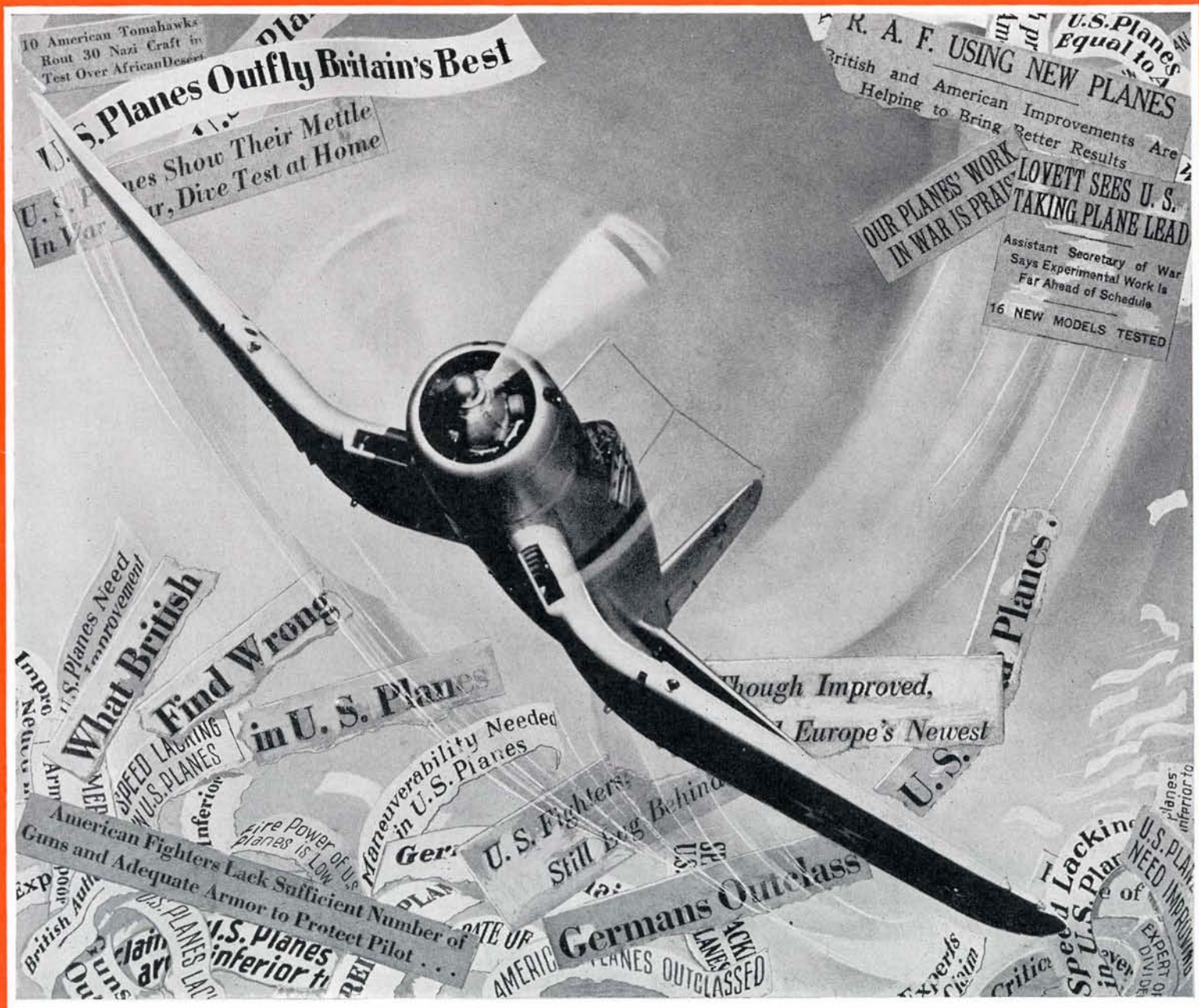
SCIENTIFIC AMERICAN

SEPTEMBER • 1941

35c. a Copy
50¢ in Canada



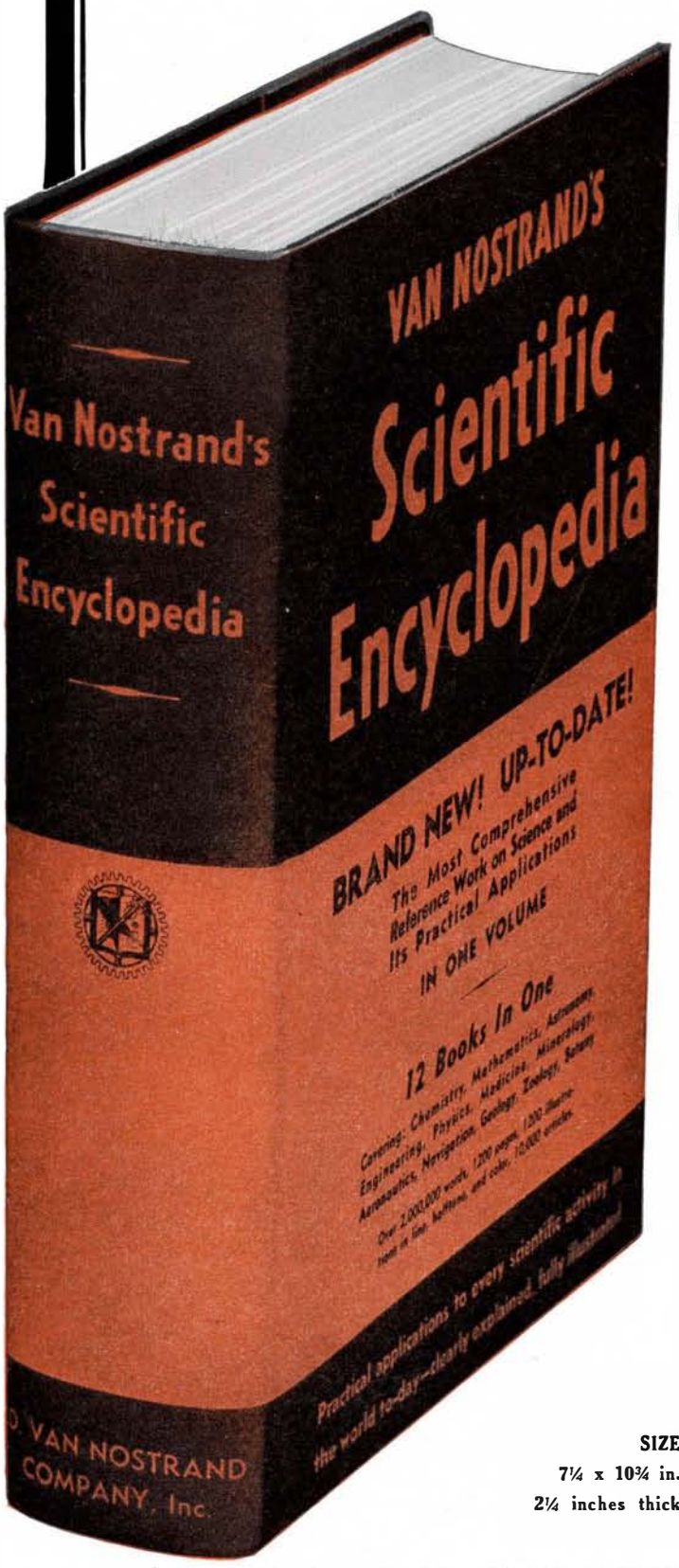
JUST HOW GOOD ARE

United States Warplanes?

All the Sciences

1500 Pages

1200 Illustrations



SIZE
7¼ x 10¾ in.
2¼ inches thick

THIS great new work presents—for the first time in one volume—a complete coverage of the terms of science and engineering. Principles are clearly explained—methods of calculation are fully described with the formulae and units—chemical structures and reactions, physical laws and instruments, engineering design, construction, and operation are merely suggestive of its tremendous scope — which extends throughout the entire range of technical knowledge up to the most recent advances and inventions. The great number of photographs, diagrams, and charts have been specially prepared and selected to show the salient facts most clearly. Innumerable tables and summaries make all this information easily available for instant reference.

This vast fund of information has been prepared and organized by a plan that insures its usefulness, completeness, and accuracy. Each entry is first explained in simple, broad terms that are easy to understand, and that serve as an illuminating introduction to the detailed and more advanced information which follows.

From Fundamentals to Latest Advanced Discoveries—

Principles, Methods, Formulas—Clear Charts, Diagrams

FOR the student, the hobbyist, the manual worker, this great volume supplies, for the first time, a single, convenient source of reference covering all the sciences. The ample cross-references make it easy to follow a complete course of study on any chosen subject. By this flexible plan of arrangement, the *professional* scientist, who wants specific information instantly, either in his own field or *any related field,* can find it in a few seconds in its alphabetical place—comprehensively treated in the language he works with—*the language of science.*

The Instant Question-Answerer for Laboratory and Shop Workers, Mechanics, Home Scientists, Students

Answers tens of thousands of questions such as: The value of radial, rotary gas engines—How the Diesel Engine operates—How air conditioning functions—What is the coming television system—How storage batteries work—How to find your position at sea—How to do dead reckoning—How your nervous system works—How to recognize every star, planet, constellation—How optical instruments are constructed—How to work arithmetic, algebra, geometry problems—How bridges are constructed—How an airplane beacon system works—How petroleum is cracked to make gasoline—How rayon is made—How to survey a piece of land—and thousands more.

CONTROVERSY regarding the over-all fighting ability of American-designed warplanes thrives on mis-information. The true facts of the situation, as revealed by careful study of various data, are given in the article starting on page 119. Our cover illustration this month shows a Vought-Sikorsky F4U-1 shipboard fighter; artwork by F. R. Paul.

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-SEVENTH YEAR • ORSON D. MUNN, Editor

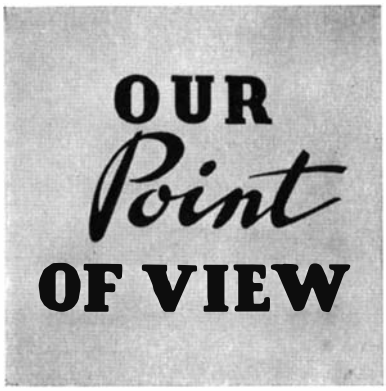
Editorial Staff

ALBERT G. INGALLS A. P. PECK A. M. TILNEY
JACOB DESCHIN A. D. RATHBONE, IV
PROFESSOR HENRY NORRIS RUSSELL PROFESSOR ALEXANDER KLEMIN

SEPTEMBER • 1941

SCIENTIFIC AMERICAN, September, 1941. Vol. 165, No. 3. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879; additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York City.

Subscription rate $4.00 per year. Canada and foreign $5.00.



MORE PILOTS — FASTER

EVERY airplane produced for the air forces of the United States requires a pilot; there can be no argument about this obvious truism. Yet, while every effort is being made to increase speed of plane production—some types are now coming off assembly lines at the rate of one every two and a half hours—pilots are still being trained by time-honored methods that take many months to produce a finished flier. True enough, an accomplished military pilot must have experience—and plenty of it—in flying the "hot" warplanes of today, yet there has been available for years a means of smoothing the road to acquisition of flying sense and ability and doing it by a method that is at once relatively rapid, inexpensive, and safe.

This means was aptly put forth by Commander E. F. McDonald, Jr., in the article "Pilots, Pilots, More Pilots," published in the July issue of Scientific American, which dealt with the definite advantages in pilot training that can accrue by the use of gliders for preliminary training. Gliding gives the beginning aviator a broad knowledge of air currents and their vagaries, a feel for flight, a confidence in his own ability to cope with emergencies without reliance on a power-plant to pull him through. The step from gliding to powered flight is far easier, far safer, than training that starts with a motor in the nose of the fuselage. And gliders are inexpensive, can be built rapidly, are easy to repair in the event of an accident. Thousands of them made available to the air forces of this nation would go a long way toward producing quickly the multitude of pilots that is necessary to our national defense.

It is gratifying to note that, since publication of the article mentioned above, public interest in glider training is on the upward climb; at the time of writing it appears that at last official recognition is being given to the advantages of the system and that, in time, it will become an integral part of our military training program.

In the meanwhile, Commander McDonald has not been satisfied with giving only lip service to the cause of gliding. Realizing that even this desirable method of training air pilots has a drawback in the shape of unreliable conditions of weather, he has designed and built a series of Wind Charger Wagons with which gliding fundamentals can be taught during periods of even flat calm. These devices, described and illustrated on page 160 of this issue, produce a controlled blast of air in which a tethered glider can take off from the ground, be put through its paces in a limited area, and landed on the take-off spot with minimum loss of time and energy. Throughout the "flight" the fledgling pilot is under continuous observation from a near-by spot, so that his operation of the glider can be constantly checked.

All of this business of glider training for powered flight adds up to the fact that this nation has been indifferent for years to an available and obvious means of providing the personnel necessary to mastery of the air. Germany grasped that means years ago, with results that are too well known to belabor here. Now that we have finally awakened to the need for national defense, and are realizing that this is no short-term affair, but a long pull that will not end when the present emergency is over, everything humanly possible must be done to build for the future as well as for the present.

As the July article pointed out, and as has been proved by German experience, gliding can serve a dual purpose. By proper promotion, it can become a national sport in which youngsters can find pleasure and education long before they are old enough to handle a powered plane. Such a national sport, supported by glider clubs and country-wide competitions, would rapidly build a pool of pilot material from which could be selected the cream of fliers for the defense of this nation.

The youth of the United States is already airminded, as evidenced by the popularity of model airplane building and of literature on the subject of aviation. Give them a chance to learn to glide and they will take to it like the proverbial duck to water. Having learned, they will take equally well to powered flight, and the United States will be in a position to claim the mastery of the air that must be established if civilization is not to receive, to be conservative, at least a serious set-back.—*A. P. P.*

STOP IT!

IN OUR August issue we took an emphatic stand for retention in this country of the less than 350 transport planes comprising our scheduled airlines system. The article, "Keep Our Transport Planes," offered factual support of that stand. In no sense did we refer to military planes; only to ships belonging to scheduled airlines. Nor did we advocate one iota of reduction of aid to England, but we did and do strenuously insist that parceling out airliners in these parlous times is an act fraught with danger to this country; that it is detrimental to the best interests of the British; and that it is wholly unnecessary in view of the British-ordered Lockheed-Hudson bombers, ready, awaiting delivery, and easily convertible to transport use.

Industrial leaders, contemporary publishers, many others unqualifiedly supported our attitude. The *American Aviation Daily* stated: "It is reported that OPM, and the Army and Navy are against this curtailment of the airlines as injuring the expeditious performance of the defense program." Yet, despite this unanimity of public and official thought, in the face of dangerously strained United States-Japanese relations, this ridiculous amputation of our potential air-defense arm continues. Twenty-four more of our largest, newest airliners were recently transferred to England and scores more are being requested for transfer to other nations.

If the Army, the Navy, OPM, the public—as indicated by our correspondence—do not sponsor this suicidal action, then, in the name of national defense *who* does? In any event, it MUST be stopped!

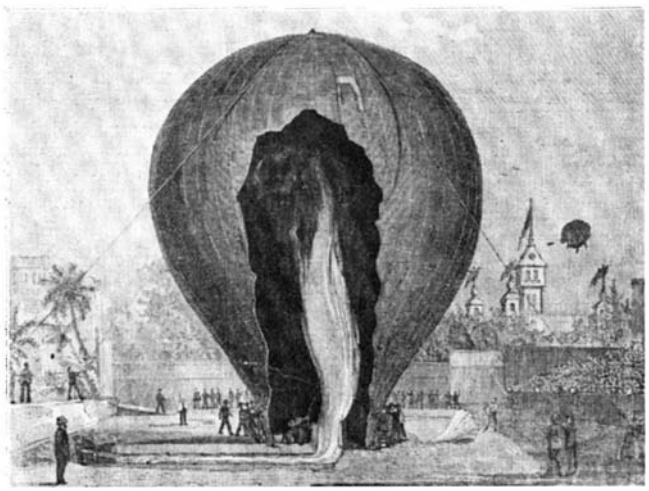
—*A. D. R., IV.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of September, 1891)

BALLOONING—"For some time past an exhibition of much interest to all concerned with aeronautics has been produced daily at El Dorado, a pleasure resort upon the top of the Palisades. . . It consists in the ascent of a Montgolfier balloon, to which a ribless parachute is attached. The aeronaut ascends with the two, and when a sufficient height above the earth is attained, cuts loose from the balloon, effecting his descent to earth in the parachute. . . The balloon is made of sheeting sized with a mixture of glue, alum, soda, salt, and whiting, in water. At the mouth of the balloon a hoop 8 ft. in diameter made of buggy wheel felloes is attached; from this hoop four ropes, called quarter guys, are brought down . . . to which the parachute



is attached. The parachute is made in gores, and in its center has a 12 in. hole. From its periphery thirty-two cords lead down to what is known as the concentrating hoop, a strong wooden ring 18 in. in diameter, which the aeronaut grasps in making his ascent. . . As the ascent is made, the entire distance from the top of the balloon to the aeronaut hanging to the parachute is about 175 ft.; the inflated balloon is about 40 ft. in diameter."

RAIN-MAKING—"There are now so many cloud compelling rain producers turning up that any opulent person who is interested in the weather can hire one of them for his own convenience. But suppose a man who would like to enjoy a shower on a warm afternoon orders his cloud compeller to produce one at a time when his next door neighbor desires to take a walk in his garden under the sunshine, what will ensue? Will the rain producer be liable to be sued for damages by his neighbor, or will the case be settled by arbitration?"

TRANSATLANTIC—"It is claimed the steamer *Majestic* is the most economical coal burner of any of the Atlantic 'high fliers.' She burns 220 tons of coal a day, shows 19,500 horse power, and makes an average of over 20 knots, or 23 miles per hour, throughout the Atlantic passage. There are only two other ships that have reached this speed, namely, the duplicate ships the *Teutonic* and the *City of Paris*. But there are a few other vessels that come near this speed."

NO PRIORITIES THEN—"Interesting experiments have recently been made on the Lake of Zurich with a boat built entirely of aluminum. The boat weighs only about half a ton—viz., about half the weight of an ordinary boat of the same size. . . It carries eight persons, and, with a petroleum engine of only two horse, easily makes six miles an hour. Aluminum not being subject to rust, the permanent color of the boat is a beautiful dull white, while the chimney, being of polished aluminum, shines like silver. The trial trips of the boat were eminently successful."

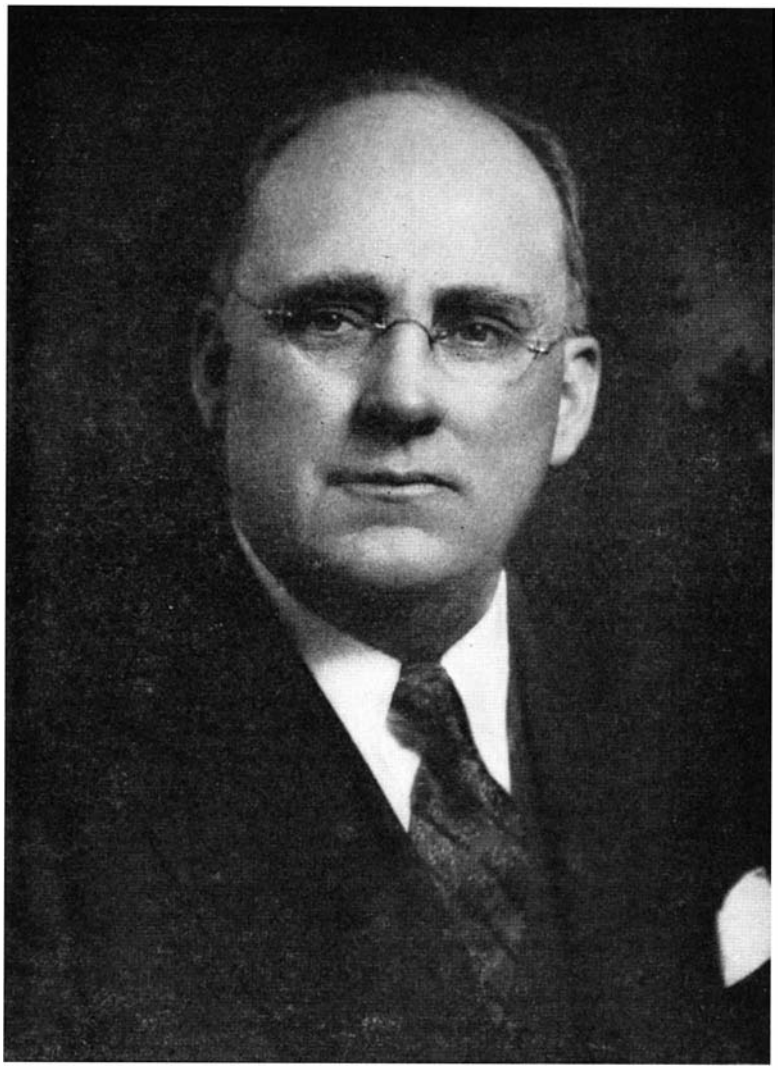
STIMULATION—"To the usual well known ways of stimulating muscles to contraction, viz., electrical, thermal, mechanical, and chemical, M. D'Arsonval has recently added that by means of light. He could not, indeed, get any contraction in a fresh frog muscle, when he suddenly threw bright light on it in a dark chamber; but having first in darkness stimulated a muscle with induction currents too weak to give a visible effect, and then suddenly illuminated the muscle with an arc light, the muscle showed slight tremulation."

GLASS—"A new use has been found for waste glass by Messrs. Rostaing, Garchey and Geille, of Paris. Any fragments of broken glass of various colors are mixed together, after having been broken to a suitable size; they are then placed in moulds lined with silica, talc, or some other resisting material and fired. A coherent mass is produced which can be dressed and cut into blocks, which are, of course, irregularly colored. Such blocks may be used as artificial marble. . . Fine decorative effects can thus be produced. Designs in relief can be obtained by pressure while the block or slab is still plastic."

PYROMETER—"It appears that at last something like precision has been secured in a thermometer for high temperatures. This much-needed instrument is made by Mr. H. L. Callender in the form of a platinum resistance, the simplest shape of which consists of a coil of fine wire welded to leads of comparatively low resistance. The electrical resistance of such a wire varies according to its temperature; so that the reading of the one gives the other by consulting a table prepared with reference to the zero of the instrument. . . Mr. Callender declares that if the wire is pure to start with, and is protected while in use from strain and from contamination, its resistance, after having once been annealed, is always very near the same at the same temperature."

CRANE—"A huge steam crane, called a steam Titan, built by Messrs. Ransomes & Rapier, will be chiefly employed for transporting blocks of concrete weighing 32 tons. . . The weight of the Titan, without water ballast or load, is 152 tons, and with ballast 170 tons. All the motions of the appliance are under perfect control by means of a set of levers situated on a platform and within easy reach of the single operator. A feature of importance in connection with this appliance is that it has to be capable of slewing round in a complete circle. . . The radius described by the arm is 50 ft., and to minimize the shock produced by stopping a load, owing to the momentum acquired when being slewed round, spring braking devices are introduced in connection with the gearing so as to bring the arm to a gradual stop."

Personalities in Science



ARTHUR W. HIXSON

DETERMINED to make this country self-sufficient in strategic metals, Professor Arthur W. Hixson, executive officer of the Department of Chemical Engineering at Columbia University, is seeking through laboratory research to uncover new and inexpensive methods of extracting aluminum, tungsten, vanadium, and molybdenum from low-grade ores which exist plentifully in this country.

Enough high-silica, low-iron aluminum deposits can be found within our boundaries to supply the needs of the nation's defense program for many years to come, Professor Hixson believes.

A similar interest in the full utilization of products on hand converted Professor Hixson from a farmer operating a 160-acre grain and cattle farm in Brown County, Kansas, into a chemical engineer. After graduating from the Northeastern Kansas Farm Institute in 1899, Professor Hixson decided to study chemistry as a means of salvaging waste farm products.

Born on July 7, 1880, near Mifflinburg, Pennsylvania, Professor Hixson attended the University of Kansas where he received the bachelor of arts degree in 1907 and the master of science degree in chemistry and metallurgy in 1911. During the years preceding his doctorate in chemical engineering, which was conferred upon him by Columbia in 1918, he was engaged in work as an assayer and metallurgist, participated in large-scale human and animal metabolism tests sponsored jointly by the government and the meat-packing industry, taught mining, metallurgy, and industrial chemistry at the State University of Iowa and the University of Iowa.

During the first World War, Professor Hixson served as a chemical engineer in the High Explosives Division of the U. S. Army Ordnance Department, supervising the production schedules of 31 explosives plants and the construction of chemical plants.

As a member of the Columbia faculty, which he joined in 1919, Professor Hixson organized and pioneered in courses which are now basic in the University's curriculum. His courses in Chemical Plant Design, Process Development, and Unit Operations have attracted graduate students from all over the world. During his 23 years at Columbia, he has served as a consultant to many firms in the chemical industry, gaining practical experience that has enriched his teaching and given point and direction to his research.

For the past ten years, Professor Hixson has directed research that has produced valuable developments in the petroleum, paint, and plastics industries. He has devised methods of accurately determining the size and power of large-scale agitating equipment from a study of models; discovered easily manufactured solvents for refining lubricating oil; isolated easily liquefiable hydro-carbons to be used as selective solvents for refining resins and fatty acids; devised a method of producing chlorine and sodium sulfate (which were imported in large quantities from Germany before the outbreak of the present war) from common table salt and sulfur dioxide; and has improved titanium pigments used in durable, non-tarnishable paints.

Among Professor Hixson's hobbies is city planning; of the 18 years he has lived in Leonia, New Jersey, he has been a member of the Board of Education for nine and chairman of the Town Planning Board for 17. Anticipating a rapidly changing civilization, he has drawn up a master plan of his and neighboring towns to care for future needs in housing, transportation, education, and recreation. He is recognized as Leonia's local historian for having compiled the town's colonial history. Also avidly interested in developing new species of plants, he has studied the effects of X-rays and ultra-violet light on producing variations in plants which he grows in his soil-less laboratory at home.

