke University, Chairman, Research Committee, Boston Society for Psychic Research.

PHILIP H. SMITH, Industrial Research.

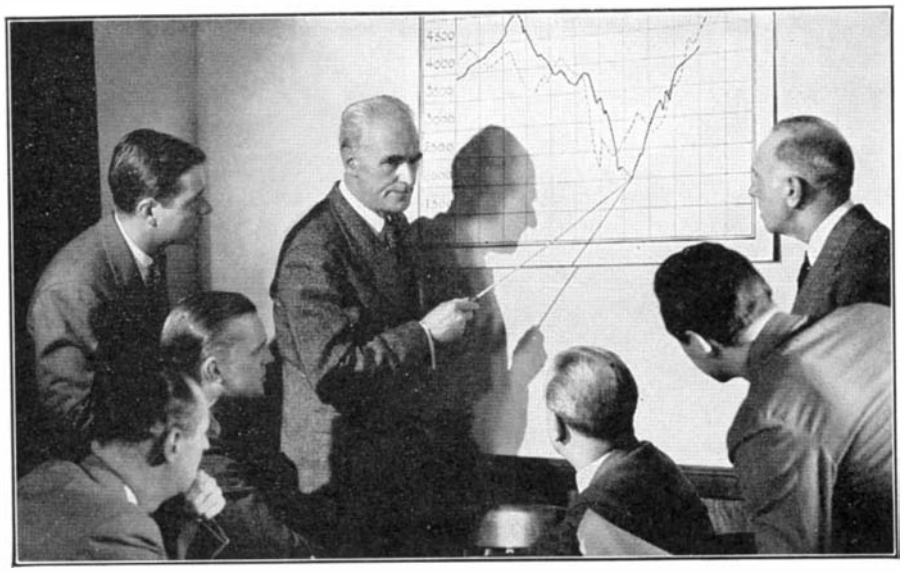
R. A. WILKINS, Vice President and Director of Research, Revere Copper and Brass, Inc.

R. W. WOOD, Professor of Experimental Physics, Johns Hopkins University.

VLADIMIR K. ZWORYKIN, Director, Electronics Research Laboratory, RCA Manufacturing Company, Victor Division.

Vol. 163, No. 1, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid.

Printed in the U. S. A. Press of the Wilson H. Lee Co., Orange, Conn.



Study Your Leaders —Know What They Know!

IF you merely admire and envy the executive ability of leaders in business, finance, and industry, you will never be endowed with their capacity, or be able to duplicate their success.

To succeed on your own account, you must gain what they have and you lack: *an understanding of the entire field of business.*

A leader in business has a thorough grasp of the principles which underlie all successful businesses. If you could sit unseen, at his conference table, during the planning of an advertising campaign, you would see that he is guided by a broad understanding of the laws of distribution, supply and demand, the psychology of selling. Advertising to him is not a daring gamble—it is a powerful, measurable force.

And if you could observe his daily conduct of financial operations, you would see his decisions based on an understanding of the principles of banking, finance, investment. His entire management is guided by a thorough knowledge of organization, costs and credit. His policies are constructed with clear understanding of commercial law. He knows business as a whole.

This knowledge has been collected, classified and presented for your use in the Modern Business Course and Service of the Alexander Hamilton Institute.

Big men founded the Institute and big business leaders are contributing to the course. Among the contributors are such executives as Alfred P. Sloan, Jr., *Chairman of the Board,* General Motors Corporation; Colby M. Chester, Jr., *Chairman of the Board,* General Foods Corporation; Thomas J. Watson, *President,* International Business Machines Corporation; Edward R. Stettinius, Jr., *Chairman of the Board,* United States Steel Corporation; Major B. Foster, *Chairman,* Department of Banking and Finance, New York University, and many others.

What is the verdict of business men as to the value of the Institute?

Chief Engineer of a Public Utility:

"The Course has brought me, not only concrete practical ideas that were directly applicable to my own work, but has given me a much wider knowledge of business in general than I could otherwise have secured. No man today has time or money enough to spend in learning basic principles *by experience.*"

Vice-President of a National Bank:

"There is no doubt that, after having conscientiously followed the Course from beginning to end, one would be thoroughly acquainted with most of the problems that are to be met in the ordinary course of business. I am glad to recommend the Alexander Hamilton Institute Course to anyone who is interested in equipping himself with that business information which will enable him to improve his position."

We could quote hundreds more. These men are leaders. They have not only taken the Course themselves, but have watched its influence on younger men. Their judgment of the Course *must* be right.

Send for "Forging Ahead in Business"

The coupon will bring you a copy of this famous book which has helped so many other men to shorten their route to success. If you are one of the few who are asking, "What am I going to be earning five years from now?" you will send for "Forging Ahead in Business."

To the
ALEXANDER HAMILTON INSTITUTE, Inc.
213 Astor Place, New York, N. Y.

Please mail me, free, a copy of "Forging Ahead in Business."