PORTABLE ATOM SORTER TO AID SCIENCE AND INDUSTRY

THE mass spectometer or "atom sorter" has been placed on wheels so that it can be moved from job to job. Heart of this device is the curved vacuum tube, surrounded at the bend by an electromagnet, shown above. In this analyzing machine atoms of chemical elements are sorted as to weight, the magnet bending the paths of lighter atoms more than those of heavy atoms, as they shoot through the tube at speeds up to a million miles an hour. More details on page 144.

97TH YEAR SCIENTIFIC AMERICAN SEPTEMBER 1941

HOW GOOD ARE AMERICA'S WARPLANES?

Analysis Shows Superiority in Factors That Count

JAMES L. H. PECK

IF THERE is anything the matter with our fighting craft, the war has been in progress long enough for the military and industry to have corrected the shortcomings. There have been a sufficient number of Royal Air Force experts over here and enough official and unofficial observers over there for the message to have been delivered. The American people, who, after all, are paying for these planes, certainly deserve to be acquainted with at least certain aspects of the deficiency, if such exist.

If our warplanes are as good as or better than any known to be in service or projected by the belligerents, this is hardly the time for the people to be told that our ships are second rate as compared with particular types of RAF and Nazi craft. The queer list of adjectives that have been tied to the tails of our military and naval aircraft have, for the most part, been directed at pursuits, fighters, and interceptors. The superiority of bombers of all types, and of our reconnaissance ships and trainers, is much too obvious for an intelligent and airminded public to be told otherwise. Billions of dollars worth of contracts speak for themselves, and second-best fighting planes are a bad investment for even a country in Britain's straits.

The cleverest jugglers in the aviation industry are the designers and engineers who are charged with the development of combat planes. They must continually balance one factor against another, add a bit of this and subtract a little of that; their job is one of compromise. Consideration must therefore be given these factors when comparison of warplanes is made.

In the military sense, these essentials are always relative. There is the matter of speed, which should be in excess of that of enemy pursuits and bombers so that swift attack and rapid withdrawal from combat remain your prerogatives instead of those of the adversary. Equally important is maneuverability, that adroitness or flexibility that permits the ship to be easily and rapidly flown through whatever aerobatic maneuvers are

NATIONAL DEFENSE

necessary to bring one's guns to bear on the enemy, or to escape his return fire. The top altitude, or ceiling, that the plane is capable of maintaining should be proportionately higher than that of hostile fighters and bombers, and rate of climb must also be higher to permit one to out-climb the enemy; top man is usually best man in a sky scrap. In order that operations will not be confined to too limited an area, and so that the fighter may remain aloft long enough to accomplish the tactical mission, it must be provided with an adequate range. Another vital flying characteristic is the plane's take-off and landing ability, and these are phases where speed is not at all desirable. If the ship cannot get off the ground and return to earth without jeopardizing the pilot's life, the other attributes are of little avail.

The combination of these six essentials is used to determine performance; performance, however, is not an end in itself but is a means to an end—that of bringing one's firepower to bear on the enemy and destroying him. The juggling and compromise of these factors is necessitated by air war tactics and the designers who are the cleverest jugglers turn out the ship with the finest all-around performance.

THERE are "built-in" qualities, however, which cannot be safely compromised. Combat planes must be built to a higher factor of safety than other types because of the speeds and stresses peculiar to these craft. Airmen must have complete confidence in their ships' ability to take it as they perform the necessarily violent and rapid maneuvers during combat. Pilots must be furnished adequate visibility from their cockpits, so that they may have an unobstructed view of the air and whatever happens to be in that air, without undue twisting and turning. Ten minutes of fast action can exhaust the hardiest of fliers. To further pilot efficiency, the ships should be provided with reasonably comfortable seats, heated suits or cockpits, and oxygen equipment. These are not non-essential luxuries, as some critics of American planes would have us believe. Cold, cramped aviators are at a disadvantage physically and psychologically against adversaries who are so equipped. Security measures dictated by lessons learned from "war research" include the installation of armor (particularly beneath the pilot's seat, at his back, and behind the legs), windshields of bullet-proof glass, and leak-proof fuel tanks. The latter serve a double purpose in greatly reducing fire hazard and in eliminating engine failure due to loss of fuel. Accessibility of the plane's engine, armament, and other vital parts must be made pos-

Official U. S. Navy photograph

Grumman Skyrocket, Navy version; 1500-horsepower Cyclones

sible by the installation of handy panels and cowling to facilitate easy, rapid maintenance. Minutes often count in air war, and the airplane is the most useless of weapons while grounded.

Last, but most important of all, is the fighter's firepower—that potential destructive force of the ship's armament. The ultimate aim of combat is to gain "fire superiority" over the enemy and thereby destroy him.

America is allegedly building fighting craft which do not "belong in the same air" with the late-type RAF and Nazi warplanes. If there is a deficiency, it must lie within one of the mentioned factors, or within a combination of two or more of these essentials.

An accompanying table gives figures which are generally accepted at this time showing the top speeds (at optimum altitude ranging from 12,000 feet to 25,000 feet) of five ships of the U. S., Britain, and Germany which are in use or in production at this writing.

On the basis of these figures, a few of which are unofficial, American craft certainly appear speedy enough to meet and best any of the European craft. Indeed, for the sake of conservatism, one might hold as much as 20 miles per hour in reserve for the Lockheed and Grumman and all five models would still compare most favorably with those of our contemporaries. True enough, the British are just commencing production of their Hawker Typhoon, powered by a 2400 horsepower Napier Sabre engine, which has been credited with a test-flight speed of 440 miles per hour, and Germany is known to be starting a new Heinkel fighter down the line which is almost as fast. [NOTE: The Westland Whirlwind, highly touted twin-engined RAF interceptor developed serious "bugs" and has been withdrawn from production, according to British sources.]

BUT if one is to follow this line of reasoning concerning "things to come," consideration must certainly be given the Navy's Vought-Sikorsky F4U-1, boasting a speed of 420 miles per hour, which is just about to go into production, and the Army's Grumman YP-50 version of the Skyrocket—which, according to reports, will be somewhat faster than its Navy stablemate—undergoing pre-production testing. One can go even farther to consider the 17 other "hush-hush" experimental models, clear up to the designation XP-63, now at Wright Field, and the several types at the Anacostia Naval Air Station. In the project stage are several prototypes with speeds exceeding 500 miles per hour. Outstanding among these, according to advance engineering data, is the Williams Aero Research Corporation's direct-lift pursuit-interceptor.

The transition from experimental status to first-line squadrons takes time, but these ships may be available before they are actually needed; that is, if we think in terms of national defense or protection of the western hemisphere.

The fact that several of our pursuits and interceptors boast performance comparable with higher-powered foreign craft would seem to turn the critics' loudest arguments against themselves: this concerns United States aircraft engines in general and air-cooled motors in particular.

Because radial air-cooled motors do not require the "plumbing"—radiators, ducts, pumps, and jackets—necessary on liquid-cooled types, they are many pounds lighter in weight. Air-cooled motors have fewer working parts, and this makes them less vulnerable to

Official U. S. Army Air Corps photograph

Flying cadets at Randolph Field study

COMPARISON OF WARPLANES, POWER, AND SPEED

United States				
Lockheed P-38E*	(Army)	2	1150 hp Allison	458 mph
Grumman F5F-1 Skyrocket	(Navy)	2	1500 hp Wright Cyclones	420 mph
Bell P-39A Airacobra	(Army)	1	1150 hp Allison	395 mph
Bell FL-1 Airabonita	(Navy)	1	1150 hp Allison	398 mph
Curtiss P-40A	(Army)	1	1090 hp Allison	360 mph
Great Britain				
Hawker Tornado		1	1780 hp Rolls Royce Vulture	425 mph
Supermarine Spitfire III		1	1600 " " " Griffin	400+ mph
Supermarine Spitfire II		1	1250 " " " Merlin	385 mph
Supermarine Spitfire I		1	1030 " " " Merlin	367 mph
Hawker Hurricane II		1	1250 " " " "	365 mph
Germany				
Focke-Wulf Fw-187		2	1375 hp Daimler-Benz	400+ mph
Focke-Wulf Fw-198		1	1500 " " "	400 mph
Heinkel He-113		1	1375 " " "	382 mph
Messerschmitt Me-110		2	1150 " " "	370 mph
Messerschmitt Me-109		1	1150 " " "	354 mph

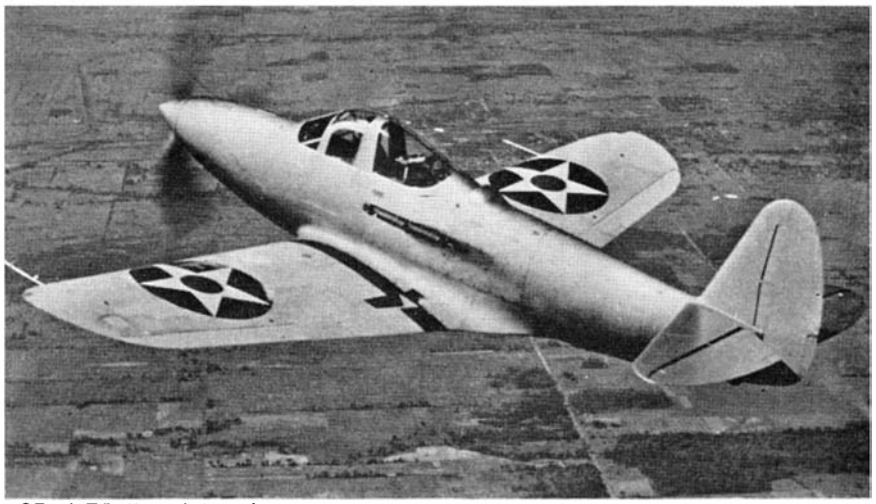
* Production model. Gen. Henry H. Arnold, Air Corps Chief, announced last fall that the P-38 could fly 500 mph, but this reference is believed to have been made to an experimental model powered by two 2500 hp Wright Tornado engines, the most powerful in the world.

enemy fire and lends them to easy, rapid maintenance and fewer overhauls. Last, but not least, the radials may be turned off the production line in greater numbers within a given time.

The linear shape of liquid-cooled motors, on the other hand, makes for efficient streamlining which is so important for high performance; the radials present their flat frontal area to the air, thereby furnishing a great amount of head resistance. The streamlined liquid engines provide the pilot with good forward visibility on single engined planes; the airman must peer around the larger cowl of the round motor, which is a disadvantage in combat.

The case of the radial engine might well have been stated in the past tense, inasmuch as the disadvantages have, for the most part, been overcome. The Pratt & Whitney Company's Double Wasp engine, which, incidentally, is good for almost 1000 horsepower more than the better-known liquid-cooled Allison, has been fitted with an extra-long shaft and gear box that permit it to be fully enclosed in a sleek, conical cowling heretofore possible only with liquid-cooled engines. The sensational Vought-Sikorsky fighter and Republic XP-47B Thunderbolt interceptor are both powered by a conventional snub-nosed model of the Double Wasp that turns up more than 2000 horsepower. Biggest news yet is the 3200 horsepower three-row Wright motor with a triple supercharger, still very secret.

a partially dismantled Allison engine



Official U.S. Navy photograph

Navy's Bell Airabonita, faster than the Airacobra, has greater range

In the meantime, development of the liquid-cooled engine is being carried forward. The most promising is the also-secret Wright Tornado motor which is good for some 2500 horsepower. Data are restricted, but it is believed to be a development of the famous Curtiss Conqueror (D-16) engine. This engine, too, has already been flight tested. The new Ford motor, a V-12 type revving up 1800 horsepower, is being tested, and Continental Motors has developed a trim 12-cylinder job of 1700 horsepower. The General Motors' Allison has been boosted to 1325 horsepower, but rumor has it that this engine, which has developed any number of "bugs," will be discontinued in favor of the Tornado, which makes good sense.

THE Associated Press carried a very interesting dispatch as far back as February 11—when there were but a few late-type American pursuits in England and fewer still in front-line action—quoting two crack RAF pilots on the behavior of one of our new pursuit jobs.

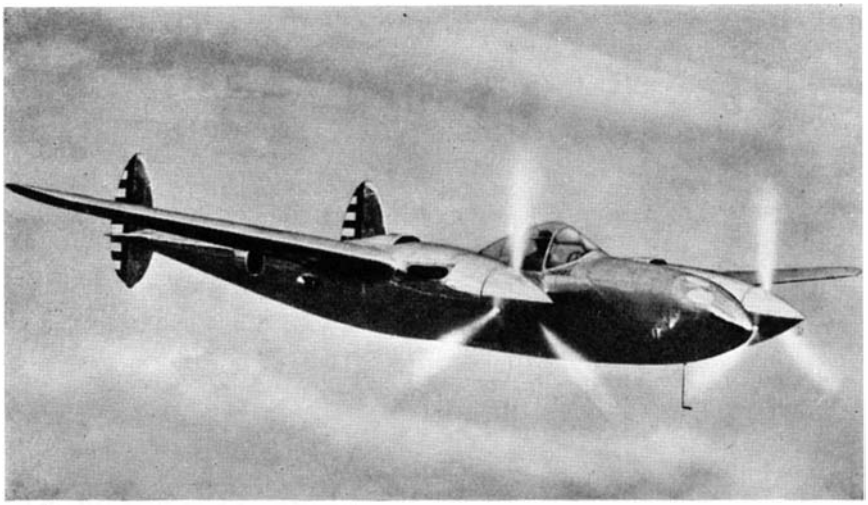
"That's a dashed fine machine. I had my legs on the Hurricane and I could even turn inside him," declared the victor to visiting fliers and newsmen as he climbed from the cockpit of a Curtiss 81-A Tomahawk—export version of the Army's P-40—following a ten-minute mock combat over a production station somewhere in Britain.

The vanquished airman was quoted as replying: "You turned inside me—never thought I'd see a plane that could do that to a Hurricane. The Tomahawks are faster than I expected. You were fast enough to catch me."

The former was an RAF Wing Commander who had spent just 15 minutes familiarizing himself with the controls and feel of the American ship, and the man he "defeated" was a famed Squadron Leader. The occasion was an air demonstration arranged by Lord Beaverbrook's Ministry of Aircraft Production for the benefit of some hundred officials and correspondents of the United States, Britain, and the Dominions.

The men of the RAF are doing the fighting; they know more about air war than we do over here. When they hang rave tags on our warplanes, that praise emanates from the highest authority. Even if a certain amount of approbation from higher quarters is to be discounted as "flattery" or "propaganda," comments of the pilots whose lives and missions depend upon the excellence of the ships they fly are not to be so easily taken with the proverbial grain of salt.

Thanks to clever supercharging, our fighters boast ceilings and rates of climb to those top altitudes which, in many cases, exceed similar phases of performance of British and German planes that are powered by engines of greater horsepower. United States pursuits have long been noted for their exceptional range, particularly the shipboard fighters, some of which can fly farther than five types of European medium bombers I can name. Not a single fighter developed within the last ten years in this country became infamous because of its evil handling qualities. Contrast this with the beautiful



Official U.S. Army Air Corps photograph

Lockheed P-38E interceptor has attained a speed of 458 miles per hour

and otherwise-efficient pilot-killer, the Nazi Heinkel He-112. A better all-around warplane than the more famed Messerschmitt Me-109, the Heinkel was jerked off the production line because of its dangerous take-off and landing characteristics.

If never before, the exceedingly high standards of the aircraft industry of this country, the excellence of materials, and the rigid specifications prescribed by the services are being demonstrated by the ability of our aircraft to "take it" in battle. There have been no reports of locked controls or shed wings in high-speed dives where United States craft are concerned, which is more than three of the belligerents may truthfully say. Vulnerability is further decreased by the use of armor, bullet-proof glass that will stop even a .50-caliber bullet, and self-sealing tanks.

THE mission of pursuits, fighters, and interceptors, however, is the dispensing of firepower and punishment rather than the taking, and there has been considerable speculation as to whether or not American planes could trade blows with German and British craft. Our planes are allegedly weak in firepower, but only allegedly. It has been pointed out that British fighters were carrying eight machine guns two years ago, at a time when first-line American ships were mounting only half that number, and, in many cases, only two guns. What was not made quite so clear was the fact that our airplanes must be designed for missions that would conform to American strategical demands, not —excepting, of course, the ships we are building for the RAF—British needs or German requirements. Our interceptors and pusuits must, generally speaking, have a greater range than foreign types because of our long coastlines and the tactical necessity for shifting from one section of the hemisphere to another. One of the characteristics RAF men admire most about our planes is the generous range. It will be recalled, however, that extensive range is gained at the expense of one or more of the other factors, in most cases. Instead of cutting down on speed or maneuverability, we carried fewer guns.

It was not, as is generally believed, during the early phases of the Battle of Britain that the need for more armament became apparent to United States tacticians, but at the time our first exported pursuits (Curtiss 75-A Hawks) went into service for France's Armée de l'Air. I say more armament, rather than heavier guns, because, as the critics also fail to point out, we have mounted heavier armament than the Europeans, and still do. American planes have been armed with heavy .50-caliber machine guns for several years, while only the very latest British and German craft are fitted with .50-caliber guns. They have continued use of the less-effective .303 rifle-caliber weapons and have only recently supplemented these with the larger guns. The first really successful 37-millimeter cannon was developed in this country a few years ago by the American Armament Corporation, and the only 37's being used abroad today are those on American-built planes. Even the ammunition for these guns is being imported from the United States. The RAF and *Luftwaffe* are arming their own craft with the smaller, less effective 20- and 23-millimeter varieties.

The armament problem derives from this: the lighter the caliber of the gun, the faster the firing rate and the shorter the range. Unless the pilot happens to be hit, all-metal ships can withstand an amazing amount of rifle-caliber fire and keep going. The .50's fire at a slower rate—about 650 rounds per minute against 1250 or more per minute for the .30's—but do much more damage. The .50-caliber Colt-Browning has an effective excess range of 125 yards—from moving station—over that of the rifle-caliber type, and an armor-piercing bullet from the former will penetrate ¾-inch armor at 450 yards. However, two .30's and 500 rounds of ammo weigh less than one of the larger guns and only 100 rounds of .50-caliber ammunition. Use of cannon makes the problem more complex. The one-pounder and 100 rounds of ammo, which comes in clips of five shells, weigh 299 pounds and the gun shoots at the rate of only 125 rounds per minute. Six rifle-caliber guns and 100 rounds of ammo for each add up to about the same amount of avoirdupois, but a direct hit from one of the cannon shells will blow a pursuit ship apart or disable the largest of bombers, and the cannon has six times the effective range.

COMBINATION, obviously, is the best solution of the problem; fast-firing guns for close-in fighting and cannon for distant pot shots. Little wonder, then, that the RAF men like our Bell Airacobra so well. For a single-engined pursuit-interceptor, the armament is ideal: four .30's, four .50's, and the 37mm cannon. This most certainly tops the eight .303 rifle-caliber guns of the Hurricane and Spitfire, and the four rifle guns and 23mm cannon of the Nazi Messerschmitt Me-109.

The latest craft of the belligerents carry much more armament, however. The Focke-Wulf FW-187 Zestörer, according to unconfirmed reports, mounts four 20mm cannon and the same number of .50-caliber machine guns. The RAF's new Tornado is reported to be carrying eight rifle-caliber guns and three 20mm cannon. Those boys aren't playing! Neither are we. On information from a highly reliable source, I have it that both the Lockheed interceptor and the Grumman F5F-1 fighter are mounting two 37mm cannon,

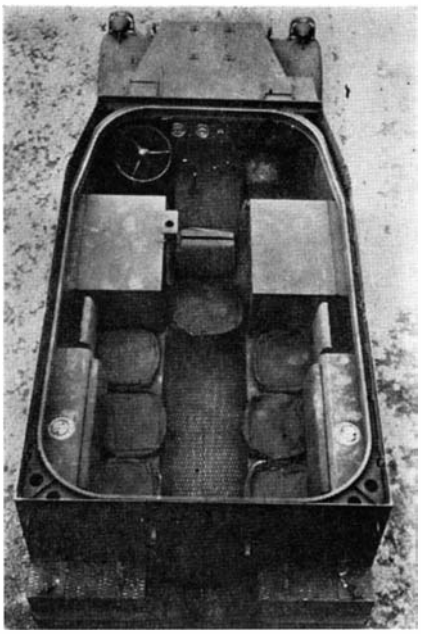
four .50's and four .30's. Add to this the fact that our ships are fitted with the electric optical gunsight, admittedly the finest in the world, to aim all this artillery accurately, and the sum totals up nicely for the red, white, and blue. With an eye to the future, we have several types of even more lethal aircraft weapons under experimentation, but all data on these are restricted by Washington.

Here, then, is the warplane picture: Speed is essential mainly for purpose of catching the enemy. Rate of climb and ceiling, for the purpose of getting up to meet—and top—him. Maneuverability, for the purpose of out-flying the adversary and thereby gaining a favorable shooting position. These are all to little avail if one's firepower is too weak to bag him after catching. By the same token, the heaviest firepower is useless if one cannot catch and out-maneuver the enemy so as to bring that armament to bear upon him. Balance is achieved through the interaction of engineering ingenuity, research, production, and the time in which to put these to work. America has more of all four than any country in the world.

• • •

Half Tractor, Half Truck

High Speed, Maneuverability, Armor Plate Protection in New Army Reconnaissance Car



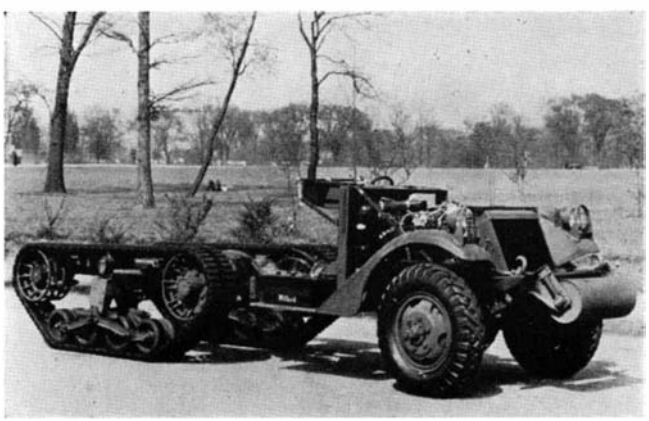
Seating arrangement, gas tanks, and machine-gun rail at edge

NOW UNDER production for the United States Army Ordnance Department is an armored and armed scout car designed for reconnaissance work over soft and broken ground as well as on level ground or highways where the vehicles can attain a speed of 50 miles per hour. Known as the Half-Trac, this vehicle is much the same as the conventional scout car, but, instead of having regular rear wheels, it is provided with an endless belt track which is driven by the forward axle of the rear bogie. This construction gives great traction power on soft and broken ground; at the same time, power is applied to the front wheels so that driving force is attained at both the front and rear.

The design of these jobs permits maximum maneuverability and the ability to climb in and out of shell holes and trenches. They will also go through mud, or ford streams up to a depth of 2½ feet. A large roller at the front end helps them out of holes or ditches. In test operations they have been able to climb out of a six-foot trench. Eight speeds forward are available.

THE Half-Tracs are fully covered with ¼-inch armor plate for protection against rifle or machine-gun bullets. When subjected to fire, there are a series of armor plate shutters which close down over the radiator, and an armor plate shield with two port holes which takes the place of the windshield.

Although these vehicles are not intended for combat purposes, they carry three machine guns—two of .30 caliber and one of .50 caliber—mounted on a special gun track which encircles the top rim of the vehicle and permits full 360-degree action. Each of these vehicles has an army-type pintle on the rear for quick attachment of any vehicle to be towed. Inside the body is a two-way radio outfit with special center post antenna. The radio enables the officer and crew to keep in touch with field headquarters. Low folding seats with wells for the feet accommodate a crew of eight, plus a driver and car commander.



Chassis of the scout car described on this page. This type, manufactured by The White Motor Company, is powered by an engine developing 147 brake-horsepower. ***Right:*** **A bank-climbing test**

Infra-Red Does the Trick

Radiant Energy From an Efficient Source is Doing Industrial Jobs Faster and Better

A. P. PECK

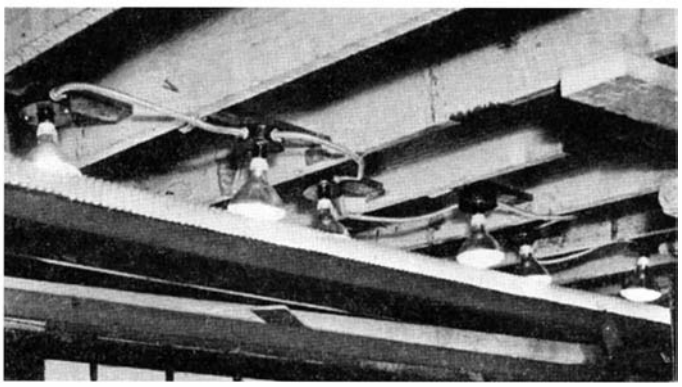
BRINGING a surprisingly large number of advantages to a wide range of industries, radiant energy, or infra-red heating, with specially designed incandescent lamps holds promise of invading even the home sometime in the future, providing a new means of heating individual rooms or perhaps the whole house, drying the family wash, and possibly cooking the food. But these menial household tasks are still subjects for those prophets whose delight it is to gaze into the crystal ball of science; of more immediate import are the industrial applications of this relatively new means of applying heat for a variety of purposes.

To attempt to list all the uses to which infra-red heating equipment is being put today would require far more space than is available. A few typical examples, however, will help point the way.

In the manufacture and repair of electric motors and transformers, the windings may be dried rapidly and thoroughly by the use of the incandescent bulbs. In one application, 30 of the lamps, of the size rated at 250 watts each, reduced drying time for a motor rotor to 50 percent of that required by a 42-kilowatt drying oven of the conventional type.

Granulated cellulose acetate must have the moisture removed from it before it is placed in an injection molding press. Infra-red lamps applied to this job made it possible to dry the material in 15 minutes; former equipment consisted of a steam dryer that required one hour to achieve the same result.

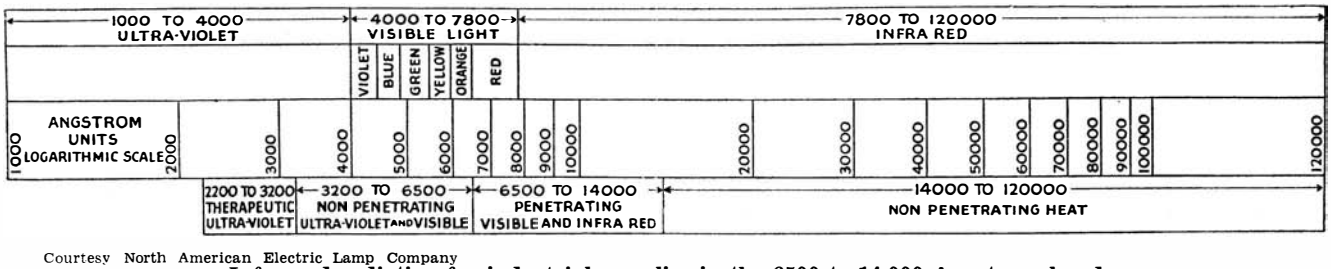
In an automobile engine assembly plant, pistons are expanded under radiant heat to permit insertion of closely fitting piston pins. Blueprints are produced faster, paper is dehumidified for lithography, label paint is fused to glass bottles, photographic paper and film are dried rapidly as are also paint and lacquer finishes, and a hundred and one other operations are carried on faster, more economically, by the use of these magic lamps of science.



As rows of matches on a conveyor belt pass under infra-red lamps, the tips are dried quickly, safely

Before dwelling at some length on the reasons why radiant heat is of such great industrial value, a brief preliminary explanation may be in order. Wherever heat is to be applied in an industrial process, whether it be for drying a surface film, for reducing humidity, for expanding parts by temperature change, or whatever, there are three general methods of transmitting the energy from the source to the surface or object to be heated. These three methods are conduction, convection, and radiation. Conduction of heat requires a solid body for transmission; when only a part of an iron rod, for example, is heated in a flame or by any other method, the rest of the bar increases in temperature as the heat is conducted through the solid. Convection heating makes use of a liquid or gaseous medium for transmitting the heat; an example of this is the ordinary oven where the interior air is heated by one method or another and this air, in turn, passes the heat to the object in the oven. Radiant heating, on the other hand, requires no known medium of transmission; the most familiar example of radiant heating is the life-giving warmth which the earth receives from the sun. Here infra-red heat rays emitted by the sun pass through the sub-zero void of space, producing no effect until they reach, and are absorbed by, the earth and objects on it. Upon absorption, however, the energy appears to our senses in the form of heat.

THUS radiant energy heating involves the use of infra-red rays, that part of the energy spectrum at the long wave end of the visible light portion and beyond. As shown in the section of the spectrum scale reproduced here, in which wavelengths are rated in Angstrom units (one Angstrom unit equals one one-hundred millionth of a centimeter), those infra-red or heat rays ranging from about 6500 to 14,000 Angstroms are generally considered as most effective for this work; beyond 14,000 Ang-



Courtesy North American Electric Lamp Company

Infra-red radiation for industrial uses lies in the 6500 to 14,000 Angstrom band

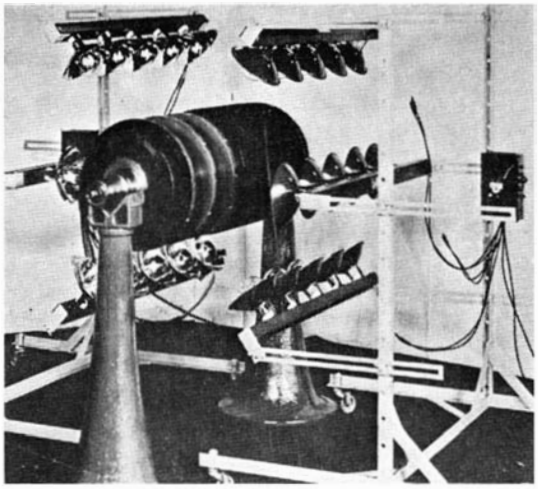
stroms the infra-red continues to 120,000 Angstroms, but this part of the spectrum is of little present interest to the researcher in the subject of infra-red heating. Just where to draw the finish line in the radiant heat part of the spectrum is still a moot question, open to theorizing and further experimental work.

From this it will be seen that, given a source of infra-red rays, heat may be transferred from that source to an object with minimum losses, since it is unnecessary first to transfer heat to a transmitting medium and then once more transfer the energy from the medium to the object. Such a source of energy is available in the incandescent lamp. For years lighting engineers have directed their efforts toward producing a light source which would give a maximum of light and a minimum of heat for the power involved. Now heating engineers have reversed the process and are producing an incandescent lamp which will emit a minimum of visible light and a maximum of radiation in the useful part of the infra-red spectrum. So successful have they been that present-day industrial heating lamps convert as high as 90 percent of the energy consumed into heat, much of which is in precisely that part of the spectrum which is most useful for industrial purposes.

PROBABLY the first large industrial application of radiant energy lamps was made by the Ford Motor Company, where the lamps were put to use for speeding the drying of automobile finishes. Since then the lamps have been improved and their use expanded to include a multitude of drying operations in the food, photographic, chemical, electrical, and a host of other industries, as well as other applications which call for economical heating for a variety of purposes.

The advantages of radiant heat in industry are so many and varied that it is difficult to list them in the order of relative merit. Since cost is frequently an important factor, however, it might be well to mention it first. Initial investment cost for an infra-red heating set-up is low, since no elaborate insulated ovens are necessary. The lamps may be mounted on simple and inexpensive frames, taking up a minimum of floor space. In some cases it is possible to suspend the lamp frames above existing conveyor lines, thus taking up no more room than is required for the conveyor itself. Still on the subject of cost, it is stated that maintenance is low, since the lamps operate at a comparatively low filament temperature and hence have long life.

Even small shops that do automobile body repair jobs find profit in portable radiant heat units for drying paint patches



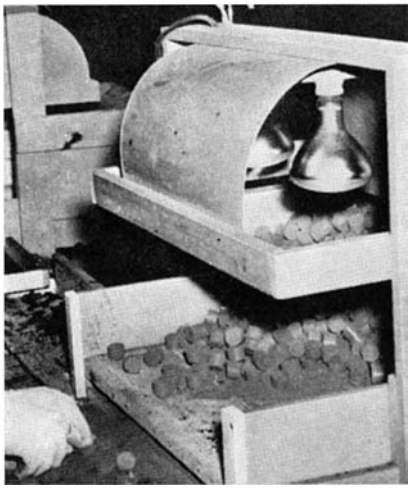
New or repaired rotors for electric motors are economically dried by infra-red

Due to the very rapid rate of energy transfer, according to one theory, infra-red heating is fast and therefore economical. Another theory to account for the efficiency of radiant heating states that the rays penetrate the surface finish or film or the pores of the surface, thus causing more rapid heating or drying than can be had with more conventional furnaces. In any event, the greater speed of operation results in lower total processing costs in many industries.

Since radiant heat is of essentially the same nature as light, the lamps which furnish the infra-red rays may be turned on and off or controlled and directed in much the same manner as incandescent lighting. When the current is turned on, the heat is there in full force with no delay. There is no need for keeping furnaces up to heat for long periods of time when the heat is needed for only short intervals. Convenience of operation enters the picture here; the only attention needed under ordinary conditions is a flip of a switch. Small installations of infra-red lamps may be entirely portable and moved from place to place as needed.

ON THE other side of the ledger are certain limitations of this form of industrial heating, and these must be considered in order to gain a clear picture of the whole situation. As stated before, one of the uses of infra-red heating is to speed the drying of surface finishes on automobiles. It, as well as other conventional methods of heating, cannot be used satisfactorily, however, for drying finishes that depend on oxidization as well as evaporation for the ultimate result. Thus it is barred largely so far from use in drying finishes containing linseed and similar oils. Where printed fabrics with a wide range of colors in the patterns are to be dried, infra-red may not be satisfactory; the darker parts of the fabric which absorb the greater amount of the rays, and hence are subjected to a greater degree of heat, may be overheated before the lighter colored parts of the material are dry. Conversely, if the degree of heat is so regulated that the highly absorbing parts are not overheated, the rest of the fabric may not dry sufficiently. There may be other similar obstacles to the use of infra-red heat, but there are so many desirable features of the system that any disadvantages are, in general, far out-weighed.

Although radiant heating is being used for many purposes there is still much to be learned about it.



Removing moisture from preformed plastic before molding

In fact, as has been hinted, there is no complete agreement among researchers about the exact way in which results are achieved. It is known that when infra-red radiation is used to dry a lacquer film the film drys rapidly without the formation, first, of a surface skin. Engineers of the North American Electric Lamp Company put it this way: "It is possible to obtain drying results with lower temperatures and/or less time because of the direct penetrating action of infra-red rays . . . a minimum of energy is lost through convection or conduction. Additional benefits of this penetrating action is the fact that surface films do not form on paints, lacquers, and so on, to slow up drying below the surface . . . drying proceeds throughout the material from the point of maximum penetration at the same rate of speed. Furthermore, vapors are free to escape so that infra-red drying is carried on in a lower humidity—a condition that speeds up drying."

From this explanation has come a frequently expressed thought that infra-red drying makes it possible for paints and other surface finishes to "dry from the inside out." This phrase has been questioned as to accuracy in some quarters; therefore the author put it up to one of the engineers of Westinghouse Electric and Manufacturing Company, who replied as follows:

"In my opinion the advantages of radiant heat over other conventional methods are due very largely to the much higher rate of energy transfer from the source to the object being heated. When the temperature differential between two objects is great, the rate of energy transfer is relatively high. As the temperature of the object being heated approaches the temperature of the source of heat, the rate of energy transfer falls off very rapidly. When radiant heat is used, we have as a source of energy a lamp filament operating at a temperature far in excess of that usually required for industrial drying and heating purposes. Consequently the temperature of an object being radiated, even when at its maximum required temperature, does not approach the temperature of the lamp filament. This being true, there is little or no change in the high rate of energy transfer.

"As to whether the theory of 'drying from the inside out' is a myth depends on the interpretation placed on this explanation," the engineer continued. "We do know that if radiant energy is projected on, for example, a finish applied to a metal surface, part of the energy is absorbed by the finish itself while the rest passes through the finish to the metal. Obviously the metal is heated and if you wish to express it that way, the paint 'bakes from the inside out.' This condition, however, occurs when convection heating is used but of course with a much lower rate of temperature increase than in the case of radiant heat."

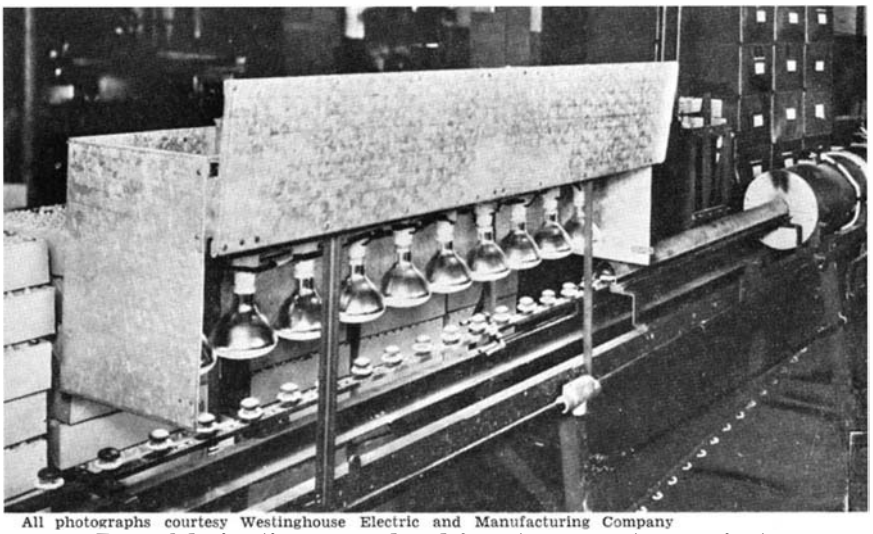
No matter what explanation is given to account for the results when infra-red heating is used, the final and practical answer is to be found in the many applications to which heat lamps have been put and in the satisfaction that they are daily delivering in speeding up production, saving costs, increasing safety by minimizing the explosion and fire hazard of open flame furnaces, and so on.

Although not too much is known about the underlying phenomena of infra-red heating and drying, excellent progress has been made and is still being made, so that practical information on specific applications is rapidly piling up. Because of the empirical status of the art, and because heating and drying requirements vary widely in different applications, engineers recommend that trial installations on a small scale be made before major installations are attempted.* Thus it is possible to determine in advance the number, size, and arrangement of lamps that will give the best results for the service demanded.

As to the lamps themselves: These are, as has been said, of the incandescent type, especially designed to give maximum heat in the usable part of the spectrum, with minimum light. In addition, experiments are being conducted with filters to decrease still further the amount of visible light falling on the work, to expedite inspection of parts during drying or heating. Even though the individual bulbs give relatively little light, the cumulative effect of the large number of bulbs used in the average installation frequently results in too much glare for eye comfort.

The lamps are available in a range of sizes from 250 to 1000 watts, the lower wattage with or without sealed-in reflectors. The self-contained reflector requires no additional equipment other than a

*Interested readers with specific problems in hand that might be solved by infra-red lamp heating installations will be referred to commercial sources of data if they will address the author.



All photographs courtesy Westinghouse Electric and Manufacturing Company

Enamel drying time was reduced from two hours to one minute

socket and a method of mounting. The other type must be used with an external reflector. The conservative operating life of these lamps is stated as being in excess of 5000 hours. They may be operated in any position, bringing to an installation the added advantage of space economy. They may be placed both above and below a horizontal conveyor belt, thus increasing the rapidity of heating by more than 50 percent over other heating installations where only one side may be heated at a time. They may be placed in vertical parallel banks with a vertical conveyor passing between two banks, a method that is impractical with other forms of heating, due to the chimney effect that tends to increase the heat at the top and decrease the heat at the bottom. Since the incandescent filaments are totally enclosed, the fire hazard is low. Where irregularly shaped objects are to be heated or dried, the bulbs may be so placed on their supporting racks as to deliver essentially uniform quantities of energy to all parts of the object.

The design and interior surface of the reflectors used with these lamps have a great bearing on the efficiency of the completed installation. In cases where the surface of the object to be heated is such that it reflects a large part of the rays, the reflectors may be so constructed as to present a continuous surface that reflects once again those rays sent back by the object. In this way loss of useful heat rays is minimized. In installations where reflection from the object is not a factor, separate enclosures may be provided for the individual bulbs.

Engineering data show that, while silver has the highest reflecting power for energy between 6000 and 16,000 Angstroms, such a surface oxidizes so rapidly under operating conditions as to be impractical. Copper, aluminum, and nickel surfaces show up well, but gold plating has characteristics that place it above all others for use in open reflectors. It has a reflecting efficiency of 84 to 97 percent, depending on wavelength, retains its surface characteristics for long periods of time under exacting conditions, and can be cleaned with the strong alkali solutions that must be used to remove the deposits which accumulate on reflectors in some industrial applications.

Thus a principle that is as old as the sun itself is being applied to a wide variety of jobs in industry, speeding operations and cutting costs. That the principle can be reduced to satisfactory practice in a great number of instances is definitely proved; that more applications will come in the future is indicated by the fact that intensive research is still continuing in an effort to improve technique and equipment and to find new uses for infra-red heating.

• • •

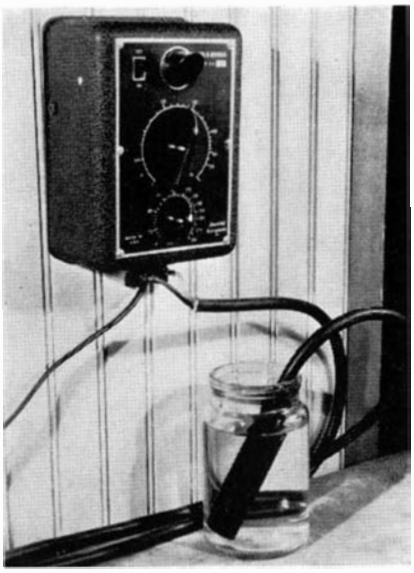
For Checking Water Purity

Electrical Equipment Gives Constant Check, Sounds Warning or Automatically Adjusts

NATHAN SCHNOLL
Chief Engineer, Industrial Instruments, Inc.

SINCE the electrical conductivity of water is largely in proportion to its deviation from the chemically pure state, it becomes feasible to check the purity of water used for various industrial and other applications simply, accurately, by measuring that electrical conductivity. Based on this principle, there have been developed equipment and methods which are now finding use in laboratories, hospitals, and many industries for checking distilled water, steam condensate, boiler feed water, output of water treatment plants, and so on.

Ordinary faucet water contains in solution a sufficient quantity of salts and other conductive substances to make it a fair conductor of electricity. Pure water, contrariwise, is a comparatively poor conductor. Thus the specific conductance of water becomes a positive measure of its purity and a conductivity measurement, at once simple and satisfactory, appraises its quality.



Solu-bridge and dip cell

THE conductivity of water obtained directly from a good commercial still in proper adjustment, for example, is on the order of 500,000 ohms per centimeter cube at room temperature. When the water is permitted to remain in contact with containers of metal or glass having even a small degree of solubility in water, the specific resistance of that water will drop to values as low as 200,000 ohms in a comparatively short time. Slight changes in the adjustment of the still may change the quality of the distilled water very markedly. Variations in the still itself, even when the adjustments are maintained constant, produce marked variations in the quality of water obtained, with corresponding changes in the measured resistance of the water. Such variations may be due, for example, to changes in the concentration of impurities in the water of the evaporating chamber.

It is thus seen that a measurement of the conductivity of distilled water may be used as a check on the adjustment and operation of any water still. The very fact that a still is used indicates the necessity for a supply of pure water. Whether the application be for laboratory, hospital, or some industrial use, the conductivity method has been found an invaluable aid towards securing consistently good results. And for the practical application of this method an automatic distilled water and condensate check-

er has been developed which operates in conjunction with a conductivity cell screwed into a standard connection in the pipe line or tank containing the distilled water or condensate. The checker is in a metal cabinet and mounts on a wall. The operating points of the relay, used to control an alarm or the valves, may be set

Typical installation in a boiler room of solu-bridge control unit

for individual requirements by means of an adjustment on the instrument panel. A meter indicates continuously the purity of the distilled water or condensate. An automatic checkup is constantly maintained, and either an alarm is sounded or flashed, or the corrective mechanism is automatically operated, when the conductivity exceeds the set limit.

FOR other installations, particularly in plants where equipment must be handled by relatively unskilled industrial workers, the "solu-bridge" has been developed. Here is an industrial version of the Wheatstone bridge, in which a simple conductivity or dip cell, in contact with the water or solution, is connected with the bridge. If several stills, vats, tanks or other pieces of equipment are single solu-bridge. The instrument this is achieved by a number of conductivity cells connected through a rotary switch to the single solu-bridge. The instrument has two knobs; one is set for the temperature of the water, condensate, or solution, while the other is adjusted until the circuit is in balance. The reading is then taken from the main dial.

With the solu-bridge, also, a relay may be arranged to control an external gong, light, or other alarm, or to operate a magnetic valve or other corrective mechanism, if automatic operation is desired.

The electrolytic conduction method of checking boiler water is finding favor among operators of steam plants troubled with scale. This method maintains close check on the concentration of solids in boiler feed water and boiler water. When readings exceed a set value, the boiler may be partly drained and fresh water introduced, or the supply can be properly treated.

The solu-bridge is also used to check steam condensate for carry-over of solids and salts that might otherwise cause damage to steam turbine blades or other equipment. A suitable warning calls for blowdown of the boiler.

In the operation of water-treatment equipment, the solu-bridge permits close check on the operation and marked economies in chemicals. The water output can be checked for proper treatment. In the case of Zeolite water-softener equipment, for example, a close check can be kept on the condition of the Zeolite bed which, when in need of regeneration or reactivation, can be so treated immediately. This is more efficient and economical than the usual practice of metering the water output and regenerating or reactivating the bed at a given gallonage.

Another application for conductivity measurements is in connection with surface condensers of steam power plants. The steam condensate in this case is essentially distilled water, with a fairly high specific resistance. The cooling water, however, is generally either ordinary raw water or, in some instances, sea water. A very slight leak of the cooling water into the condenser can be detected immediately by a decrease in the resistivity of the condensed water, and steps taken to correct the trouble that, if allowed to continue, might have serious and costly results.

• • •

For Information on New Products and Processes, See the Section

Industrial Growth

Page 152

VANISHING OIL

Designed for Lubricating High-Temperature Bearings

LUBRICATING oil which does its work, then vanishes without a trace, is now available for solving industrial problems of lubrication at extremely high temperatures. A contradiction in petroleum research which has pointed constantly toward giving lubricants greater endurance and more lasting quality, the new oil, known as Caloria, is the first petroleum lubricant to embody the characteristic of complete disappearance at high temperature. It is designed for lubrication under intense heat, such as is found in kiln cars, glass-making machinery, ceramics and glass molds, annealing and baking ovens, working parts of die casting machines, and various hot parts of machines in the metal industries.

Unlike conventional petroleum lubricants which often begin to break down or crack at 400 degrees, Fahrenheit, and thereby leave a residue of carbon, varnish, and other matter which coats bearings and causes wear and power loss, Caloria is recommended only for temperatures above this where it lubricates and while doing so evaporates completely, leaving the lubricated surfaces absolutely clean. Laying up of equipment for cleaning or replacement of bearings is eliminated, replenishment of the lubricant being all that is required to maintain equipment in service. Extensive field tests have proved that this "vanishing oil" is the solution to hot-spot lubrication.

The new product is available in several viscosities ranging from a light-bodied water-white liquid to a viscous, slightly turbid liquid which requires more than 11 hours for two ounces to flow through the orifice of a viscosity measuring device. Different viscosities are needed to meet varying methods of lubrication under a wide range of conditions.

In addition to its ability to disappear completely under high heat, Caloria has another unusual characteristic. Conventional oils spread over many hundred times their original area when dropped on a surface heated to 400 degrees. Caloria spreads to only four or five times its original area, assuring that it will remain in greater quantity

and for a longer time on bearing surfaces under high heat.

The amount of time required for all of the Caloria in a bearing to disappear depends upon the amount used, the surface area to be lubricated, the time the oil is in contact with the surface, and the bearing temperature. Replenishing may be regulated accordingly.

For use in cases where Caloria cannot be re-applied before complete evaporation takes place, as in some kiln car bearings, the use of Van Caloria, which incorporates colloidal graphite, will cause a dust-thin layer of graphite to remain on the bearings after complete disappearance of the petroleum lubricant. The graphite will prevent metal-to-metal contact until a new supply of Van Caloria reaches the bearings.

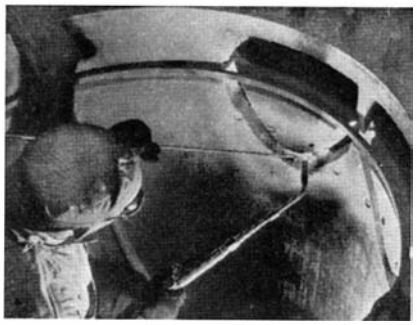
SALVAGE

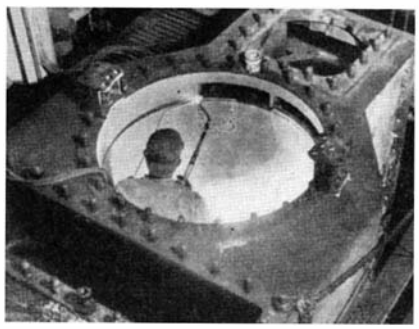
Welding Processes Reclaim Equipment

METHODS of welding metals—by both the electric arc and oxy-acetylene processes—are playing important parts in the salvage of worn or broken machinery and other equipment.

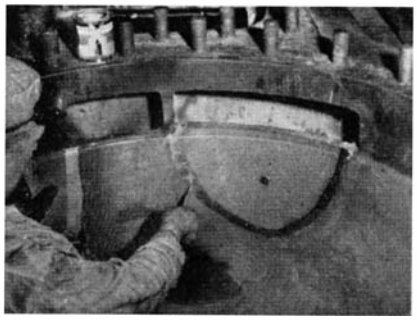
According to a study of statistics covering 21 pieces of equipment salvaged by arc welding, made by the James F. Lincoln Arc Welding Foundation, the average salvage cost was only 22.3 percent of replacement cost.

One striking example of arc welding salvage, obtained from the machine-tool industry, was the repair of the frame for a metal-working press. It would have required 10 to 12 weeks to replace this press, whereas it was repaired by welding in 56 hours and at only 10 percent of the replacement cost. In another case the frame for a metal-stamping press was repaired by welding in 5½ days.