Modern Business

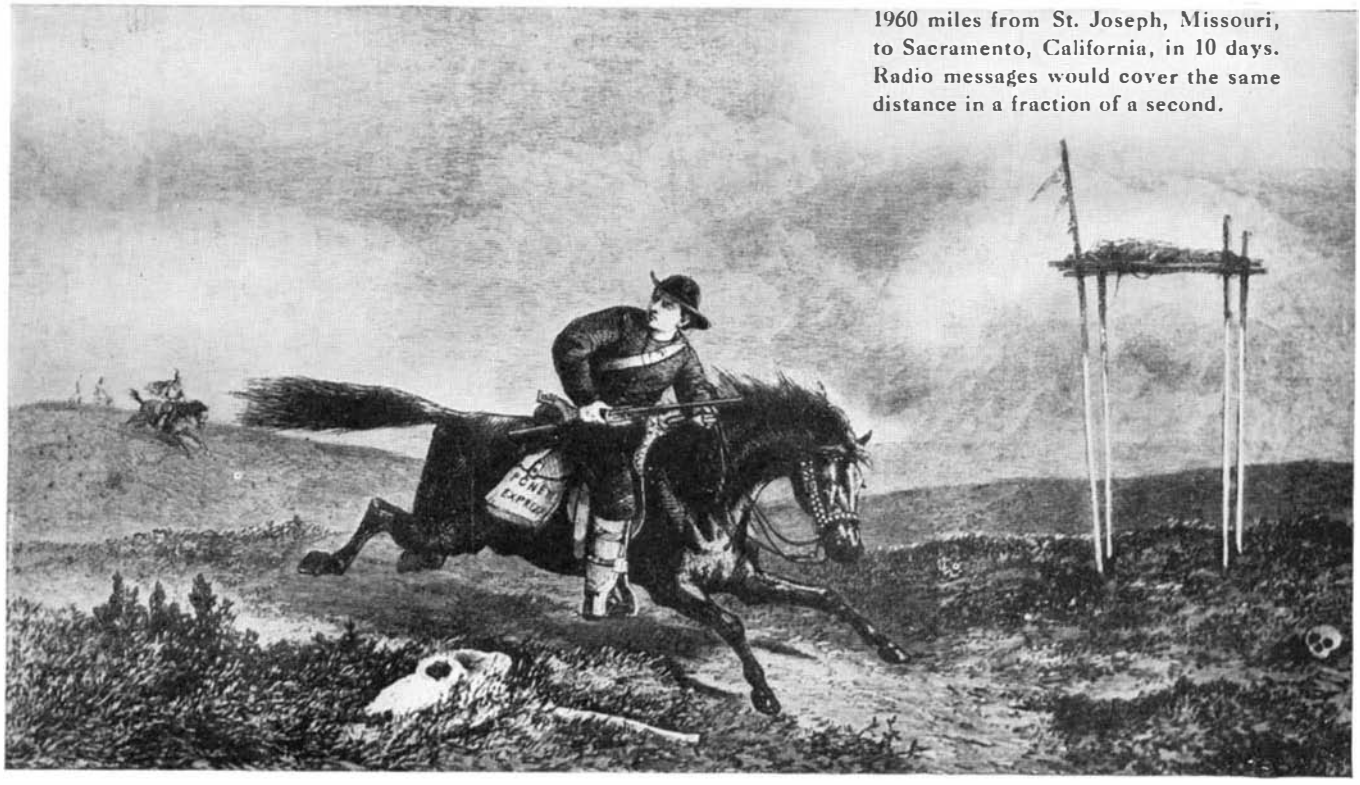
Name.....

Business Address.....

Position.....

Radio Would Have Made The Pony Express A Local!

Back in 1860 the wonder of the day was the picturesque Pony Express. Racing horses in relays, riders carried the mail 1960 miles from St. Joseph, Missouri, to Sacramento, California, in 10 days. Radio messages would cover the same distance in a fraction of a second.



What a difference the Services of RCA would have made in 1860... Communication is the life-line of civilization. Up to a hundred years ago, civilization spread slowly, because communication could travel no more swiftly than the gallop of a horse.

Henry Wells

In contrast, if the West were being opened up today, the Services of RCA would coordinate developments with instantaneous communication. Portable broadcasting equipment would go wherever pioneers went. Over nation-wide broadcasting networks a running history of progress and achievement would be heard by millions. R.C.A. Communications would keep two-way contact between our scattered outposts and forty-three foreign nations.

Young men, following the classic advice, would "go West" carrying RCA Victor Pick-Me-Up Portable Radios. And through the RCA Photophone, motion picture audiences in the East would hear as well as see the saga of the winning of the West. Lonely settlers would carry into the wilderness their favorite musical selections on Victor and Bluebird Records.

Yes...the Services of RCA in every field of radio and sound could have contributed immensely to building our country in 1860. But...the contribution they could have made is in no sense greater than the actual contributions they are making to our civilization today.

RCA Manufacturing Company, Inc.
National Broadcasting Company • RCA Laboratories
Radiomarine Corporation of America
R.C.A. Communications, Inc. • RCA Institutes, Inc.

RCA

RADIO CORPORATION OF AMERICA *RADIO CITY, N. Y.*