How welding was used to repair cylinder walls in ship power plants without removing engines. *Below:* General view of a welder at work. *Above:* Welding into place a cast section shaped to fit the break. *Above, left:* A completed weld after boring

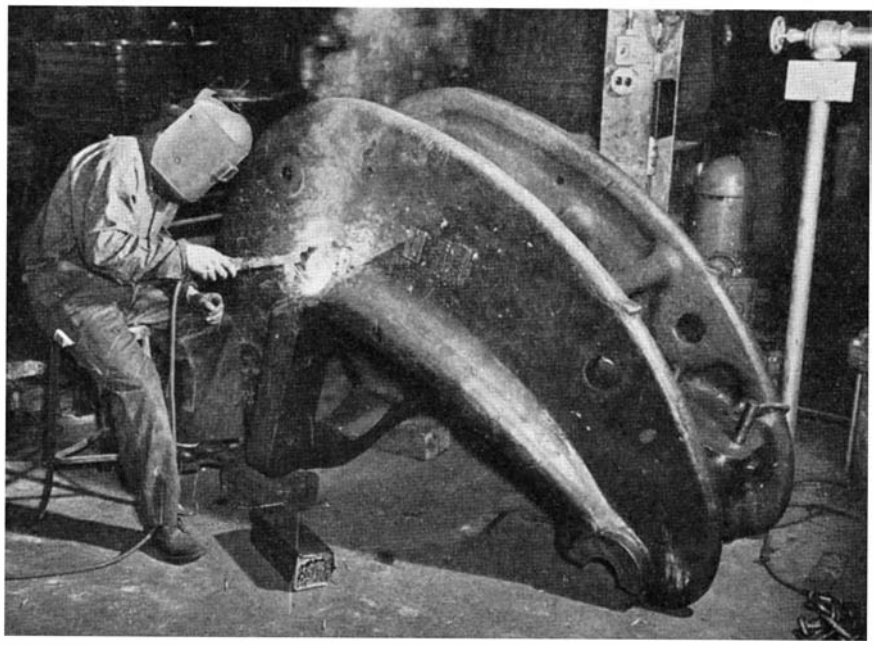


Added advantages of salvage by welding, of particular importance to national defense industries, is the possible reconditioning for immediate service of production machines and equipment now idle because of inability to obtain replacement parts. Delays in obtaining new machine tools and replacement parts, for example, range from 90 days up to one year, whereas even serious damage can be corrected in a matter of hours by welding; the repaired machine could then be continued in operation until the new equipment is delivered, if replacement, for any reason, seems desirable.

An outstanding example of salvage by oxy-acetylene welding is the repair work which is being done on the main engines and other vital parts of the foreign cargo vessels which the United States government took over last April. Repair work on these ships, according to The Linde Air Products Company, is being speeded up to a point where a number of them will soon be back in service.

In three of the accompanying photographs are shown stages of oxy-acetylene repair work on the main engines of two Italian freighters. The bronze-welding was accomplished without the necessity for removing these engines from the ships.

On each ship, U-shaped sections had been broken out of the walls of the intermediate pressure cylinders. New sections, cast to fit the contour of the breaks, were bronze-welded in place and then finished off to make a perfect repair.



The electric arc salvages a part of a metal-working press

PAINT SAVING

Thousands of Gallons Reclaimed Annually

SEVEN years ago a group of employes in the Westinghouse Merchandising Division Works at Mansfield gave C. L. Van Derau, Works Manager, a tip which led to

Unused paint falls into vats, is salvaged for further use

a "million dollar" idea. Ranges, refrigerators, and other electrical appliances manufactured in the plant are painted with spray guns. About half of the costly finish was being lost to the walls and floors of the painting shops. The employes obtained permission to try some of the waste paint for their spring house decorating. They reported that it was "swell" for painting interior woodwork.

"Why not put a stop to paint losses?" asked Mr. Van Derau. He and his staff went to work on the problem. Last year 60,000 gallons of paint, about 95 percent of the amount which "missed" in the spraying operation, were reclaimed. The paint is processed in a specially designed reclaiming apparatus presided over by a graduate chemist. It emerges pure and durable, suitable for many utility paint jobs and for maintenance work in the company's manufacturing divisions.

PLASTIC FILLER

Inexpensive By-Product Gives Satisfactory Results

THE search for new types of plastic has resulted in the use of cottonseed hulls, a very cheap by-product of the cottonseed oil mills. In a paper read before the American Society of Mechanical Engineers, Professor R. W. Morton has described some of the several new applications.

The plastic compound contains 60 percent of cotton hulls when used for regular plastic, 85 percent when used for tile, and 95 percent when used for wallboard. The relatively large quantity of hull filler used greatly reduces the amount of chemical binder necessary, and this fact should materially reduce the cost of production of the finished plastic. The plastic is of the thermo-setting type. Products are formed at a pressure of 3000 pounds per square inch and a temperature of 310 degrees, Fahrenheit, in 1½ minutes, and possess hard polished surfaces.—*Plastics* (London).

MAN-MADE RUBBER

Advantages and Disadvantages in Commercial Use

IN THE first detailed scientific "box score" ever issued on the specific characteristics of synthetic rubber, the B. F. Goodrich Company recently disclosed that the man-made product excels natural rubber in four important service properties, equals it in six, and is only slightly below natural standards in three.

"The results of a year of intensive testing show that Ameripol, the synthetic rubber created from petroleum, soap, natural gas, and air, can go to bat for natural rubber 769 out of 1000 times in the broad field of mechanical rubber goods," declared V. I. Montenyohl, vice-president in charge of the company's synthetics manufacture.

In various compounded states, the synthetic is already being widely used in airplane de-icers, aviation and gasoline hose, and in many mechanical applications where it is in contact with acids, oil and grease, benzol, and carbon tetrachloride.

The tests showed that the synthetic substance excels natural rubber in its resistance to aging, oxidation, heat, and oil, four mortal enemies of nature's product. It equals natural rubber in range of hardness, elongation, tensile strength, permanent set, and in resistance to abrasion, acids, and alkalies, and is only slightly below natural standards in elasticity, tear resistance, and reaction to sub-freezing temperatures, and even these can be remedied by skilful compounding, Mr. Montenyohl stated.

Very similar in appearance to natural crude rubber, Ameripol can be tubed, calendered, frictioned, spread, milled, and vulcanized just like natural rubber. Special cements have been developed which will permit vulcanization and adhesion to metals, including brass, provided the metals can be suitably roughened by sand- or shot-blasting.

Resistance to mineral, animal, and vegetable oils and fats, to the oxidizing influence of the metallic soaps used as driers in paints and inks, to heat, and to abrasion particularly in the presence of oil, are among the most valuable fundamental properties of the synthetic product.

Ameripol compounds can be made in the same hardness range as those of natural rubber, and elongation is also about the same. Tensile strengths can be varied by the materials used in compounding. Best quality compounds are obtained with black pigments. They have a faint, pleasant odor. Special compounds are made nearly odorless and tasteless.

Tear resistance of the best Ameripol compounds is somewhat lower than the best compounds of natural rubber, while abrasion resistance under normal conditions is about the same, although at high temperatures and in the presence of oils the synthetic product is considerably superior in abrasion resistance. Swelling and shrinkage of the synthetic in the presence of petroleum products is less than that of compounds of natural rubber.

INDUSTRIAL TRENDS

WHAT ABOUT THE MOTOR CAR?

DISREGARDING for the moment whatever curtailment in unit production will take place in the motor-car industry as a result of national defense requirements —latest figure on curtailment at the time of writing is 50 percent—there are certain other factors that stem from the same source and which will definitely affect the trend of the automotive industry at least "for the duration." And since these trends will be more or less apparent in the cars that the public will be buying for some time to come, they are of compelling interest to the man-in-the-street as well as to industry at large.

Published rumors have it that "ersatz" materials, forced upon the motor-car industry by inescapable conditions, will result in lowered quality, impaired efficiency. Such a trend would be the easy way out of a difficult situation, but the ingenuity that has made American industry synonomous with material progress just doesn't work that way and, unless present indications are completely erroneous, it won't start to work that way now.

Pioneer in the automotive industry, the Ford Motor Company may safely be considered spokesman for the entire field of motor-car producers. Thus when a Ford representative recently denied emphatically that inferior materials will be used as substitutes for strategic metals, it can be taken for granted that the same will hold true throughout the industry. Substitutes—yes; inferior materials—no. Higher production costs—yes. Lowered efficiency—no.

The manufacturer's representative put it this way: "The thing I want to stress is that we very definitely will not build an 'ersatz' car made up of inferior materials. The cars will cost us slightly more to build and will be slightly heavier, but the owner would never know the difference as far as performance and operation of his car are concerned."

That, briefly, is Ford's answer. And here's about how it works out. Many of the parts that now use zinc, aluminum, and nickel will be replaced by parts of iron and plastics. In many cases the weights of various parts will be increased by the substitutions and in some instances re-design of parts has been necessary to keep efficiency up to standard. The total weight increase, however, according to Ford, will not be great enough to affect gasoline consumption in the least.

Specific cases that prove the point are such items as carburetor bowls and engine valves. The bowls have for some time been made of zinc, produced by the die-casting process. These are now to be changed to cast iron. The substitute is, of course, cheaper in raw material cost but will do the job just as well. The Ethiopian in the stock pile is that the bowl made of the cheaper material will be higher in final production cost. This is brought about by the increased time needed for machining a cast-iron bowl, as compared with one made of zinc. In the case of valves, it is found that the nickel which increases the "hot strength" of the valves will no longer be used. It has been possible, however, to change the design of the valves in such a way that the new valves, which would be considered inferior under former standards of design, will be as satisfactory in service as those containing nickel.

So it will go in many other parts of the motor-car produced in the United States during World War II. Plastics will replace metal in such parts as instrument panels, cast iron will be more widely employed, engineering ingenuity will find new ways of doing old jobs with other materials, and the net result will be that Americans will still be able to buy motor-cars that, while available in limited numbers as dictated by the industrial requirements of national defense, will undoubtedly still be superior in every respect to any that are made anywhere else in the world.

THE PART THAT PLASTICS PLAY

TOUCHED upon lightly in the foregoing paragraphs was plastics' place as a substitute material in motor-car manufacture. But substitution is only one of the roles that plastics play in that industrial theater; they have other important parts which they fulfil best because of their own inherent characteristics. And, the motor-car being what it is in the over-all picture of American industry, these roles are of particular importance to all those who follow the progress which plastics are making in so many fields of endeavor.

A recent survey of the major motor-car manufacturing plants resulted in the construction, on paper, of composite cars in which were embodied the plastic parts used by the manufacturers represented. In the 1941 composite model were a total of 110 components; in the 1942 models this number will increase to 120. Obviously, all these uses for plastics do not come as a result of the scarcity of certain metals; plastics themselves have desirable qualities of durability, beauty, colors of many hues, light weight, and economy.

Thus plastics are to be found in motor-cars in uses ranging from radiator ornaments to tail and stop-light lenses, from the "meat" in safety-glass sandwiches to accelerator pedals, from name plates to horn buttons. The acrylic resins are being widely employed for their "light piping" qualities, bringing easier-to-read instruments and an absence of glare to the instrument panel which, itself, as noted before, may be of plastic.

Much has been said about the possibility of fabricating bodies from plastics. Automobile engineers, however, warn against over-optimism in this respect, and do not predict an early solution to the problem of molding large body panels from these materials. In any event, car manufacturers are continuing active research on applications of plastics to their problems.

FM-AM COMBINATION

A NEW radio tube developed by Philco makes possible a receiving circuit that responds to both standard and frequency-modulation transmitters, a job that formerly required two sets of tubes in the receiver. Here, undoubtedly, is the beginning of a trend in the radio industry toward combination receivers at reasonable prices, triggered off by Philco's announcement of a model selling in the neighborhood of 50 dollars.

—*The Editors*

The Sun's Faint Edge

How Three Dutch Astronomers Verified a Theory of the Sun with Simple Apparatus

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astromony and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THERE are still many kinds of astronomical observation which may profitably be made with small and relatively inexpensive instruments; but it is rarely that this can be done in the case of a total eclipse of the Sun. When large sums have to be spent to transport the observers to a station where the whole time available for observing hardly ever exceeds five minutes, it is sound scientific management to use powerful and nearly automatic apparatus which will make, during the precious seconds, a series of photographs upon which months of measurement and calculation may be well spent. But devices which satisfy this essential requirement need not always be costly. A remarkably pretty example to the contrary has just come to hand. The observations were made during the Russian eclipse of 1936, and published, with full discussion, in Holland in April, 1940. But it is only within a few weeks, when a long file of copies of the *Bulletin of the Astronomical Institutes of the Netherlands* reached this country, that we knew the results.

It has been known for a long time that the center of the Sun's disk appears much brighter than the edge. We do not notice this when we look at the Sun directly through smoked glass; for the edge, contrasted with the dark sky outside, looks brighter than it really is. But when a magnified image of the Sun is projected upon a white screen held a foot or two behind the eyepiece of even a very small telescope, the fading toward the limb is conspicuous. The edge is not only fainter than the middle, but different in color, looking reddish-brown instead of white.

With a large solar image, such as is given by a modern tower telescope, it is possible to measure with accuracy the way in which the light of any specified color falls off from the center to the limb, and it is found that the graph of the variation is gently rounded near the middle, and drops off very steeply at the edge. Up to 95, or even 98 percent of the way, measures are fairly easy. But, close to the edge, great trouble comes from bad seeing. The unsteadiness and "boiling" of the image, arising from irregularities in refraction in our atmosphere, is at its worst for observations of the Sun, whose heat causes all sorts of air-currents. When we have set the slit of our apparatus on what would be, with a steady image, 99½ percent of the way to the edge, the dancing of the image may at one moment bring on a brighter region, farther in, and at the next it may shift the Sun clear off the slit. The average effect will be a smeared mixture which does not accurately represent any particular point on the Sun's disk. The best chance of escaping this difficulty is to observe the intensity of sunlight during the partial phases of a total solar eclipse. Shortly before totality, when but a narrow crescent of the photosphere remains in sight, all the light which reaches us comes from near the limb, and, as the eclipse advances, it is the very edge which sends us light longest. Bad seeing may distort the image of the solar crescent, but will not affect the whole amount of light which we get from it.

HENCE an accurate light-curve, showing the changes in the last five minutes before and after totality, should provide the data for a solution of the problem. At any given instant, the light received comes from an arc of a certain length along the very edge, a shorter arc 1 percent of the way toward the center, and so on. To "unscramble" the effects of this mixture is a purely mathematical problem, which costs some algebra and arithmetic, but is no real obstacle. The real problem is to get as long a series as possible of good measures of the intensity of sunlight, precisely timed, during the critical minutes.

Our Dutch colleagues, Messrs. Ferwerda, Uitterdijk and Wesselink, solved the first part by taking their photographs with "amateur movie cameras" of a standard make, at the rate of 16 per second.

Timing was provided by two small electric lamps in the field of view, one flashing regularly at intervals of a second, the other at irregular intervals as a key was pressed. Both circuits were recorded on a chronograph, and the time of any exposure was thus determined to about a hundredth of a second.

OBSERVATIONS of the Sun were made upon its reflections in a series of small convex mirrors—set up on the board which carried the lamps. There were ten mirrors (ordinary spectacle lenses aluminized on the convex side) with radii of curvature ranging from seven feet to about an inch. Each mirror, viewed directly with the eye, would show a small image of the solar crescent—smaller of course the more curved the surface was—whose apparent size can easily be calculated by geometrical optics. The cameras were purposely set a little out of focus so that all ten of the reflected images appeared as circles of the same size —1/75 of an inch in diameter— much bigger than the geometrical images of even the largest reflected crescents would have been in focus.

The geometrical images would be of different sizes, but all of the same surface brightness. When expanded to extra-focal disks, they are of the same size, but very different brightness—the whole range from mirror 1 to mirror 10 being nearly 1200-fold. The relative brightness of these images could be simply and exactly calculated.

When the movie cameras were started, two minutes before totality, the sunlight was fairly bright. The images from the less-curved mirrors were hopelessly over-exposed; that from the most curved (No. 10) was too faint to be used, but mirror No. 8 gave a properly exposed image, neither too black nor too thin. As the light diminished, and this image grew too faint, image No. 7 was well-ex-

posed, and so on, until, just before totality, only No. 2 could be used.

In this way, without shifting anything, or interfering with the steady running of the spring-driven movie mechanism, it was possible to secure at least one properly exposed image, and often two from neighboring mirrors, while the intensity of the light fell from about 1/100 to less than 1/10,000 of that of the unobscured Sun. Two cameras were used, with color-filters, one working with blue light (λ4540) and the other with yellow-green (λ5670).

The 90 seconds of totality gave time to substitute two new movie cameras (and, we may hope, for a glimpse of the eclipse) and then as the Sun emerged, the whole process was repeated in the increasing light.

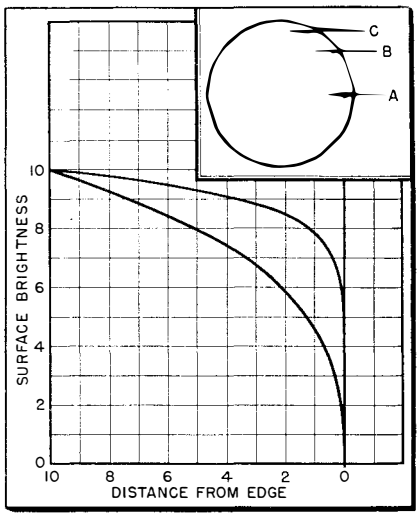
The apparatus was set up at Beloretchenskaia, in "the north-western outskirts of the Caucasus," and worked perfectly on the day of the eclipse. The one uncontrollable factor—the weather—was unkind. Thin wisps of cloud drifted across the Sun at times. These would have done no great harm to spectroscopic observations; but the thinnest cloud plays havoc with photometric work. The plates were nevertheless measured—a matter of 30,000 settings to determine the degree of blackening of the available images—and the results worked up.

IT APPEARED that the clouds had been bad after totality, and for part of the time before it. But, for a vitally important minute just before the Sun disappeared, and for ten precious seconds after it came out, the sky was practically clear, and good results were secured, covering a decrease of five magnitudes in the light.

Two unexpected results stand out clearly from these observations. First, during the last minute, though the light was reduced to 1 percent of its initial value, it maintained exactly the same color. The observations in the blue and yellow give exactly the same curve. Second, there was more light left, when only a very narrow sliver of the Sun remained, than would have been supposed from previous measures of the brightness farther from the edge of the disk.

The analytical discussion which our authors give of their measures, though as ingenious and pretty, in its way, as their instrumental inventions, would be less interesting here. Suffice it to say that they got an excellent representation of their data by the assumption that the surface brightness for points close to the edge of the Sun varies as the tenth root of the apparent distance from the edge.

This is illustrated by the upper curve in the graph. Passing from a given distance from the edge to one tenth as much, the surface brightness falls only 20 percent, and the drop at the actual limb is practically (though not mathematically) perpendicular. The older measures show that, farther inside,



Curves of Sun's brightness near edge. (Insert: The explanation)

the brightness changes about as the cube root of the distance from the edge (as illustrated by the lower curve).

The observations are accurate enough to show that the change in brightness must follow very nearly the upper curve. The assumption of uniform brightness—which would give a horizontal line followed by a vertical drop—is wildly inconsistent with the measures.

So far these results may appear less interesting than the way in which they were found. But their interpretation is more noteworthy.

It has been realized for a long time that the change in brightness and color toward the Sun's limb depends upon two things. First, the Sun's surface is not solid, but composed of gas full of thin incandescent haze. Second, this gas grows hotter as the depth increases.

The corner insert in the illustration (which is very far indeed from being drawn to scale) illustrates what happens. It represents the Sun—the Earth being far away on the right. Consider first a ray *A* which appears to come from near the center of the disk. It will carry light from deep layers, greatly weakened by passage through the overlying haze, from intermediate layers, moderately weakened, and from superficial layers, hardly weakened at all. On the average, we can treat it (closely enough for our purpose) as if it all came from a certain properly chosen average depth, as shown by the arrow. For a ray emerging obliquely at *B* the amount of haze lying above the average depth will be about the same—but this amount must be measured along the slanting path of the rays, so that, on the average, the light comes from a smaller depth below the surface. For the more oblique ray *C* the effective average depth will be still smaller.

HENCE the light at *A* will come on the average from hotter layers than that from *B*, and still more, compared with *C*. Light from a cooler source is weaker and redder; hence the Sun's disk will be brightest and bluest at the center and grow fainter and redder toward the limb.

From the regions extremely near the limb, which were studied in the eclipse observations, the light escapes at a very small angle to the surface, and the effective depth is also very small. For these almost grazing paths the light is very little fainter, and not perceptibly redder, from the very uppermost layer than from those a little below. The meaning of this is clear—the drop in temperature, which continues steadily, from the deepest layers we can study directly, almost to the top, must finally level off very near the "surface," (that is, the level at which the solar gases cease to be perceptibly hazy).

Why this should happen is not yet explained, but evidence that it does has been derived by two other investigators in different ways. Professor H. H. Plaskett, studying the distribution of surface brightness farther from the edge, finds that it can be interpreted only by the same hypothesis of an almost isothermal layer; and Miss M. G. Adam of Oxford has shown that this will also explain the otherwise puzzling fact that, though the strong lines of the solar spectrum are weakened at the limb, the faint lines are strengthened there. It is remarkable that a simple proof of the same thing has been obtained with no more unfamiliar apparatus than movie-cameras, spectacle-lenses, and flashing light bulbs.

Telltale Tracks

Human Footprints in Hardened Rock in Central America Reveal a Dramatic Flight

Footprints hardened in the rock

AN ARCHEOLOGICAL discovery which promises to be of the utmost significance—footprints in rock of persons fleeing from a volcanic eruption 2000 to 5000 years ago—has been made by an archeologist of the Carnegie Institution of Washington on the outskirts of the city of Managua in Nicaragua.

Aside from the dramatic story told by these footprints, they constitute the earliest known evidence of human beings in Central America, where the most advanced of New World cultures were to arise many centuries later.

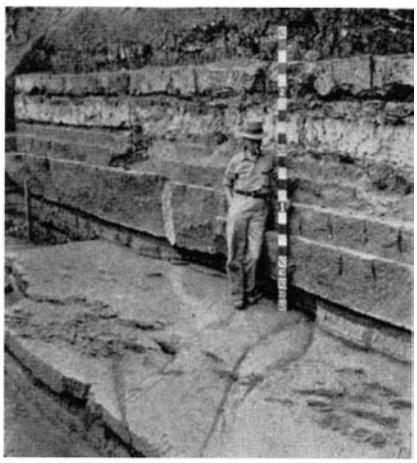
The prints were made in a layer of volcanic mud while it still was soft, probably within a few hours after it covered the area. There is some evidence that cinders from a nearby volcano were raining on the heads of the people as they fled.

The site was found by F. B Richardson of the Carnegie Institution staff and was inspected shortly afterward by Dr. A. V. Kidder, head of the Institution's

Man tracks and deer tracks

Division of Historical Research. Impressed by the significance of the discovery, Dr. Kidder asked Dr. Howel Williams, volcano expert of the University of California, to fly to Managua.

It was found that over a deposit of volcanic ash of unknown age and depth there had been laid down about six inches of volcanic mud in which the footprints had been made. Above this stratum there has accumulated several subsequent deposits of volcanic origin to a total depth of about eight feet. President Samosa, keenly interested, at once acquired the land for the government.



Footprints and later strata

The footprints are of two individuals walking on fairly firm material and a number of others who were crossing mud so soft that their feet sank in it. Either just before or just after the humans crossed, a large deer, running at right angles to them, left his hoofprints in the mud.

THE INDIVIDUALS were fairly small people, to judge from the size of their feet. They appear to have been going toward a nearby lake to escape an eruption. Quarrymen say that all the footprints they have uncovered in the past were turned in the same direction.

Before the footprints were made there probably had been millions of years of volcanic activity in the neighborhood, since the prints are underlain by hundreds of feet of ash. It may be that, just before the prints were formed, the volcanic craters a short distance from the present city burst into unusually violent eruption, causing mud flows—known to volcanologists as "lahars"—to sweep down over the plains around Managua. They may have been formed because of temporary blocking of the rivers that drain from the highlands to the south. They are remarkably like those which buried the Roman city of Herculaneum in 79 A.D.

Such flows harden very quickly—a somewhat similar deposit was laid down on the slopes of Lassen Peak in California in 1915 and within a few hours it was difficult to stamp an impression in it with the feet.

Very shortly after the prints were made—perhaps simultaneously—they were covered by a thin veneer of black cinders. Then followed another mud flow, another eruption of black cinders, and then a rapid succession of thick mud flows. These hardened to rock, and a quiet interval followed, during which a river cut a channel through the layers of rock and deep into the underlying deposits.

Subsequently, a distant volcano threw out showers of white pumice. This piled up to depths of more than a foot. There was another long period of quiet. Rivers cut new channels through the pumice. Elsewhere a top soil about a yard thick was built up. Renewed eruptions covered this soil with ash. Another soil, in some places ten inches thick, accumulated. Finally the topmost layer of soil was laid down.

It required a long time for these four layers of soil to be accumulated and a deep river channel to be cut. About the shortest possible lapse of time from the day of the footprints is 2000 years. It may easily be about twice that long. Further study next winter is expected to shed more light on this.

The Silver Clamp

Experiments in Progress Give Some Promise of a Remedy for High Blood Pressure Ills

BARCLAY MOON NEWMAN

AT LAST the kidney has been definitely incriminated in the mystery of persistent high blood pressure, known to medical men as hypertension or, more accurately, "essential hypertension," and hitherto of unknown cause. Hence medical science for the first time has a substantial basis for hope of therapeutic progress in what is known as the physician's most difficult problem: degenerating heart, blood-vessels, and kidneys. For such degenerations are generally associated. Together, these ills carry off one of every two individuals past 50 in the United States.

In 1836, Richard Bright set certain facts and a theory before the medical world. It was he who pointed out that a significant percentage of those who have chronic kidney diseases also have circulatory trouble and, especially, a pathologically enlarged heart—that is, a heart that becomes enlarged because it is overworked; and overworked for a reason that remained mysterious. Bright further pointed out that in autopsies of such cases only minor changes are to be found outside the kidneys—changes that do not in themselves provide adequate explanation of the enlargement of the heart. He asked: "What, then, is the cause of the unusual efforts to which the heart is impelled?" And he theorized: "Something so affects the minute and capillary circulation as to render greater action necessary to force the blood through the distant subdivisions of the vascular system."

Thus Bright put forth the conception of the heart working against increased pressure, caused by increased resistance to the flow of blood through the lesser blood vessels. He went on to ascribe the origin of the increased resistance and pressure to kidney disease. This suspicion of the kidneys was justified by the degenerations found in them at autopsy and by the very frequent association of heart conditions with kidney upsets.

So, more than a century ago, Bright posed another question: "In kidney failure is there not to be discovered a great source of circulatory failure?"

He had no way of measuring blood pressure, and did not know definitely that chronic elevation of blood pressure accompanies a large percentage of chronic kidney conditions—though his keen investigations provided him with ample hints. Extensive blood pressure measurements of any sort have been made only since well into the first decade of the present century. Through rare precision of observation, and through rare clarity of judgment, which enabled him to see meaning in details that were meaningless to contemporaries, Bright led the way toward eventual effective measures against the greatest killers of mankind — heart-blood-vessel-kidney disorders.

AFTER Bright, investigators lost themselves in the countless enigmas and apparent contradictions of such research. Nevertheless, year by year, it was becoming obvious that disturbance of heart or blood-vessels or kidney did disturb the whole heart-blood-vessel-kidney system. Thus this trio slowly attained the title among medical men of "cardio-vascular-renal." Ever more striking statistics disclosed the intimate if not causal relationship of advancing age and increasing failures of heart, blood-vessels, and kidneys. The high frequency of pathological, or diseased changes in the blood vessels of the kidneys studied at autopsy of high blood pressure cases forced deeper thought.

In 1928, Dr. Harry Goldblatt, of Cleveland, had become convinced that one of the world's fundamental secrets was given hint of by the frequency of association of kidney blood-vessel degeneration with high blood pressure, or essential hypertension, and he began to test the century-old theory of Richard Bright.

As is obvious from the century-long puzzlement, many lines of thought were possible. Goldblatt had the acumen to pick the essential line. Thus he pondered: "What will happen if you imitate the apparent condition in hypertension by reducing the blood supply to the kidney? The man or woman with essential hypertension usually has narrowed blood-vessels in the kidney. Will the dog used in the laboratory experiments develop persistent high blood pressure if experimental narrowing of kidney arteries and consequent reduced blood flow to the kidneys can be brought about?"

Four years of effort were required before the extremely delicate experimental technique could be worked out and the first studies reported. Because he knew of no way of narrowing all the vessels in the kidney, Goldblatt set himself the problem of narrowing the main artery to a kidney. This, he reasoned, should produce the same effect. The solution to his problem came through the invention of an ingenious silver clamp, so constructed that all degrees of narrowing can be accomplished, and the clamp left on the vessel permanently, or removed later, according to the desire of the experimenter.

In 1932, Goldblatt and his associates gave their preliminary answer to Bright's question: Indeed the kidney can be a great source of circulatory failure. Narrowing of the artery leading to only one kidney, in the dogs used in the experiments, caused hypertension which lasted in several cases for months. The next logical step, narrowing of both main arteries leading to the kidneys, brought a great discovery. For experimental purposes, the counterpart of essential hypertension in man can be produced experimentally in the dog. The dog's blood pressure can be maintained at an abnormal level for years.

The silver clamp was applied to monkeys, nearer kin to man—success again!

Next came the most important finding of all. When the clamping

of the arteries leading to the kidneys was made moderate, high blood pressure developed, but without detectable injury to the function of the kidneys. Thus, as in the so-called benign form of essential hypertension in man, an ordinary clinical examination would not have incriminated the kidneys as the cause of the trouble. This is why, in the past, medical men have been unwilling to accept the idea that the kidney could be the cause of this form of human hypertension.

IN HUMAN beings, sometimes the persistent hypertension suddenly shifts into a more malign form that speedily kills, as opposed to the insidious progress of the benign type. In dog and monkey, the counterpart of the malign type of hypertension, with accompanying marked kidney damage, can be readily brought on—as the silver clamps are screwed tighter and tighter, until the arterial tubes are nearly closed. In this type, kidney function is also damaged, hence it is easier to accept the fact that the source of the trouble lies in the kidney. All grades of the hypertensive condition can be produced, according to the constriction of the clamps.

When narrowing of one renal—that is, kidney—artery has caused hypertension, release of the clamp or removal of the kidney is followed by a drop of blood pressure to normal. Soon, application of this discovery was successful in the clinic. It was recognized for the first time that patients can also have high blood pressure caused by the reduction of blood flow through *one* kidney, and that they may speedily show a return of blood pressure to normal if the diseased kidney is removed. Of course, death follows removal of both kidneys, hence other therapeutic measures must be devised for treating the more frequent condition in which both kidneys are involved; these amazing measures appear to be on the way.

Again the work of Goldblatt and his collaborators pointed the way; they concluded, as a result of various experiments, that a chemical from the kidney, which they called "the hypothetical effective substance," was responsible for the rise of blood pressure which follows the clamping of the artery leading to the kidneys.

A recent report on this phase of the problem, yet to be fully confirmed, is that of Doctors Arthur Grollman, J. R. Williams Jr., and Tinsley R. Harrison, of the Medical Schools of Johns Hopkins and Vanderbilt Universities: "The abnormal kidney may liberate some substance which plays a part in causing hypertension—but the amount of normal renal tissue present in the body also determines whether or not hypertension occurs. We have prepared renal extracts which are capable of reducing the blood pressure of animals with experimental hypertension. Further evidence, however, is necessary before it can be established that the principle present in our extracts is a normal physiological constituent of the kidney, the absence of which is responsible for the development of hypertension."

The preparations made from animal kidneys by these experimenters, and by Dr. Irvine Page of the Indianapolis City Hospital, have been used in a very few cases of hypertension in man—and with excellent results in some. But the pioneers themselves point out that it will be long before any such impure product can be purified and made generally available.

If it should turn out, as this report indicates, that the kidney plays a part in the maintenance of normal blood pressure, as well as in causing high blood pressure, the contribution of the silver clamp to our knowledge of blood pressure will be high indeed. Such a discovery would be even more fundamental than the new knowledge of the old theory of Bright.

Meanwhile, the mechanisms that are set to deadly work by reduction of blood supply to the kidneys are the focus of attention on the part of those who pursue the secrets of essential hypertension. The kidney, with blood supply reduced, is widely believed to manufacture a weird chemical which brings about body-wide narrowing of the lesser blood-vessels. The heart then must work against the resistance brought about by this narrowing, and becomes enlarged. There is no evidence, however, that the higher pressure of the blood is a cause of ordinary arteriosclerosis—that is degeneration and hardening of the arteries. Quite the contrary. According to Goldblatt, the arteriosclerosis comes first, and, when it involves the kidneys, the hypertension follows. The cause of the arteriosclerosis is still an enigma.

Yet, here again, Goldblatt and his co-workers have made an important contribution, for they have shown that in the malign type of hypertension, at least in animals, profound changes develop in the small blood-vessels in many parts of the body, as also happens in the corresponding type of hypertension in man. But this is not ordinary arteriosclerosis, and they believe that the cause of this change in the blood-vessels is the hypertension and the damage to the functions of the kidneys which result in some chemical factor which gets into the blood. Both factors play an important part in bringing about these extraordinary changes in the blood-vessels.

The precise nature of the chemical agent manufactured by the kidney is under the most painstaking investigation, but it seems that the trapping of the deadly molecule of it will be an enormous labor; it is probably produced in exceedingly small quantities, and can thus elude all present methods of isolation.

At least medical science has in this vast problem won its way to the point where the view can be seriously entertained that most cases of essential hypertension in man are not different from experimental renal hypertension in animals.

Alfred Blalock, distinguished experimenter of the department of surgery, Vanderbilt University, Nashville, who has recently reviewed more than 200 scientific reports on experimental hypertension, concludes:

"Granting that there are some types of hypertension which are non-renal in origin, the evidence which has been reviewed indicates that most instances of experimental and probably of clinical hypertension are related to some abnormality in function of the kidneys."

• • •

FORESTALLMENT

Epileptic Fits Deliberately Produced Electrically

VACCINATION against epileptic fits, so to speak, to protect both public and patient against sudden seizures in traffic, at work, and under other dangerous conditions, is about ready for practical use.

The epileptics are literally shocked through the brain, elec-

trically, deliberately, into seizures, but these occur safely in the privacy of a physician's office.

Dr. Lothar Kalinowsky and Dr. Foster Kennedy, New York psychiatrists, have suggested this new method to the American Neurological Association. It upsets ideas physicians have had about this disease, reports *Science Service.*

Shocks of over 100 volts are administered to the brains of patients. This electric shock treatment is identical with that used in treating schizophrenia (dementia praecox). Dr. Kalinowsky originally introduced in this country this other electric shock treatment.

• • •

SIGHT—More than 20 percent of draft-age men are being barred from military service because of defective eye sight. Lighting engineers ascribe this fact largely to poor lighting conditions in homes and classrooms.

• • •

ASTHMA

Old-Fashioned Croup Remedy For Asthma Attacks

SIRUP of ipecac, which children of grandmother's time were given for attacks of croup but which modern physicians have abandoned, gives better results in some severe asthma attacks in children than any modern medicines, Dr. Bret Ratner, of New York, recently told the American Association for the Study of Allergy, reports *Science Service.*

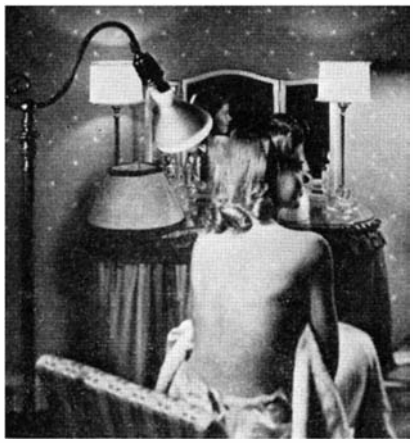
He advised it for children in asthmatic attacks due to obstruction of the small endings of the bronchial tubes. These attacks, he finds from guinea-pig studies, are generally caused by allergy due to substances that are inhaled, such as horse dander, dust, or pollen. The vomiting induced by the ipecac helps the child dislodge the plug that has been obstructing the bronchioles.

The modern remedy, adrenalin, extracted from the adrenal glands, "works like a charm" in severe asthma attacks of another type in which food proteins to which the child is allergic reach the bronchioles via the blood stream and cause spasm. Adrenalin should be given to these children in small doses, he stressed. If the small doses do not help, larger ones will not either, and the physician is advised to try ipecac. Large doses of adrenalin, he pointed out, only increase the feeling of impending doom which the patient, gasping for breath in a severe asthma attack, already feels badly enough.

SUNLAMP

Self-Reflecting, Operates In Ordinary Sockets

EXTERNAL control devices are unnecessary with a new type of sunlamp which fits into an ordinary house socket and produces radiations similar to that of midday, mid-summer sunshine. This new lamp, developed by General Electric, consumes 275 watts and operates on 110-125 volt, 50-60 cycle circuits.



Self-contained

Built into the all-glass hermetically sealed unit are the ballast control, reflector, and elements for producing ultra violet and infrared radiations. The light generator is of the mercury arc type, combined with a special tungsten filament designed to control the operation of the arc.

Engineers estimate that this new bulb has a life sufficiently long to permit more than 400 average exposures.

INSEMINATION

Nearly 10,000 Human Offspring by Proxy

A RECORD of nearly 10,000 American children brought into the world with the aid of the proxy-father procedure — technically termed artificial insemination — is reported by Dr. Frances I. Seymour and Dr. Alfred Koerner, of New York City, in the *Journal of the American Medical Association.*

The central and Atlantic seaboard sections of the United States have the greatest number of children sired by artificial insemination. Donors were used successfully in 3649 of the 9489 pregnancies.

More than 97 percent of all the pregnancies resulted in living, normal babies. The number of miscarriages and abortions was only one fifth the rate among women achieving pregnancy without the aid of artificial insemination. More than 1000 mothers had more than one baby with the aid of this method.

More than 400 surgical operations of the type frequently performed on mothers to cure sterility and enable them to have babies were prevented.—*Science Service.*

FATIGUE

Timing Breaks Down When Skilled Workers Tire

TIMING is the first thing to go wrong when workers at highly skilled tasks get tired, Prof. F. C. Bartlett, noted British psychologist, states in the British scientific journal, *Nature.*

"Until a state of great fatigue is reached," he says, "it is far more likely that the right actions will be performed at the wrong times than that the wrong actions will be performed. If accurate timing is insisted upon, gross mistakes of action may appear."

The worker at such highly skilled tasks is, unfortunately, unaware when his work deteriorates with fatigue. He is likely to think he is doing better work, Prof. Bartlett found, because he becomes more and more lenient in his judgment of what errors are significant. When he does recognize an error, the fatigued workman is likely to blame it on conditions or on the interference of other people.

The fatigue that comes from highly skilled work makes the worker "forget" details not closely organized with the main part of his work. Yet, at the same time, he is more easily distracted by things that have nothing directly to do with the task. Bodily sensations, such as hunger or thirst, become more pressing and insistent, and affect worker performance, even in such easy tasks as the naming of colors.

Our Search for the Supernatural—VI

With the Aid of "Psychic" Powers a Table is Tilted, a Pendulum Clock is Stopped

A. D. RATHBONE, IV
Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

• Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. •

CONTINUING our search for the supernatural, Chairman Dunninger, of the Scientific American Committee for the Investigation of Psychic Phenomena, introduced Signor Raduano to members of the Committee, representatives of the press, and guests who had assembled July 21st in the Commodore Hotel, New York City. Through the aid of certain mysterious powers claimed by Signor Raduano, and which he prefers to term "psychic" rather than "supernatural," Dunninger explained that the signor would endeavor to stop a clock at a pre-designated time, and that he would attempt table levitation. Finally, stated our Committee Chairman, Signor Raduano would essay an unique and difficult experiment in telepathic - hypnotic clairvoyance. The latter, Dunninger added, does not fall within the realm of our Committee's investigation (Scientific American, April 1941), but in view of the popular interest evidenced by readers in telepathic, hypnotic, and clairvoyant ventures, and in deference to the signor's close study of these matters and his sincere application of his powers, it had been determined to try the experiment as an extra-curricular episode.

The clock in question was the property of Signor Raduano and resembled a type of pendulum time-piece often found in American homes of a generation ago. During introductory remarks it had hung on the black-draped wall of the room, facing the audience, but at this point it was removed and carefully examined by members of the Committee and press, none of whom could find anything untoward in the mechanism. So far as could be determined it was a normal time-piece in good working order. The clock was replaced on the wall, set for the correct time, and the pendulum was started in motion.

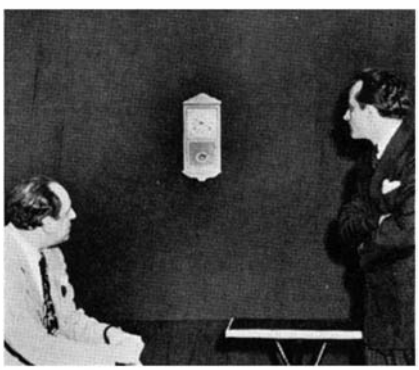
At Dunninger's request, the newspaper men present agreed on a moment at which Signor Raduano should endeavor to still the motion of the constantly swinging pendulum; the selection was announced as 4½ minutes to nine.

IT WAS then 10 minutes to that hour. Signor Raduano, a slight, dark man with unusually piercing black eyes that seemed to reflect unplumbed depths of mystic capabilities, folded his arms, cradled each elbow in the palm of one of his long-fingered hands and, standing sidewise to the audience, began gazing intently at the clock. Our Chairman, seated at Signor Raduano's right, likewise watched the time-piece with pronounced fascination.

Signor Raduano presents his pendulum clock to Dunninger and others for thorough inspection

A minute passed; two minutes, and the third and fourth fingers on the signor's left hand straightened out, then folded back about his right elbow. Next, the first and second fingers moved to a horizontal position where they remained stiffly stationary for long seconds, mechanically ticked off in otherwise utter silence by the pendulum. Again the fingers of Signor Raduano's left hand closed over his right elbow; again they moved, apparently by some sub-conscious reflex, and all the while his obsidian eyes never wavered from their intense stare at the face of the clock.

As the minute hand drew closer and closer to the appointed time, it seemed that the tenseness of the audience and of the signor became almost a tangible thing. "He has about a minute to go," remarked Dunninger in a guarded voice, and with that Signor Raduano put his right hand to his face, stroked his aquiline nose and his chin. His face muscles began to twitch slightly, his hand went back to his



First effort through "psychic" power to make time stand still

elbow where it convulsively clutched the sleeve of his coat, and it was evident that the signor's concentration of mental or psychic power was reaching its zenith. "Just about time," whispered Dunninger, whereupon the signor turned his back to the audience, stretched out his left hand, fingers open, toward the obstinate, still moving clock. He opened the door of the time-piece, gestured energetically, but the inexorable pendulum continued unabated — and the time was then two minutes to nine.

As it was patent the first attempt had failed, Dunninger said kindly: "It's a

little late now, Signor Raduano. Would you like to try to levitate the table and return to the clock later?"

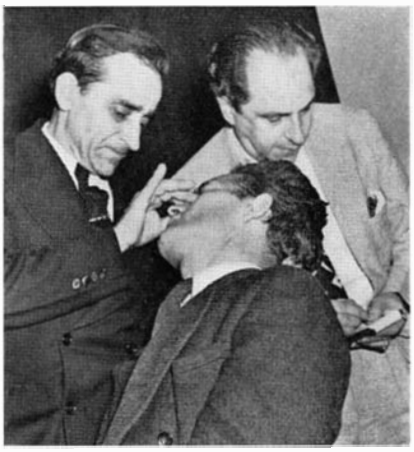
The signor at first used his own table, a light-weight, three-legged affair with a top approximately two feet square. He sat facing the audience with two of the tripod-like legs toward the group and the third toward himself. His own legs were sufficiently widespread that

Hands lightly laid on the top, the Signor prepares to tilt table

they did not touch the table legs and his only physical contact with the instrument appeared to be the flat of his two hands as he laid them lightly on the front edge of the table.

In the ensuing moment of concentration by both audience and demonstrator, the obstinate clock melodiously struck nine. Immediately thereafter a slight forward tilt of the table was observed, but it lasted only a few seconds and settled back almost at once. Then, with hands barely off the table, the back leg again left the floor for a brief interval. Once more the nervous agitation of the audience became a near-tangible force as people leaned forward in their chairs or stood upon them in order better to observe operations.

Signor Raduano removed his coat. He beckoned to a reporter who took his place at the table and allowed the signor to guide his hands to the outer, forward corners, where they lightly touched the top surface. The signor then placed his own palms between those of the newsman and drew them ever so lightly and slowly across the table top. After a few repetitions of this process, one leg was again discerned to be raised from the



Telepathic-hypnotic experiment by Raduano, Dagan, Dunninger

floor. Signor Raduano at once removed his own hands and for a few seconds the table remained in suspension, apparently motivated only by the palms of the reporter's hands. This performance was climaxed with the use of a small table, the property of the hotel, which was also tilted on two legs by the signor and so maintained without apparent physical contact with any part of Signor Raduano's body, other than his hands.

Noticeably weary from his intense mental and physical concentration, Signor Raduano nevertheless consented to again endeavor to stop the clock. It was then 9:17 P.M. and the newspaper men's group suggested 9:24 P.M. as a stopping time. In this instance the signor stood on the other side of the clock, but in the same arm-folded attitude. Once more his elbows were cradled within the palms of his hands; once more the fingers twitched convulsively. With greater intensity than ever, members of the audience leaned forward expectantly in their seats, for it was evident that the dark-eyed Signor Raduano had captured the sympathy of the group.

On swung the pendulum; the minute hand moved excruciatingly slowly, but it did move on toward the fateful moment of 9:24 P.M. At exactly 23 minutes past nine Signor Raduano's right hand shot forward in a determined gesture toward the face of the clock. It was as if this little man with the black hair and piercing eyes was telling all time to stand still. His fore-finger pointed; then the second finger joined the first. There were 30 seconds to go; then 15; then 10, and finally only five. Suddenly the swinging pendulum showed its first sign of hesitancy. It wavered in its stroke; it slowed down; it stopped completely. The time was exactly 9:24 P.M., and Signor Raduano gleamed a brief smile of triumph.

THROUGH fortuitous circumstances it was possible for our Committee to place at the disposal of Signor Raduano a clairvoyant subject in the person of Roger Dagan. For the past 17 years Mr. Dagan claims to have practiced self-hypnosis and states he is able to mentally transport himself by this means to the world as it was a hundred centuries or more ago. Although the signor had been able to test Mr. Dagan's receptivity but once prior to the Commodore Hotel demonstration, both men agreed to attempt the experiment again in the presence of our Committee and their guests. Accordingly, Roger Dagan was seated in a chair at the front of the room. Signor Raduano pressed Mr. Dagan's head backwards and, in a voice inaudible to the witnesses, began talking to him and stroking his forehead, his eyes, the sides of his nose. In a few moments it was evident that the subject was completely relaxed.

"Headlines!" murmured Signor Raduano, "Headlines! Tomorrow's headlines—see the headlines!" he commanded. "Read what you see in the headlines! Speak!"

Meanwhile, Dunninger, pad and pencil in hand, had taken a stand just behind the subject's head. A moment of silence and then—"U. S. Needs Huge Army," came in a low monotone from Roger Dagan's lips. This was followed by, "Japs Accuse Soviet Russia," and with that Signor Raduano sharply slapped his subject's cheeks, shook his shoulders, spoke commandingly to him.

Mr. Dagan blinked a few times, shook his head, and rose to his feet, apparently none the worse for the experiment. What he had enunciated in his trance were purportedly newspaper headlines of the following day. Close study of New York City's dailies failed to show satisfactory evidence of success.

In conclusion of this month's story it must be remembered that Signor Raduano was given absolute freedom to perform whatever exploits he deemed pertinent and that he was in no way put to any test. The signor claims to have the ability to conduct other psychic experiments and it is anticipated that in the near future our Committee will recall Signor Raduano for further and still more interesting developments.

Across Panama By Road

Concrete Surface and Bridges Sufficiently Strong to Carry Safely a 55-Ton Tank

NOT SINCE the days of the gold trail of the 17th Century has there been a passable road across the Isthmus of Panama. Now, however, under blazing tropical sun by day and under electric lights at night, 1000 men are toiling on the construction of a highway that will cross the Isthmus, linking the Atlantic with the Pacific. Aided by giant scrapers and power shovels, by next spring these men will have completed a modern highway 24½ miles through hills and jungle from a point near the Fort Randolph Road in the Canal Zone to Madden Dam. Built for safe use at speeds of 60 miles per hour, the highway and its bridges will safely carry a 55-ton tank.

This section of highway is a part of the 50-mile Trans-Isthmian Highway which will connect Colon, on the Atlantic end of the Panama Canal with Panama City, on the Pacific end. Most of the highway that it was practical to locate within the Canal Zone has already been built. Now the United States is constructing the remaining 24½ miles, most of which is located within the Republic of Panama. All of the highway is on the South American side of the Canal. The accompanying map shows the location of the entire Trans-Isthmian Highway with respect to the Panama Canal, the railroad, and the principal cities in the Canal Zone and in Panama.

This road has been increasingly in demand since the opening of the Panama Canal in 1914. Under an agreement with the Republic of Panama, the Public Roads Administration of the Federal Works Agency, a U. S. Government unit, is in charge of the construction now in progress.

Not only will the new road provide for vehicular traffic across the Isthmus; it will also connect at the City of Panama with the proposed Pan-American Highway from the United States to South America. Between Texas and the Canal, this highway now consists of about 727 miles of cart and foot trails, and 2525 miles of roads that are either paved, all-weather, or dry weather. The last 164 miles to the Canal are paved. Except for about 25 miles of all-weather road below the city of Panama, the proposed location of the Pan-American Highway to Colombia is still impassable jungle.

Present plans for building the Trans-Isthmian Highway are the result of a treaty with Panama proclaimed in 1939. Under the terms of this treaty, the United States agreed to provide a corridor from the Panamanian city of Colon, formerly entirely surrounded by the Canal Zone, to the boundary of the Zone, and to construct a highway through this corridor.

The Republic of Panama, in return, agreed to provide a right-of-way to Alhajuela where the dam forming Madden Lake bridges the Chagres River and connects with the road from Alhajuela to Summit and the Pacific end of the Canal.

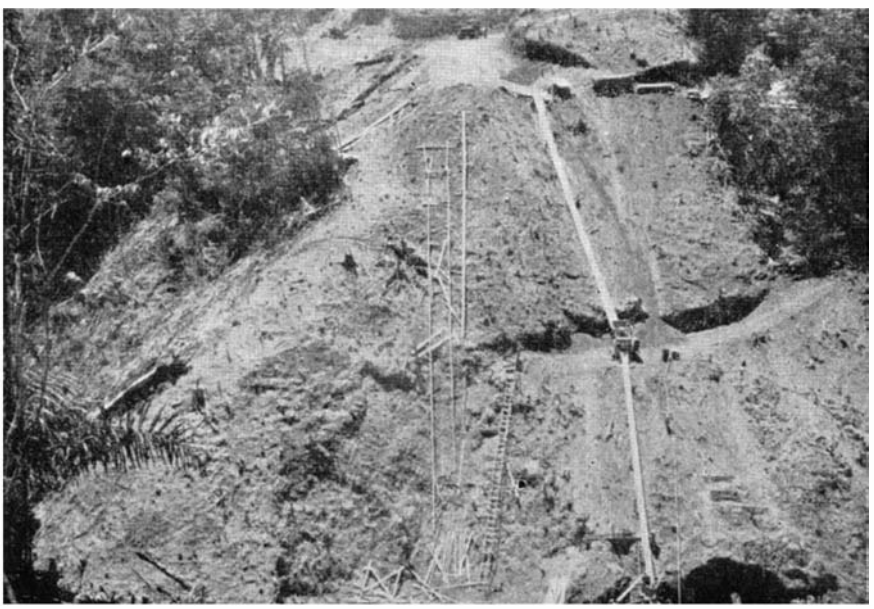
The road will have two 10-foot lanes of reinforced concrete, of nine-inch uniform thickness, separated by a four-foot bituminous strip. Eight-foot shoulders will be built on each side, making a roadway width of 40 feet. The minimum radius of curvature is 573 feet, and the minimum sight distance is 600 feet. The maximum plus grade toward the Pacific will be 5 percent. But toward the Atlantic the maximum plus grade will be 7 percent for grades not more than 400 feet long, and 6 percent for longer grades. The total excavation on the road is estimated to be a little more than 3,000,000 cubic yards.

Most of the excavation is expected to be of the "common" classification, although considerable ledge rock has been uncovered on the Madden Dam end, and more is expected in the deeper cuts. Some of the heavier cuts and fills approximate 100 feet in depth.

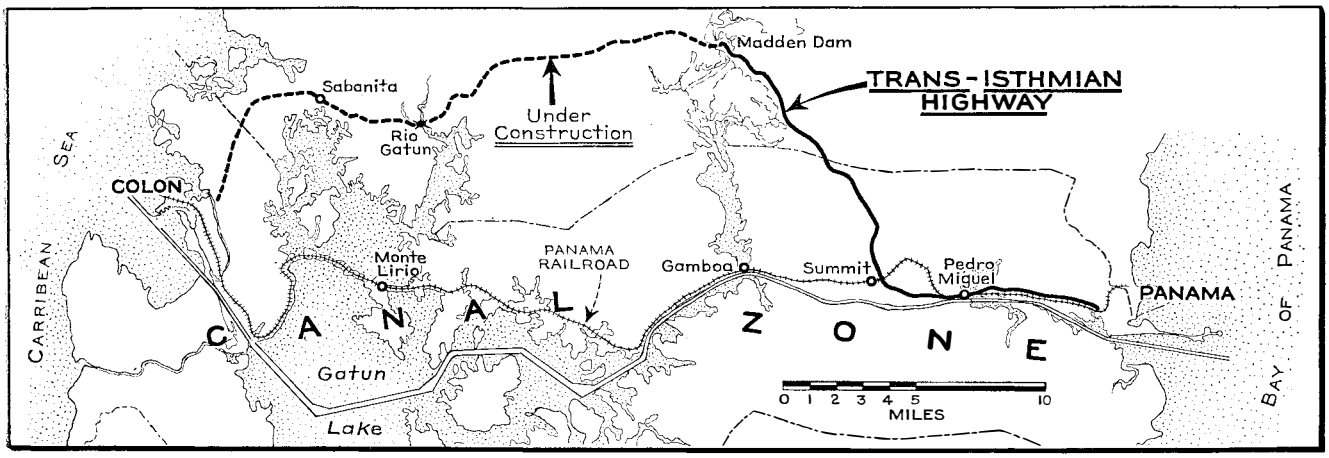
EXHAUSTIVE soil tests are being made by Public Roads Administration soils engineers assigned to the work. Their tests will reveal the composition and classification of materials, the maximum permissible heights of fills and the safe angle of slope for cuts and fills.

More drainage structures are required on this route than are needed on most roads of equal length in the United States, because of the heavier rainfall. The average annual rainfall in Panama is about 100 inches, most of which falls from May to December, the rainy season.

Six major bridges, six minor



Culvert construction where grade line is 97 feet above the culvert. Aggregates slide down to mixer; concrete is poured, by another chute, to culvert



Route of the Trans-Isthmian Highway that will connect the Atlantic and Pacific ends of the Canal

bridges, and numerous culverts are required. The largest bridge, that over the Rio Gatun, will be 330 feet long. Each of the major structures will have three spans, with continuous steel girders. The decks will be of reinforced concrete, with a roadway width of 26 feet between curbs. Railings will be of structural steel.

In designing the bridges it was desired to avoid any sort of portal structure and to select a type of structure that could be erected regardless of weather conditions. These requirements were met by a deck structure that could be erected without falsework.

THE location survey was started from three points in October, 1940, and was completed last April. Construction of concrete box culverts is being carried on directly in advance of excavation work, and clearing and grubbing work is proceeding from various points on the projected line.

At the time of writing, grading operations are in progress out from Madden Dam, from Rio Lopez southeastward to Rio Gatun, and in both directions from Rio Gatun near the site of the bridge crossing.

At the present time nearly a thousand men are employed on the engineering and construction of the highway. They are housed in camps located at Sabanita, Rio Gatun, and Madden Dam. Electric lights have been installed so that some of the work is on a 24-hour basis, six days a week. Twenty-seven 12-yard tractor-scraper units, three 1½-yard power shovels, and two ¾-yard draglines are in use. In addition to the tractor-scraper units, 15 bulldozers are used for pioneer road construction and opening large cuts. A portion of the excavation is of such a nature that movement of earth by bulldozers is very economical.

All clearing and grubbing is done by native machete men; four treedozers assist in removing from the right-of-way large trees that have been felled by the machete men.

Two eight-inch sand and gravel pumps mounted on barges are at work in Rio Gatun approximately one mile from where the route crosses the river. Sand and gravel are pumped 600 feet to a plant where they are loaded into six-yard trucks which haul the aggregates over a pioneer road to the batching plant at the crossing of the Rio Gatun.

Most of the heavy duty equipment—shovels, tractors, and scrapers—was unloaded at Monte Lirio on the Panama Railroad and carried by barge 11 miles to the point where the highway crosses the Rio Gatun. At other points where camps were established, pioneer roads were constructed and equipment, supplies, and materials were sledded in, using tractors.

Panamanians are employed extensively for the unskilled labor in clearing and grubbing and other construction operations. Panamanian instrument men, chainmen, rodmen, and machete men are employed with the engineering parties. Operators for the heavy power equipment have been brought from the United States because of the need for men skilled in the use of these types of equipment. Panamanian laborers are given every opportunity for employment in all positions for which they may be qualified.

Cement will be shipped in a chartered bottom in order to assure a constant supply. It will be brought to the work through Summit and Monte Liro by truck and barge, respectively. Cement and structural and reinforcing steel will be shipped from the United States. Construction of reinforced concrete pavement will begin in the near future.

All engineering and construction work is being carried on by the Public Roads Administration under an agreement with Panama. Panama furnishes all right-of-way and deposits of local materials.

• • •

SAFE AT WORK

Record of Employees In Petroleum Industry

OIL-COMPANY employees in 1940 sustained only a little more than half as many fatal injuries while on duty as they did when not working, a review of the fatalities by the American Petroleum Institute's Department of Accident Prevention reveals.

The 1940 fatal-injury record of the petroleum industry was the lowest since data have been reported, according to H. N. Blakeslee, director of the department, and was 49 percent below the fatality rate in 1930.

Oil companies employing 327,112 workers reported 101 fatalities last year, or a rate of 30.9 per 100,000 workers. Off-duty fatalities of oil-company workers, reported for more than two-thirds of these employees, were almost twice as high as the industrial fatalities. The rate per 100,000 employees for those reporting both industrial and off-duty fatalities was 28.3 while on duty, compared with 48.3 while off duty.

Plain Water's Unplainness

Recent Research Reveals Some Odd New Facts About Common, Ordinary "Simple" Water

WALTER L. FINLAY
Remington Arms Company, Bridgeport, Connecticut

"EUSTACE, here," the Research Director crowed fondly, "has just discovered a cheap substitute for water!" Thus quipped a recent cartoon. But before his Board of Directors could be lamentably sure that they had the biggest white elephant of all time on their hands, Eustace would have a lot of work ahead of him until he established that the new "Eustacium" duplicated water in all important respects. For water —common garden-variety water— is not so simple a substance as first it seems.

Quite early the schoolboy learns that water is H_2O; that it freezes at 32 degrees, Fahrenheit, and boils at 212 degrees, Fahrenheit. Later, about the time he substitutes 0 degrees, centigrade, and 100 degrees, centigrade, for the more plebeian Fahrenheit points, he adds the qualification "under a pressure of one atmosphere." Then the complications begin. It seems that all water is not just H_2O; it seems that there is a variety termed "heavy water"; it seems that not merely one but seven different ices exist; that pure water is actually stronger than pure lead or pure tin; that, even when at the boiling point, water always contains a high percentage of ice; that pure water does not freeze at 32 degrees, Fahrenheit (or at 0 degrees, centigrade, either); that water at atmospheric pressure can be heated past its traditional boiling point of 212 degrees, Fahrenheit, without boiling; conversely, that water can readily be cooled 10, 20, even 30 degrees below the time-honored 32 degrees, Fahrenheit, without freezing; and finally it seems that 700-odd closely printed pages in a recently-published treatise by N. Ernest Dorsey, were barely adequate to describe the "Properties of Ordinary Water Substance." The glass of water tossed off unheedingly several times a day is thus seen to be a rather remarkable fluid.

Assuming that this glass holds the usual eight ounces, the drinker swallowed about 780,000 billion billion (780,000,000,000,000,000,000,000) H_2O molecules seasoned with some 120 billion billion D_2O molecules. The latter — dubbed "heavy water" or deuterium oxide —differ from the usual water

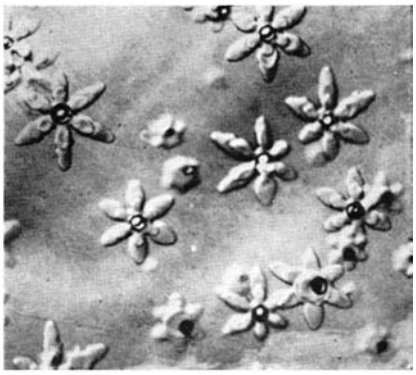


Figure 1: **Tyndall's ice flowers**

molecules in that their hydrogen atoms possess twice the mass of the standard hydrogen. One hundred and twenty billion billion D_2O might appear to be quite a mouthful of molecules but heavy water constitutes less than 1/50 of 1 percent of all the water molecules present in normal water. As a matter of fact there are almost as many dissolved air molecules present in water under room conditions as there are heavy water molecules. A census of the eight-ounce glass would roster about 45 billion billion oxygen and some 50 billion billion nitrogen molecules. The latter figure includes the numerically insignificant rare gases —argon, neon, helium, krypton, and so on. The 45-to-50 oxygen-to-nitrogen ratio reflects the fact that water prefers oxygen to nitrogen. Fish, therefore, enjoy a more stimulating oxygen - to - nitrogen ratio than man, but their's is much more dilute.

Dissolved air is no exception to the rule that dissolved impurities raise the boiling point and lower the freezing point of water. Since the freezing point of water is normally determined in the presence of air—and the 32 degrees, Fahrenheit, and 0 degrees, centigrade, thermometer points are so fixed— the freezing point of pure, air-free water is higher than 0 degrees, centigrade. The exact figure is 0.0024 degrees, centigrade.

Dissolved air also acts as a sensitive set of nuclei about which bubbles can form. Hence, while air-free water can frequently be raised considerably above the boiling point before boiling begins, provided the liquid is not subjected to shock of any kind, it is extremely difficult to heat aerated water beyond 212 degrees, Fahrenheit, without boiling. The world's record for this is an almost incredible 270 degrees, centigrade, obtained in 1924 by the research team of Henrick, Gilbert, and Wismer. They used a capillary tube under normal atmospheric pressure. When boiling does start in such superheated water the entire mass flashes into steam with explosive violence. The tendency of dissolved air molecules to act as points about which additional air or water vapor molecules can congregate as bubbles also lowers the tensile strength of the water.

BUT IN what sense does a liquid have a tensile strength? Recalling that tensile strength is normally determined by pulling a rod or other suitable solid shape into two pieces, it would seem to require a neat trick to pull a column of water apart. Marcellin Berthelot, the first great organic synthesizer, did just that, however, and he did it quite simply. Berthelot enclosed the liquid in a sealed tube which it almost completely occupied. Careful heating then expanded the liquid until it just completely filled the tube. Equally careful cooling tended to contract the liquid; but, for a time, dog-in-the-manger-like, it clung to all the volume it had gained. As the force of contraction increased, Berthelot literally stretched the liquid until, with a distinctly audible snap, it gave way. From the difference in the volumes he thereupon readily calculated the force required to tear liquid water apart. The highest value so far recorded is 2400 pounds per square inch; which, Mr. Ripley might be interested to know, considerably tops the ten-

sile strengths of lead and tin.

When water is protected from the air, as by sealing it in a Berthelot bulb, it can often be easily cooled below 0 degrees, centigrade, without freezing. Temperatures down to —21 degrees, centigrade, have thereby been repeatedly attained without freezing. One unconfirmed report gave a record low of —40 degrees, centigrade. Nature, not to be outdone, has provided her own "Berthelot bulbs" in the form of tiny natural cavities in quartz filled with very nearly pure water. And as far back as 1858 John Tyndall, of "Tyndall phenomenon" fame, found that he could supercool these liquid inclusions to —20 degrees, centigrade, without freezing the liquid. Still more interesting than these quartz cavities are the same investigator's "ice flowers." Tyndall observed that, when a beam of light was passed through a block of ordinary ice, its path rapidly became marked with bubbles from which grew six petals, as illustrated in Figure 1. A clicking accompanied their growth, since the water that was formed occupied less volume than the ice which gave it birth and, just as in a Berthelot bulb, the liquid water was stressed by continued melting until it snapped audibly. Ice flowers are a strange phenomenon, and not a least part of their strangeness is the fact that they are invariably formed by the internal melting of the ice. That is, the heat from the Sun first traverses the upper part of the ice without melting it and then neatly carves out, by melting just the right portions of ice somewhere in the middle of the block, a six-petaled and often perfectly-proportioned flower.

MANY of water's unique properties arise from the fact that the water molecule is electrically positive at one end, where the two positive hydrogens cluster, and electrically negative at the other end where the negative oxygen dominates. Figure 2 illustrates the structure of the water molecule. Neither hydrogen molecules (H_2) nor oxygen molecules (O_2) have positive and negative poles. But when they react to form water the bigger oxygen atom shares two negative electrons with each hydrogen atom, the way Hitler shares "living room" with his neighbors. As a result, the oxygen becomes negative, leaving the hydrogen atoms in a positive state.

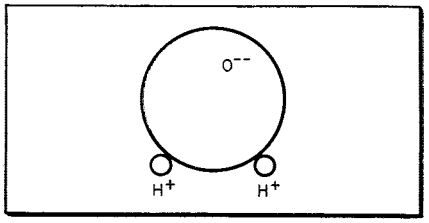


Figure 2: **Structural model of a molecule of water, showing the origin of its dipole moment**

Since unlikes attract, the positive end of one water molecule tends to attach itself to the negative end of another. The force tending to prevent this association is heat—the hotter a substance becomes the more lively do its molecules dance and the more vigorously do they bounce their neighbors away. Thus, when water boils, the molecules jig so agitatedly that vapor rather than liquid or solid is the normal state. Flying about thus fancy free, the water molecule is solitary, that is, $(H_2O)_1$. But when enough heat is removed, the molecules bounce each other about less energetically and the H_2O's pair off. In fact, many do not stop at pairing but form threesomes. Thus liquid water, from its freezing point right on up to its boiling point, is a mixture of $(H_2O)_3$ and $(H_2O)_2$. The startling aspect of the foregoing is that ice—ordinary frozen water—has been demonstrated to be $(H_2O)_3$: thus all plain liquid water is a solution of ice in a liquid of simpler molecules.* The evidence for this $(H_2O)_1$-$(H_2O)_2$-$(H_2O)_3$ picture has been accumulated during the past 40 years and is too involved for discussion here. A very crude analogy, however, is furnished by a brick wall. If pulverized brick dust floating about in the air is taken to represent water vapor, $(H_2O)_1$, then $(H_2O)_3$ would be represented by a brick. A haphazard jumble of bricks and partially agglomerated brick dust would thereupon symbolize liquid water, whereas ice would be a regular arrangement of the bricks as in a wall. Several different regular arrangements of bricks are possible and, as intimated in the opening paragraphs, no fewer than seven different ices, or arrangements of $(H_2O)_3$ molecules, are known. Very few persons, however, have ever seen or handled any ice other than Ice-I. Figure 3 shows why. It indicates under just what conditions of pressure and temperature the various forms of water can exist—and Ice-I is the only ice existing under normal atmospheric temperature and pressure. The dotted line in Figure 3 indicates the pressure-temperature conditions under which man lives; that is, one atmosphere pressure (roughly 15 pounds per square inch at sea level) between —30 degrees, centigrade, and 50 degrees, centigrade.

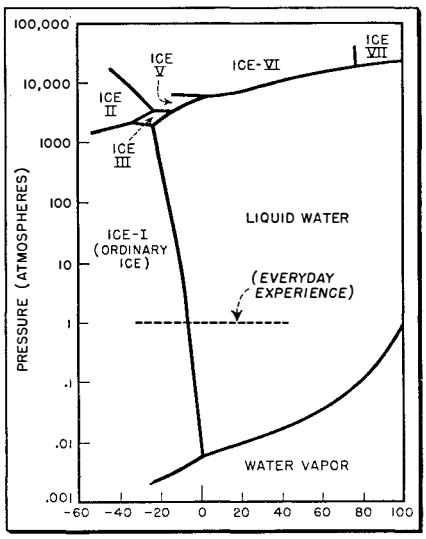


Figure 3: **Phase diagram, water**

VIEWED on such a broad general scale as Figure 3, the human range of temperature-pressure experience seems circumscribed indeed. The solid lines in Figure 3 separate regions within which the form of water labelled is stable. By stable is meant the form into which all other forms, transported to its region by an appropriate pressure-temperature change, will transform. Thus, at the center of the dotted line, liquid water is stable; moving to the left by lowering the temperature transports the liquid to the Ice-I region, whereupon it freezes into Ice-I; moving to the right by raising the temperature transports the liquid past the end of the dotted line and eventually to 100 degrees, centigrade, whereupon it boils and becomes vapor.

The secret of Sonja Henie's effortless skimming is also contained in Figure 3. It lies in the slope of a line, the line separating Ice-I and Liquid Water. If that line were sloped to the upper right Miss Henie's flying feet would be grounded; her skates would stick

*The alert reader might wonder, if the $(H_2O)_2$ were separated by some means from a sample of hot water, whether only ice would remain. The answer is no. If $(H_2O)_2$ could be removed from liquid water, enough of the $(H_2O)_3$ would break down into $(H_2O)_2$ to maintain the original ratio of $(H_2O)_2$ to $(H_2O)_3$.

to the ice. But ice melts under pressure. To represent this fact the line slopes to the upper left, indicating that the localized pressure of the edge of the skate runner melts the ice and the skater skims along on a film of liquid water. However, when the temperature gets far enough below freezing, this pressure is no longer

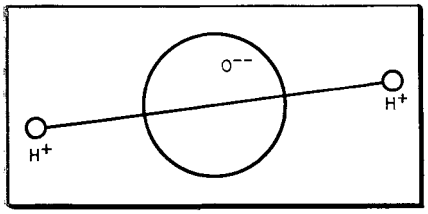


Figure 4: **Impossible structure of an H_2O molecule, without poles**

sufficient to melt the ice and the skater, her runners sticking, is reduced to walking.

Still more interesting than its explanation of ice skating is Figure 3's representation of the pressure-temperature relations under which six separate and distinct forms of ice can exist. Perhaps the most spectacular of these is Ice-VII—hot ice which, before it will freeze—that is, change from the liquid to the solid state—requires that the water be heated to at least a scalding 179 degrees, Fahrenheit! As the phase diagram shows, if the water is at any lower temperature than this, the formation of Ice-III, V, or VI, instead of Ice-VII, will occur with the application of sufficient pressure. And if enough pressure is applied, Ice-VII can even be frozen from water which is well over the normal boiling point, 100 degrees, centigrade.

None of these forms of ice can exist under pressures of much less than 2000 atmospheres. However, Tammann has been able to remove both Ice-II and Ice-III from the pressure chamber and examine them under atmospheric pressure during the short period before they transformed to Ice-I. Both slowly swelled and broke up into a coarse white powder consisting of ordinary ice. The seventh form of ice, Ice-IV, is unstable and occasionally forms in the region of Ice-V.

Figure 4 is based on the water molecule of Figure 2. If a pulp-magazine bad man were somehow to manage the minute shift of less than 0.000,000,01 of an inch in the position of the hydrogen atoms in the water molecule, as shown in Figure 4, most forms of life would speedily cease to exist. Figure 4, unlike Figure 2, illustrates a molecule without positive and negative poles. And life as we know it is unthinkable without water having the properties bestowed by the polarity of the water molecule. For the polarity—the positive and negative poles—of the latter gives to water the tendency of the molecules to associate in pairs and threesomes; the remarkable dissolving powers which have earned it the title of "universal solvent"; and the abnormally high physical properties such as surface tension and boiling point which render it invaluable. Should the shift to the Figure 4 structure transpire, the change in surface tension alone would fatally upset the delicate balance of many bodily functions; moreover, the lowered boiling point and lowered heat of vaporization would prove but poor defense against the Sun's heat and what life might survive for a short period would find much or all of the Earth's water evaporated.

Fortunately, however, there is no likelihood that any misanthropist will ever be able to effect this shift. Moreover, there is little point in speculating on the characteristics of a hypothetical water molecule when, despite the already vast accumulation of data on the properties and vagaries of ordinary water substance, a large and fertile field still is unexplored. And, as sure as plain water is not plain, additional proof of its unplainess will reward the diligent investigator who draws the subject of his study from the lowly tap.

• • •

ATOM SORTER

For High-Speed Analysis in Many Processes

PRESENT indications point toward use of a new portable mass spectrometer (see page 118) as an accurate tool for high-speed analysis of gas in oil refining and prospecting, and in heat-treating and hardening of steel. Other uses involve tracing of carbon and other elements in animal bodies in an effort to learn more about vital processes.

The new analyzing machine, demonstrated recently at the Westinghouse Research Laboratories by Dr. E. U. Condon, associate director, and Dr. J. A. Hipple, research physicist who developed the device, can sort out by weight the molecules and atoms which are the building blocks of all matter. It can quickly answer questions about intricate combinations of gases which are very difficult or impossible by ordinary chemical methods. With a little further development by oil company laboratories, the "atom sorter" probably could improve the quality of refinery products by keeping a constant check on the separation and combination of gases, and there are possibilities that the instrument can assist materially in the discovery of new oil deposits by analyzing soil gases.

"Until about 25 years ago," said Dr. Hipple, in explaining the operation and use of the "atom sorter," "it was believed that all atoms and molecules of a chemical element, such as hydrogen, oxygen, or iron, had the same weight. But recent research has shown that almost all elements contain a mixture of atoms falling into two or more weight groups. These weight groups are called isotopes, some of which are abundant, others very scarce. The portable mass spectrometer can detect and measure the percent of atoms in each of these weight classes, even when they are as scarce as one part in 100,000.

"Since the difference in weight has almost no effect on the way the particles of an element behave in chemical reactions, it gives us a valuable method of atomic analysis. For example, when a lot of heavy carbon atoms are fed to a guinea pig, these atoms go through the digestive processes just the same as other carbon atoms in the animal's diet. Then the biologist can discover where all the carbon goes in the guinea pig by analyzing bits of his body in the mass spectrometer until he discovers places where the heavy carbon atoms show up in abundance. Such research often reveals valuable clues about the bodily processes."

The portable mass spectrometer sorts atoms and molecules by shooting them around a bend in a glass vacuum tube at speeds up to a million miles an hour. The curved part of the tube is encased in a powerful electromagnet which bends the paths of the atom. The lighter the atom or molecule, the more its path is bent. At the other end of the tube the percentages of particles of different kinds are measured with electric meters.

A False Paradise for Pests

Intensive Investigation of Control Methods for Man's Multitudinous Living Enemies

CHARLES M. HACKETT

"A GROWING plant," observed the hard-bitten farmer, "hasn't got a friend in the world."

He regarded the green corn nodding at knee-level and lamented the ancient hazards of husbandry.

"That seed I put in the ground—like as not there was disease on the kernel itself. There was more in the soil. If the plant survived and grew, there were bugs waiting for it. If the bugs didn't get it, the wilts, smut, galls, or root rots might. If it gets through and grows corn, there's still more bugs waiting for it in the warehouse.

"I declare," he concluded morosely, "I don't see how so much stuff grows as does!"

The farmer's discourse, while non-scientific, is close to the truth. And scientific men know, only too well, the importance of keeping these enemies of the growing plant under control. For convenience sake, they class them all under a single head—pests. This terse designation is now a vital word in modern agricultural economics—and in public health statistics as well.

Pest control is a well-established science, supported by millions of dollars in Federal and State funds and the expenditures of endowed institutions and private manufacturers. The defense budget is large, but its significance may be judged by the estimate that "pests"—including insects, weeds, and the fungi that cause plant diseases—cost the nation more than $6,000,000,000 a year.

This spring, a new laboratory devoted to pest-control research was completed at Wilmington, Delaware, as a part of the Experimental Station facilities of the Du Pont Company. It replaced a smaller structure where, since 1937, scientists have been coping with the problems of insects, damaging fungus growths, and other challengers of man's preëminence. The new laboratory is believed to provide the most modern equipment in the world for the study of insecticides and fungicides.

All photographs courtesy Du Pont Company

Field conditions are closely paralleled in the laboratory. Carbon arc lamp simulates sunlight

"Pests," says Dr. Wendell H. Tisdale, director of the laboratory, "can be defined as those living things that cause discomfort, annoyance, or disease of humans, and those that compete with the human race for its means of subsistence. Scientifically, we group under pests destructive insects, protozoa, worms, marine forms (such as teredos, barnacles, squids), rodents, fungi, bacteria, weeds, marine algae, and other harmful forms of animal and vegetable life.

"Pests compete with man for his every means of life. They invade and infest everything. They attack from the air, soil, and water. Our animals, plants, foods, clothing, buildings, furniture, ships, and numerous other items are damaged or destroyed by them. Humans are tortured with bites, stings, diseases, and death, sometimes in its most horrible forms.

"Pests attack from all sides," continues Dr. Tisdale, "and advance in overwhelming numbers. A prominent entomologist has said that one would have to learn the names of 10,000 species of insects a year for 60 years to know them all. Bacteria and fungi or molds also can be enumerated in terms of thousands of species. Many insects, in addition to the direct damage they cause, spread other disease-producing pests such as protozoa, worms, bacteria, fungi, and viruses, which may be even more destructive to humans, animals, and plants than the carriers that spread them."

The new laboratory at Wilmington is equipped for the chemical and biological exploration necessary to develop and evaluate pest control chemicals. Insects of various kinds are raised and their habits studied for a clue that might show a chink in their armor. Elaborate equipment is employed, permitting experimenters to reduce greatly the time required to complete studies under less favorable circumstances. The peculiar habit of the Japanese beetle, for example, of gorging itself on bright, hot days when the humidity is high is indulged by favorable artificial weather conditions.

A coördinated program is carried out. Laboratory work is followed by field investigations of promising chemicals under a wide range of conditions. Thus it is possible to keep a proper balance between biological and chemical development. Thousands of new compounds have been prepared and tested within the past few years—more than 700 chemicals are examined at the laboratory yearly for their toxic qualities. The work is painstaking and often discouraging, but diligent inquiry

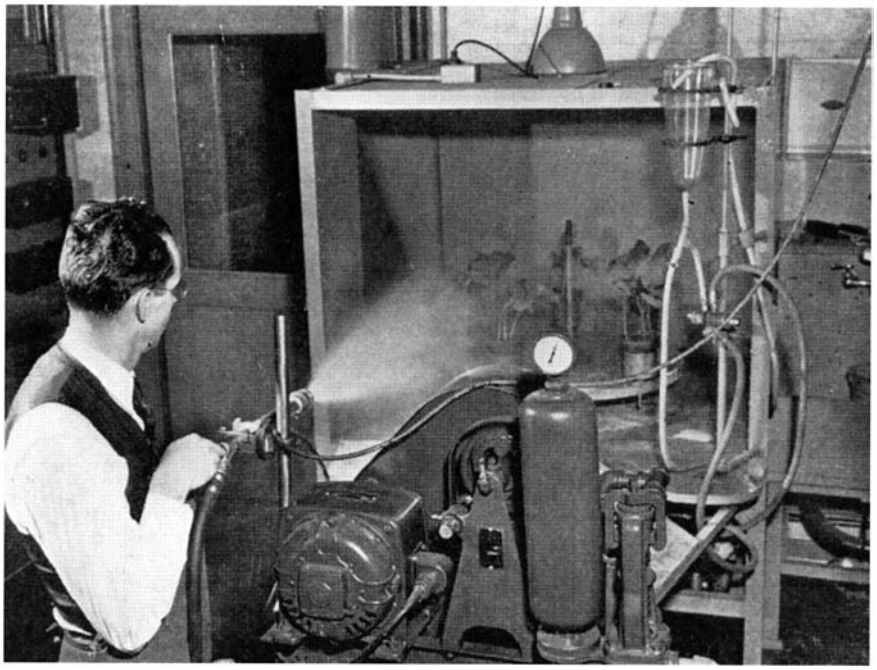
under controlled conditions is its essence. A single chemical has been subjected to as many as 286 modifications before being declared adequate for the assigned task.

Let's trace a typical experiment. A chemical is found which, after laboratory analysis and study, seems to show stomach insecticidal possibilities. It's makeup and behavior indicate possible effectiveness against the Mexican bean beetle. So a small quantity is prepared and passed on from the chemist to the entomologist for actual testing.

This scientist has a number of bean beetles in all stages of growth, reared in pampered captivity to die for science. From the greenhouse he selects pots of growing bean plants, favorite ration of this beetle. These plants are now sprayed with various concentrations of the new chemical, sequestrated in tagged jars, and hordes of hungry beetles are turned loose on the foliage.

The job now becomes a matter of tabulation. The damage done to each plant is carefully noted. What percentage of the beetles were dead in each test as compared with controls? How did the new chemical compare with chemicals in common use for the purpose?

Assume that the new compound is shown to be an excellent repellent or stomach insecticide. The trail is only slightly warm; how will it stand up under sunlight, rain, sudden changes of temperature? Will it of itself harm plants or domestic animals? In the greenhouse, treated plants are subjected to the rays of a huge carbon-arc lamp, said to be the closest thing to natural sunlight ever devised. Another period of painstaking analysis ensues. Every other circumstance of usage is anticipated and properly tested in the greenhouse.



Laboratory apparatus duplicates effect of pressure sprayers used in field

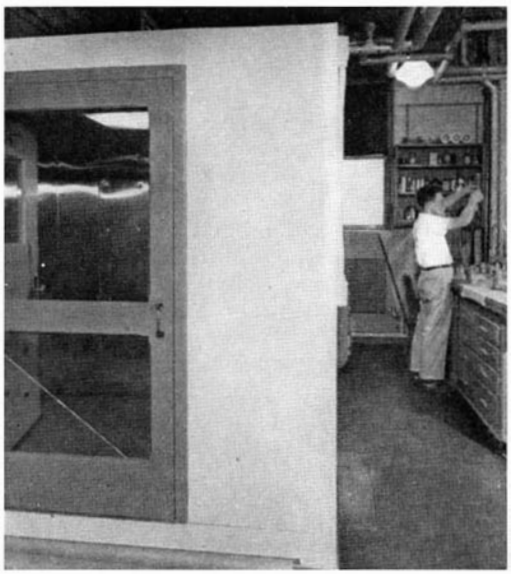
Assume again that Chemical X passes all these tests with flying colors. Now, how will it mix with the various spreading and sticking agents which would be necessarily be incorporated in a commercial insecticide? More calculating and experiment, more patient testing, more tabulation, and then the analyses of results.

If the chemical survives these tests, it is tried out on the experimental test plot, where plants are grown under garden conditions. Should this performance still be satisfactory, the chemical is ready for more extensive field tests. Samples are shipped to all parts of the country and tried out under various climatic conditions. Reports arrive from the field and the results are weighed against each other and against laboratory conclusions. Certain changes in formula are suggested by the field observations and new trials are initiated. Only after such extensive search and checking of results is a pesticide recommended.

The outline presented here is, of course, highly simplified, but in its broader sense it is representative. The research plan is pacing the present trend away from the older "universal" pest poisons and toward specific chemicals for specific purposes. Achieving this end requires full study of the exact differences in living matter. It is recognized that thorough and expert scientific service is necessary. The problem at hand must be accurately diagnosed and the most effective remedy prescribed. Scientists at the laboratory predict that this method will become increasingly important with future developments.

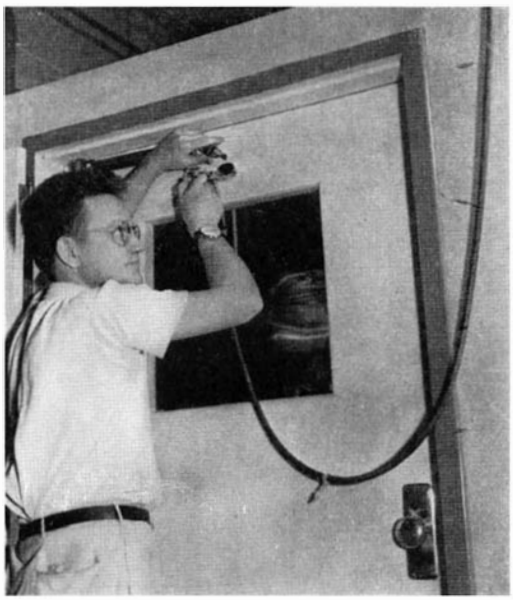
Apples are thoroughly coated with chemical spray in this laboratory set-up. Codling moths are then hatched on the apples and spray value is checked

THE GROWING economic importance of pest control has emphasized the necessity of measures consistent with the needs. Entomology for too long was regarded as a high-brow, purely academic subject. Its practitioners were once ridiculed as mysterious and slightly comic fellows, pursuing butterflies with nets. Happily this myth has been dissipated. There remains, however, a greater need for the realistic approach such as that taken by organizations like the one under discussion. In entomology, the gap between theory and practice is a hard one to span. Dr. Tisdale regards confirmation of laboratory findings by actual, extensive field tests as an essential.



Fly laboratory, with "lethal chamber" at left. ***Below:*** **Inside the chamber are numerous buzzing flies. Insecticides are introduced by air gun, results tabulated**

"Chemical warfare against pests is one of our most effective methods, if used properly," he says. "Chemicals can be used in many ways, including injections, baths, dips, lotions, sprays, dusts, poison baits, anti-fouling paints, explosives, and gases. Despite this array of applications there are many problems unsolved or only partially solved. The pests with which we have learned to live, but not trust, are many.



"In the earlier use of chemicals, the relatively few well-known inorganic poisons were employed. Some of them are still extensively used. The gradual increase in the numbers of pests and the resulting demand for more frequent and general use of chemicals has aroused anxiety over the possibility of poisoning humans who eat treated fruit or other treated food products, or who may come in contact with excessive amounts of poisonous pest-control chemicals. Cases of persons being poisoned by insecticides on fruits and vegetables are, however, extremely rare.

"Extensive investigations are directed toward improvement along many lines of chemical control. Better stomach and contact insecticides, insect repellents and attractants, rodent and other animal poisons and repellents, fungicides and bactericides, and more effective, safer weed killers are needed. Effective means of removing poisons from fruit and vegetables have been developed. Safety measures for handling poisons have been devised and further studies are under way.

"Still the need is for safer and more effective synthetic chemicals. They are hard to find, but the task does not seem impossible. Plant products such as rotenone and pyrethrum give us something at which to aim, but these imported natural plant products are unstable and the supply is uncertain. When synthetic products are found, the supply and uniformity can be regulated, as is shown by the recent chemical development of a synthetic insecticide base which reduces American dependency on imported pyrethrum."

The use of "parasites," or natural enemies, to destroy pests has been successful in some instances. In nature, many common and potential pests are held in check by other species which prey on them. A pest introduced into new territory, free of its natural foes, may develop at a rapid rate and cause enormous damage. A careful study of the pest in its native haunts usually reveals natural enemies often previously unknown. Many of such natural enemies are not adapted to different conditions, but generally some are.

Two wasp-like insects which prey on the Japanese beetle have been introduced into this country and are apparently becoming adapted. It is hoped these will eventually control the beetle, at least until a better means is devised. Fluted scale once threatened the citrus industry of California until a small lady beetle that feeds on the scale was introduced from Australia. It has kept things under control ever since. One of Australia's chief weed problems is a prickly-pear type cactus plant, which spreads rapidly, and once ruined thousands of acres of the best agricultural land. In the course of a scientific search for effective parasites, a bacterium was found that destroys the cactus. Following its release, this parasite was spread by cactus-feeding insects and is proving very effective.

There is, of course, the danger that the cure may prove as bad or worse than the pest. The West Indies, for instance, once imported the cobra-killing mongoose from India to fight rats. All went well until the rat population was annihilated, after which the embarrassed zoologists wondered how to get rid of the mongoose. Its appetite for native wild birds, chickens, and even cats made the rat seem relatively harmless. Since 1910, this animal has been denied entrance into this country.

"More should be done toward studying the natural enemies of pests," Dr. Tisdale agrees. "In the meantime, chemical research applied to pest-control problems appears to offer the best solution."

Investigations at the new laboratory cover a wide range in following out this approach. In addition to the usual problems of insect and fungus disease control, the work includes development of non-poisonous fungicides for use on stored agricultural products such as fruits and vegetables; wood preservation for the control of stains, fungus decay, and termites and other insects; preservation of cellulosic materials; preservation of harvested plant products; weed extermination; and a study of plant hormones.

"Progress appears to be slow despite the accomplishments," Dr. Tisdale admits. "Organized investigations directed toward more effective means of pest control have not been commensurate with the suffering and tremendous economic losses caused by the mul-

titude of destructive pests. However, there is a real awakening. The battle is between overwhelming numbers and dogged persistence on the part of pests against the intellectual methods of man. Which will win? I should prefer to gamble on the cunning of the human mind."

• • •

FLYING SUITS

Wired for Comfort at All Temperatures

MANY pounds lighter than the sheepskin-lined garments which they replace are the new electrically heated flying suits now being manufactured for the United States Army Air Corps by the General Electric Company. This saving in weight alone is a definite advantage to aviators, giving them far more freedom for manipulating instruments, controls, and armaments. The suits are designed to keep the

Stratospherian dress

wearer comfortable through a 130-degree range of temperature from 70 degrees above zero to 60 degrees below.

The final design of these suits, reached after much experimental work, involves an outer shell of pure wool, cut on the bias for elasticity. Sewed to the inside of this shell are the resistance wires that supply controlled heat when current from the airplane's battery passes through them. Inside the wires is a lining made of 100 percent cotton cloth. The cotton lining permits passage of heat to the body, while the outer woolen shell reduces heat loss to the air.

Wired cloth boots made of overcoat material with molded rubber soles are provided to keep the aviator's feet warm. The electrified boots are worn inside standard light aviation boots. Wired into the circuit between the battery and the heating elements in suit and boots are suitable controls to adjust the heat delivered to the body to the correct amount to compensate for changes in external temperatures.

• • •

MAN SLUMPED: The knights of the Middle Ages were mere pigmies compared to present military standards, for a twelve-year-old American boy of today can scarcely get into their suits of armor.

• • •

LAWN IMPROVEMENT

Directions by Experts for Maintenance

IN SPITE of the fact that golf greens are seeded in the fall, rather than in the spring, and that most experienced professional gardeners follow the same practice, there are thousands of home owners who cling tenaciously to the erroneous idea that spring is the time to sow all seeds.

The real enemies of grass are, in order of their importance, extreme heat, drought, and weeds. None of these occurs during fall and winter and new grass withstands the rigors of cold weather with little injury. Soils in the early fall, too, are easy to work. J. W. Lentz, Director of the Scott Lawn Research, declares most emphatically that: "Fall weather is nearly ideal both for quick germination of grass seed and for the development of a deep, sturdy root system." The seeds lodge in the warm soil, are aided by favorable temperature variation and by adequate rains.

The mechanical consistency of the soil is a prime factor in building a new lawn. Clay, silt, sand, and gravel in about equal proportions makes an ideal foundation for the perfect lawn, and the area should slope one inch in every ten feet to insure good surface drainage. The addition of liberal quantities of humus such as peat, sludge, or well rotted manure vastly improves the mechanical condition of any soil. At the same time, it is good technique to apply a good special food for grass, working in both humus and fertilizer to a depth of from two to three inches. Where grubs are known to infest the soil, about 10 pounds of lead arsenate per 1000 square feet should be applied and thoroughly raked into the soil.

Early fall seeding is recommended by most turf authorities and it is best done in two directions to ensure an even coverage. The ground should then be given a light raking and rolling so that the seed is firmly implanted in the soil.

Established lawns, too, can best be renovated in the fall. If the lawn is in such poor condition that reconstruction is advisable, determine the cause of the present failure and guard against its recurrence. Of course, even a good lawn will benefit from seeding and feeding at this season; the lawn should be vigorously raked so that the seeds will lodge in the loosened soil surface. Irrespective of weather conditions, a good lawn mixture, according to a report from Scott Lawn Research, will not be harmed if it lies dormant in the soil for several weeks. If the new fall seeding is once watered, it should then be thoroughly sprinkled several times daily thereafter in preference to one heavy watering each day, as the sprouting grass requires constant moisture. When the new grass is 2 inches high, it should be cut with a good sharp-bladed mower, using the catcher wherever possible.

LOCOMOTIVE

Fireless, Reduces Operating Costs

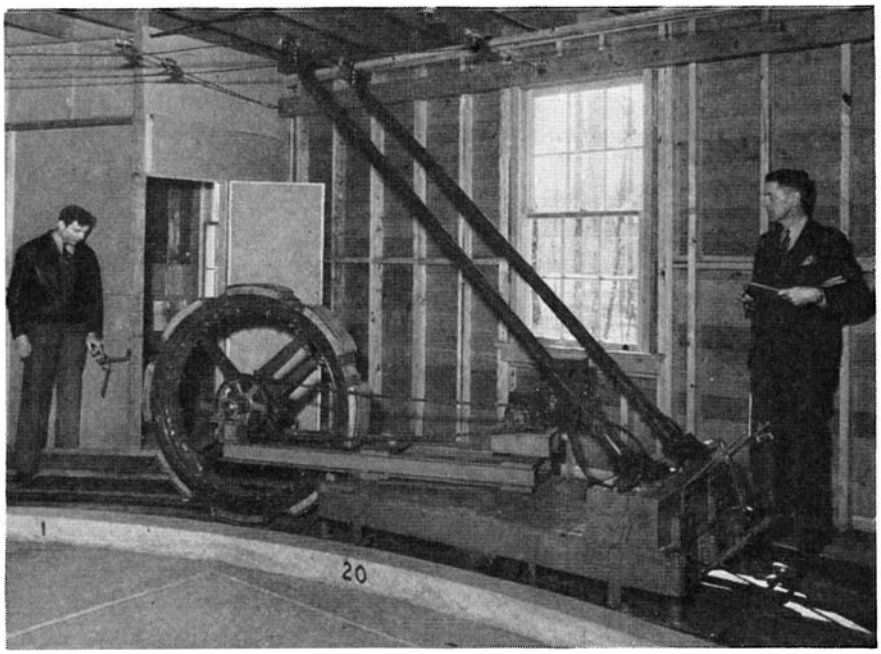
FIRELESS locomotives, described in some detail in Scientific American, January 1941, are finding increased uses in many industries where they offer a reliable means of

Runs on stored energy

cutting switching and materials handling costs. One type, illustrated herewith, made by H. K. Porter Company, Inc., operates on steam charged into it at 425 pounds pressure. This steam is delivered to the cylinder at a pressure of 100 pounds; the locomotive exerts a drawbar pull of 1333 pounds. It is claimed that this locomotive will operate for a working day on not more than two capacity charges.

Of particular interest to industrial plants where fire hazards must be carefully considered, fireless locomotives offer advantages of not contributing to these hazards and of being explosion proof since excess boiler pressures are impossible.

The initial cost of Porter fireless steam locomotives is less than that of other types of locomotives of comparable power. They are said to have a longer life than other types and hence a longer write-off period for depreciation. Other advantages claimed include low operating costs and an availability factor of 99 percent.



Its business is to wear out floors and floor coverings

• • •

TAXES—Motor vehicle owners in the United States pay nearly two billion dollars in special levies on their automobile equipment and its operation each year.

• • •

GAS MASKS

Status of Production for Civilian Use

QUERIES addressed to the editor of Scientific American regarding the availability of gas masks for possible civilian use in this country in case of an emergency prompted correspondence with the War Department. Investigation revealed that educational orders for "noncombatant masks" have been placed with five different commercial establishments in this country.

These educational orders provide for the manufacture of a limited quantity of low-cost gas masks of a type designed to meet the requirements of a military commander in providing gas masks for noncombatants remaining in areas under military jurisdiction and control.

This mask provides protection against all known war gases in the same manner as does the service gas mask issued to troops. It is not, however, designed for the long life and rugged use of the service gas mask. It is, the War Department believes, a mask that would be suitable for general civilian use if necessary. At the present time, the War Department states, "no further extension of the manufacturing facilities for these masks is contemplated."

FLOOR COVERINGS

How Materials are Tested Mechanically

IN A SERIES of tests recently conducted by the National Bureau of Standards on the durability of a variety of floor coverings placed over different types of floors, a specially constructed test chamber was employed.

The floor-testing chamber contains a circular track four feet wide and approximately 40 feet in diameter in which were installed sections of concrete, strip-wood, and plywood subfloors, and the various floor coverings. The floor coverings were subjected to 48,000 passages of a two-wheeled platform truck, a "walking wheel" four feet in diameter, and two casters. The truck carried a total load of approximately 1100 pounds and was equipped with a steel-tired wheel and a rubber-tired wheel. The walking wheel, loaded to approximately 275 pounds, was shod with eight wooden blocks which were covered with leather during the first half of the test and with abrasive cloth during the second half. One caster was a steel wheel of two-inch diameter and the other a one-inch steel ball. The equipment traveled around the track at a speed of about two miles an hour. The floor coverings included linoleums in sheet and tile form, cork-combination tiles, sheet rubber, rubber tile, asphalt tiles, fiberboard tiles, felt-base floor coverings having various wearing surfaces, three monolithic floors, and a number of wood floors. The bonding agents were lignin pastes, cumar-resin cement, alumina cement-latex paste, rubber cements, various asphaltic adhesives, and nails.

Complete results of the tests, with photographs, are given in bulletin BMS68, available through the Government Printing Office at 15 cents.

• • •

SMOKING SIRUP: One fourth of all the maple sirup produced is used in the tobacco industry and nearly all of this is purchased by one company.

• • •

CAULKING COMPOUND

Applied Without Tools, Easy to Handle

A SEALING and caulking compound, called Kalk Kord by the manufacturer, Presstite Engineering Company, is a plastic, non-oxidizing compound that, it is claimed, will not check crack or harden. It can be easily applied without tools to caulk window and door frames or to seal cracks in wood, plaster, and

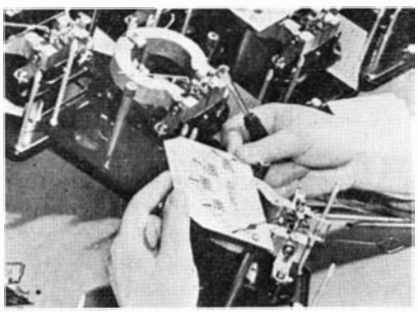
so on. Kalk Kord is simply applied with the fingers, being pressed into the opening to be filled. It is packed in convenient rolls, so that application consists merely of pressing a length of the cord-like plastic substance into place.

It is clean to handle, grayish-white in appearance, can be painted over immediately and will not stain paint. Because it always remains plastic, Kalk Kord will not crack with temperature changes or expansion and contraction of surrounding areas. It is waterproof, and can be used in the bathroom to seal cracks in fixtures, around tub edges, and so on.

PLASTIC PAINT

Protects Dials on Electrical Instruments

A NEW white plastic finish, capable of resisting indefinitely the combined attacks of high temperature, corrosive fumes, and humidity, will protect dials on the latest type industrial and military instruments. The new finish, developed by engineers of the Westinghouse Meter Division, eliminates destructive discoloration of dial faces which often hampers emergency reading of instruments vital to the safety of industrial machinery, tanks, aircraft, and ships.



Stays clean

The "world's worst weather" has been created in the laboratory to test the new plastic. Finished dials were placed in chambers where the heat and humidity of the tropics and the cold of polar regions were reproduced artificially. Biting salt vapors simulated conditions at sea and along certain coastal areas. Oil and tar smoke were used to determine whether the dials would remain pure white in their glass-enclosed cases when placed in factories and in the engine rooms of ships. Other tests revealed that the finish is resistant to gaseous fumes encountered in industrial and military service.

In a series of experiments ordinary dial lacquer changed to light coffee brown after 10 hours of exposure to dry air at a temperature of 317 degrees, Fahrenheit. Fumes from heated raw phenolic plastics changed white to straw color after 120 hours. Dials were mottled with yellow splotches after 100 hours of saturation in a sulfur-dioxide atmosphere. Plastic-coated dials remained unchanged under identical conditions.

Metal dials are coated by an automatic spraying process; lettering is done by a printing process using specially prepared inks. Accuracy required in electrical instruments makes it necessary to print dial markings with a variance of less than 5/1000ths of an inch.

• • •

MOSQUITOES—There is no royal road to mosquito elimination, according to entomologists of the Department of Agriculture. Carefully planned action against the breeding places is the only dependable control measure. This should be supplemented, however, by thorough screening and the use of sprays and repellents.

• • •

HOME SYPHON

Uses Any Bottled Carbonate Beverage

DOUBLE advantages are to be found in a newly designed device for dispensing carbonated beverages from the original container. First, dispensing is made easier, and second, the bottle remains sealed at all times, the contents retaining its "pep" until used.

A good mixer

The dispensing device, known as Soda-Mizer, consists of a tube which is inserted in the bottle after the crown cap is removed, terminating in a plastic cap which houses a simple yet effective valve mechanism. A wire clamp holds the unit firmly in place. After the bottle is sealed with the Soda-Mizer, it is only necessary to press the button on the top of the unit to draw a stream of the carbonated beverage.

BATTERY

Rechargeable Unit For Hearing Aids

ENCASED in transparent Lustron, a plastic which is not affected by strong acids, a new rechargeable battery is now available for use with various types of hearing aids. Known as the Wheat rechargeable battery, it is light in weight, compact, and yet is reported to have ample power for the purpose.

Liquid type, yet safe

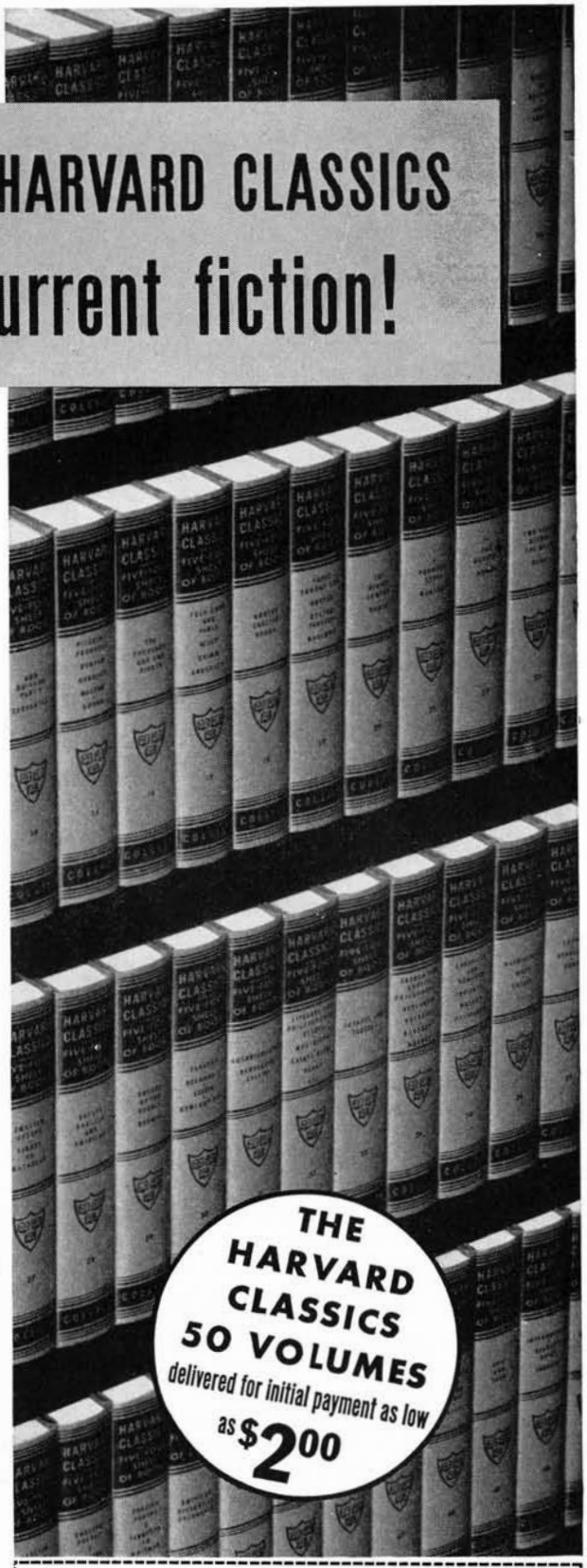
GLASS RECORDS

Replace Aluminum Sound Recording Discs

HIGH quality sound-recording blanks using a plate glass base are now available on the market. These disks are being manufactured by the Presto Recording Corporation to replace the aluminum base disks which were generally used in the past.

The new record is .104 of an inch in thickness; the coating compound which serves as the recording medium adds to the durability of the disk. Breakage is reported to be no more of a problem than with ordinary commercial phonograph records. The holes for the turntable shaft and the cutting mechanism drive pin are bushed with soft brass eyelets to insure a snug fit and to prevent chipping.

NOW—THE WORLD-FAMOUS HARVARD CLASSICS at 1/3 the cost of current fiction!



Low price makes it easy for everyone to own THESE FAMOUS BOOKS that afford success and happiness!

HERE it is!—The chance of a lifetime to own DR. ELIOT'S FIVE-FOOT SHELF OF BOOKS (The Harvard Classics) at a cost per volume *⅓ the price of popular fiction!* Actually, for as little as 7¢ a day, you can *have* this marvelous library that makes a university of your home—a price so low that no one now needs to be without these world-famous writings.

Educational Background Necessary

To the modern man or woman, the broad background of general education is an absolute necessity for business or social success. Perhaps you didn't go to college. Perhaps you did—but missed the liberal courses that give cultural background. *In either case,* The Harvard Classics can make it up to you.

Liberal Education At Your Fingertips

It was the purpose of Dr. Charles W. Eliot, President of Harvard University for 40 years, to give the equivalent of a liberal education in this famous fifty-volume library. That he succeeded masterfully is borne out by the fact that more than half a million sets of 50 volumes each—or *25,000,000 actual volumes*—have gone into American homes!

Nowhere else in the world will you find such riches for so little money! Brentano's, one of the largest firms of retail booksellers in the world, recently stated that *for only the partial contents* of The Harvard Classics, in ordinary cloth-bound editions, the cost would be $402.00. Yet here, in a magnificent new Library Edition, exquisitely printed, beautifully illustrated, handsomely and unifotmly bound, you can have these precious writings at *a fraction* of that cost. Truly, this is a marvelous opportunity!

Contents Complete, Inclusive

This handsome new edition contains the complete contents of DR. ELIOT'S FIVE-FOOT SHELF OF BOOKS! Every word, every line, every paragraph is here! Fifty volumes, 22,407 pages of superb reading, 418 of the world's masterpieces, the famous Lecture Volume, the Daily Reading Guide—*and* the unique Index of 76,000 entries that gives you the key to this vast storehouse of knowledge! All at a cost per volume *⅓ the price of a current popular novel!*

Only 50 Cents a Week

Not only is the new price of these famous books amazingly low! You are given the advantage of extremely liberal terms. Think of it! For an initial payment as low as $2.00 you may have this luxurious edition placed in your home with all shipping charges prepaid by us! No man or woman in America needs to wait longer to profit from the stimulation, inspiration and entertainment of these precious volumes!

Send For These Famous Free Books

The famous little book, "Fifteen Minutes a Day", furnishes you with full information about The Harvard Classics. It gives Dr. Eliot's *own plan of reading*—is packed with helpful, practical information! Also, for a limited time only, we will send you "Men Behind the Classics" which contains dramatic biographies of men whose immortal writings appear in The Harvard Classics. A fine piece of literature. Both of these booklets will be sent you free, postpaid and without obligation. Simply fill out and mail the coupon below.

DR. ELIOT'S FIVE-FOOT SHELF OF BOOKS

(THE HARVARD CLASSICS)

THIS COUPON ENTITLES YOU TO FREE BOOKLETS (For Adults Only)

P. F. COLLIER & SON CORPORATION
The World's Largest Subscription Booksellers
250 Park Avenue, New York City

Yes! I am interested in receiving by mail, free and without obligation, your valuable booklet, "Fifteen Minutes a Day," describing the famous library, Dr. Eliot's Five-Foot Shelf of Books (The Harvard Classics) and containing Dr. Eliot's own plan of constructive reading. Also the beautiful brochure, "Men Behind the Classics." HCN. 646

Name Mr. Mrs. Miss .....

Address .....

Industrial Growth

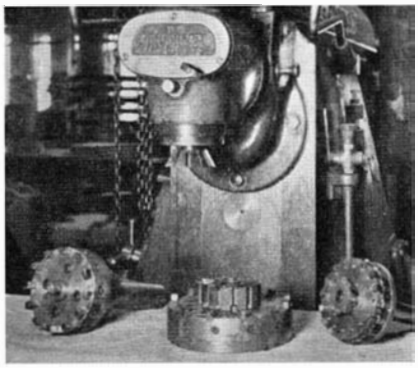
New Products and Processes That Reflect Applications of Research to Industrial Production

INSERTED BLADES

Standard Tools

Speed Production

STANDARD low-cost Carboloy turning, facing, and boring tools, which are now available on the market, are being adopted by a number of manufacturers, including the C. A. Porter Machinery Company, producers of industrial machinery. By



Cutters that use standard tools

using such standard tools, which are manufactured on a mass-production basis, it is possible to avoid delays incident to design and production of special tools or blades. In many cases the standard tools can be used without alteration; at most it is necessary only to cut off the shanks and perhaps regrind the cutting edges.

One of our illustrations shows three multi-blade cutters of which the bodies are made by Porter. These bodies are then assembled with the inserted blade cutters in the company's tool room, after grinding the standard tools to be used.

EFFICIENCY

Handling of Materials

Expedited Simply

MORE than 1000 parts and 75 different materials are used in the assembly of a De-ion motor line-starter in one of the plants of the Westinghouse Electric and Manufacturing Company. These parts are assembled by means of an electrically operated nut driver. To simplify assembly operations the parts are placed in the fan-shaped arrangement shown in one of our photographs and the nut driver is suspended from a vertical spring to remove it from the point of application when not in use.

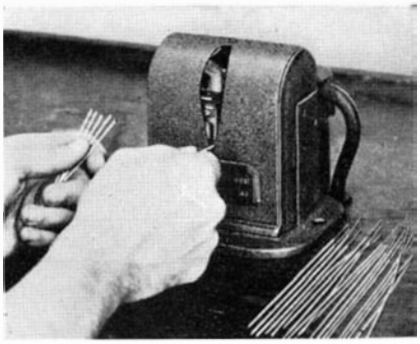
WIRE STRIPPER

Electrically Heated

Blades Remove Insulation

A DEVICE for rapidly stripping cotton, silk, and rubber coverings from wire, known as the Ideal Hot Blade Wire Stripper, announced by the Ideal Commutator Dresser Company, operates with blunt blades. Thus there is no possibility of cutting the strands of fine wire or of injuring the conductor in any way.

The wire is merely inserted between the electrically heated blades in the stripper head. Pressing the foot pedal brings the blades against the insulation and instantly two parallel grooves are burned right down to the conductor. The grooves are completed with a slight twist



Insulation is stripped clean

to right or left; a pull removes the insulation, leaving a clean edge. With a little practice the twist and pull become practically a single movement. The strippings fall into a water drawer where any burning particles are quickly extinguished.

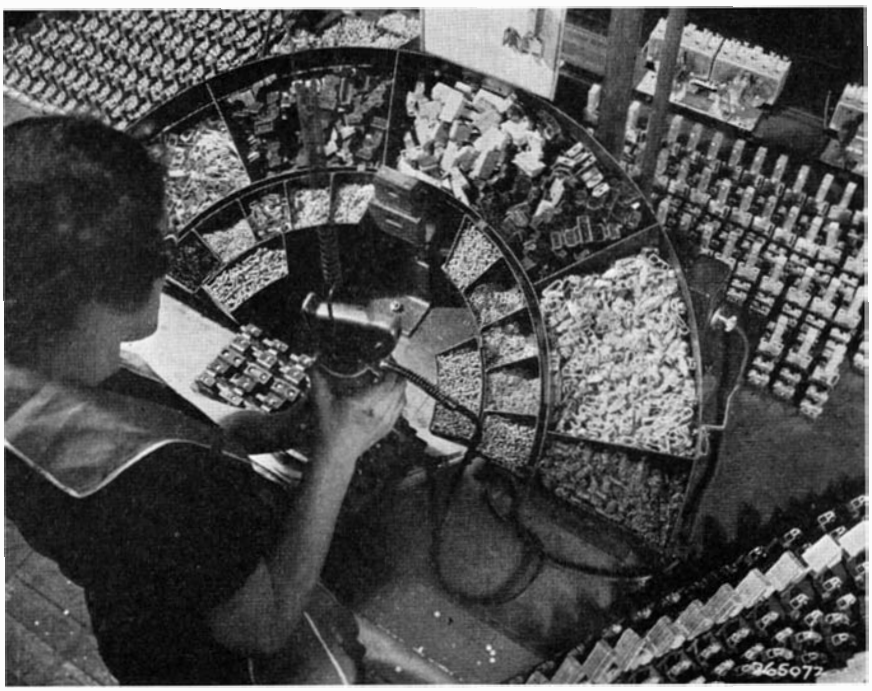
Each blade has an individual heat control and transformer so that the burning temperature of each can be separately raised or lowered as desired, depending upon the type of insulation and thickness. Both the distance between the blades, and desired length of stripping are quickly adjustable.

GASKETS

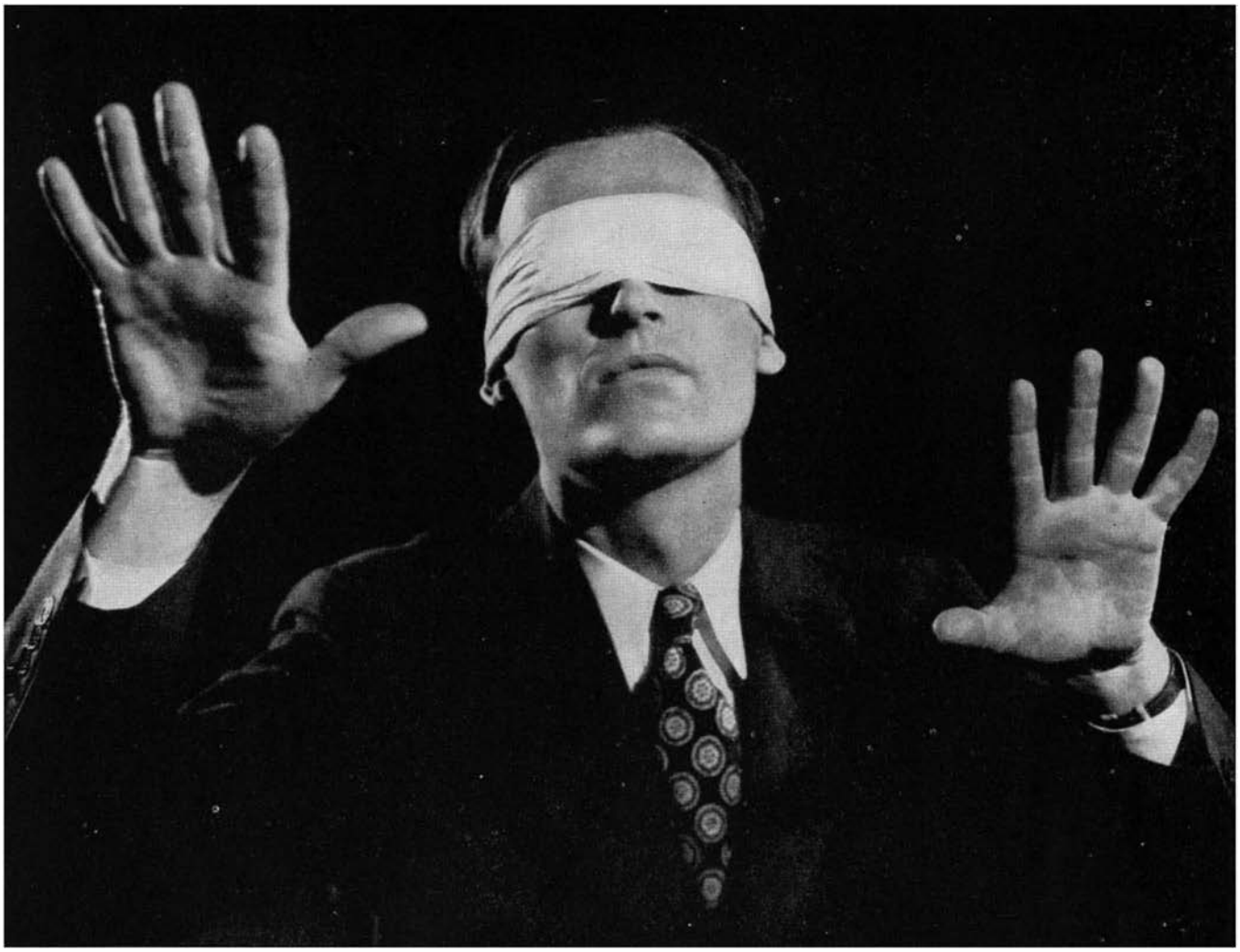
Synthetic Rubber

Proves Satisfactory

FOR keeping grease and oil confined in bearings in various types of machinery, gaskets made of Ameripol, the synthetic rubber developed by the B. F. Goodrich Company, is proving highly successful. Tests show that the gas-



Parts for assembly are placed within convenient reach of operator



WHITE COLLAR MEN ARE STILL A DIME A DOZEN!

LOOK around your office. A few men have "arrived". They are the executives, earning big money. The others are what the top men in the company call "white-collar workers"—able, conscientious, hard-working—perhaps with specialized training, but they are nevertheless figuratively worth a dime a dozen.

WHAT'S THE DIFFERENCE between the executive and these "white-collar workers"? That's the question being asked by men who have hopes . . . men who want to climb out of the rut and into the top-flight class themselves. The answer is—*there's very little difference!*

Has the man who makes $5,000 twice as much brains as the man who makes only $2,500? Has the man who makes $10,000 twice as much brains as the man who makes $5,000? Of course not! And it would be amazingly easy for *many men* to transform an average salary into a large salary!

HOW IT'S DONE! The difference between success and merely "getting along" lies in executive training. In the old days, successful executives had to gain their ability through long years of experience. But as business became more complicated, educators became business-minded. Many big universities added schools of business; the Alexander Hamilton Institute was founded—and since then has pointed the way to success to more than 400,000 men!

HOW YOU CAN DO IT. The Institute has organized and formulated the knowledge of the country's most successful business men. Co-operating with it are dozens of leaders like Edward R. Stettinius, Alfred P. Sloan and Thomas J. Watson. As a result, the Alexander Hamilton Institute offers you modern, up-to-the-minute training and information you would almost have to give your right arm to gain by any other method!

CUSTOM-MADE TO SUIT YOUR NEEDS. Please get this fact clear in your mind. *The Alexander Hamilton Institute offers a PERSONAL service, geared not only to YOUR particular needs, but to your particular needs TODAY—whether you are a young man just earning his first business laurels, or a busy corporation official who wants to keep up with rapidly changing economic conditions.*

PUT IT UP TO US. Why not prove to yourself that you have the first quality of an executive—the ability to make a decision? Write us for a free copy of that important little book, "Forging Ahead in Business". For many men this simple act has been a major turning-point in life!

Alexander Hamilton Institute, Inc.
231 Astor Place, New York, N. Y.

Please mail me, without cost, a copy of "Forging Ahead in Business".

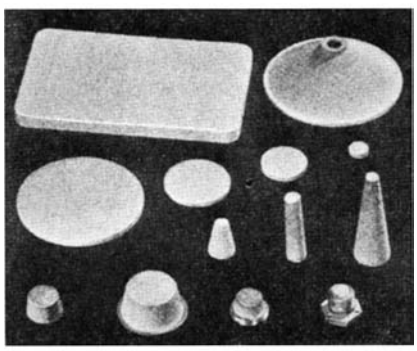
Name . . . . . .
Business Address . . . . . .
Position . . . . . .

kets do not swell at all in gasoline at room temperatures, and that after immersion in oil for long periods they do not swell materially. A high degree of flexibility and abrasion resistance is found at all times. These gaskets are made by either the molded or lathe cut methods.

FILTER, DIFFUSER

Made from Powdered Metal, Has Many Applications

REPRESENTING what is described as a new technology in control of filtration and flow of liquids and gases, a porous metal product known as "Porex" has just been introduced by Moraine Products Division of General Motors Corporation. Porex has two principal functions: to remove foreign materials from fluids, such as oil; and to alter the characteristics of gases by diffusion, reducing pressures and controlling flow rates. The new filter and diffusing material is manufactured from powdered metal subjected to a series of processing operations.



Standard shapes of metal filter

Applications for Porex are possible in almost any appliance or piece of industrial equipment involving the flow of gases or liquids. These uses are found in pumps, refrigerators, fuel lines, lubricating systems, oil burners, evaporators, absorbers, paint sprayers, premixed gas burners and other devices.

This new material, for example, is used to prevent clogging of orifices in Diesel injector nozzles with effective removal of fibrous materials not stopped by other types of filters. It also acts to prevent a drying agent from passing from its chamber into a refrigeration system when the refrigerant passes through it to be dried. An additional use is in separating oil, moisture, and solids from air supplied to paint spraying equipment.

The characteristics of Porex, such as chemical composition, structure, porosity, strength, and ductility, may be varied within certain limits to suit specific applications. Similar variations may be accomplished in its size and shape. Standard shapes now available are disks, sheets, cylinders, and truncated cones, while special shapes also are obtainable.

PAINTS

Black and Aluminum for Hot Surfaces

METAL surfaces which are subjected to intense heat can be adequately protected with one or the other of two new paints recently announced by Thurmalox Company. One of these paints, available in black, is intended for use either indoors or out and will withstand temperatures up to 1600 degrees, Fahrenheit. The other paint, in aluminum finish, is for indoor use at temperatures up to 1200 degrees, Fahrenheit.

Either of these paints can be applied by brush or spray to hot or cold surfaces that have been cleaned thoroughly.

EYE SHIELDS

Flood-Lighted, For Use With Shop Grinders

AN ILLUMINATED eye shield which is suitable for use on all types of bench grinders has just been an-

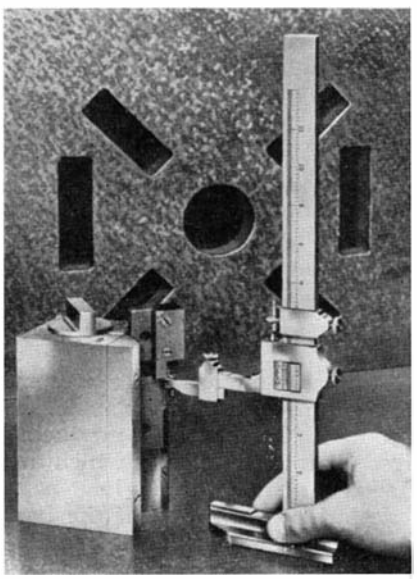
Safety in grinding

nounced by the Stanley Electric Tool Division. Known as the Flud-Lite eye shield, the device is fitted with two bayonet type light bulbs located between two sheets of glass. One of these, a piece of ordinary window glass, is located adjacent to the grinder wheel and can easily be replaced when it becomes pitted. The other sheet is of safety glass which provides ample protection for the operator. The two bulbs throw light directly on the grinding wheel and the work, providing 30 percent more visibility than previous models. The complete eye shield unit is adjustable and can be arranged to suit the operator's position. It cannot, however, be moved to a non-guarding position without dismounting.

MAGNETIC

Holding Tool For A Variety of Jobs

NEWLY designed, a precision holding tool of the permanent-magnet type is now available in a small and



Magnetism holds parts

convenient size. The height of this V block is 3¼ inches, it is 2½ inches wide over-all, and has an over-all length of 6¼ inches; the capacity of the V diameter is 1¾ inches. It is designed for holding iron or steel work of round or rectangular cross-sections as well as irregularly shaped pieces which can be placed between and in contact with the V faces. The permanent-magnet construction of this block is such that, by turning a knob on one end of it, the flow of magnetic flux through the V can be controlled from full "on" to full "off". If the

end of the V block is placed on a magnetically conductive surface, block as well as work are held firmly until the control is turned to the off position. By reducing the holding power work can be removed from or re-positioned in the V without releasing the block from the conductive surface.

THWARTS EXPLOSIONS

Conductive Rubber for Cart Tires

STATIC electricity, generated by the operation of carts carrying materials in factories, often reaches such intensities as to create spark dis-

Rubber tire conducts current

charges. These sparks can constitute an extreme hazard in armament factories and other places where ammunition or other explosive or inflammable materials are present. To eliminate this danger, B. F. Goodrich Company is producing tires for industrial carts which are made of rubber that has been transformed from one of the best electrical insulators into a conductive compound. Static charges pass through these tires before they can reach dangerous concentrations. One of our photographs shows a simple test of a conductive rubber tire; current is conducted through the tire and lights a small lamp in the circuit.

PAINT REMOVER

For Stripping Painted Steel and Iron

USED in a solution tank at 210 degrees, Fahrenheit, a new paint remover in semi-paste form quickly strips paint, lacquer, varnishes, and

so on from steel and iron parts. The semi-paste is dissolved in water in the proportion of approximately eight ounces to one gallon of water. It is claimed that this material, known as D. C. Stripper, manufactured by D. C. Cooper Company, is economical to use and works faster than any available liquid paint remover. It is easy to rinse, gives off no offensive odor or fumes, is non-explosive and non-inflammable.

BLACK STEEL

Lustrous Finish

Produced By Immersion

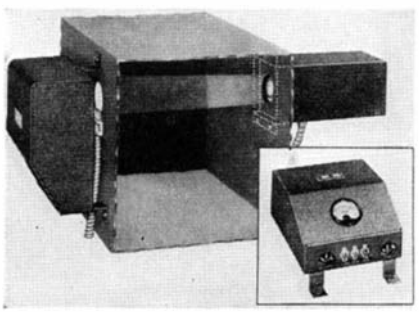
WHEN steel parts are immersed in a solution of water and Houghto-Black salt, at a temperature of 290 degrees, Fahrenheit, a lustrous black finish is produced, without, it is claimed, any change in dimension of the parts. Before the dipping operation is performed, the parts must be made chemically clean.

SMOKE DETECTOR

Photo-Electric Cell

Controls Equipment

MORE accurate control of combustion in all types of industrial boilers is possible when a photo-electric cell detector is employed to indicate the presence of excessive smoke in the flue. Two such units have been made available by the Rehtron Corporation, one of which gives any desired type of signal when smoke in the flue reaches abnormal density. The second type is provided with an automatic



Smoke detector mounted in stack and (inset) control box

mechanism which will go into operation when smoke becomes excessive and will operate controls to correct the condition.

These units are stated to be easily installed and adjusted and can be applied to any type or size boiler, whether stoker or hand-fired coal burning or oil burning.

Washington National Airport

Designing Engineers Have Created the World's Finest Port for Air Transport Lines

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University.

FOR FIRST hand information on the new Washington National Airport, now open to air traffic, we are indebted to General Donald H. Connolly, Administrator of Civil Aeronautics. Located at Gravelly Point, only 10 minutes drive from downtown Washington, the National Airport covers 720 acres, of which 325 is filled in marsh, and is larger than La Guardia, Le Bourget in Paris, Croydon in London, and Schipol in Amsterdam. Only Tempelhof in Berlin exceeds it in area, and Tempelhof is by no means as well equipped. At the new Washington Airport, the weather conditions are generally good and there are clear approaches from at least eight directions with gliding ratios of 40 to 1.

One of our photographs is a view from the north, showing the sweep of the Potomac 'round the Point and the criss-crossing runways which allow landing or take-off into the wind, whatever the wind direction may be. While the Terminal Building is truly functional, the architect, H. L. Cheney, has not neglected beauty, as so many modern architects do when an industrial or transportation building is involved. Not even at Tempelhof are there more convenient arrangements for the public. There will be parking space for 5000 cars. Splendid terraces give a complete view of the field. Each airline has its own individual ticket booths. There will be as many facilities, as many stores, barber shops, and what not, as at Grand Central Station. Air travel has come of age.

But, of course, the general convenience of the public, however important, is less important than efficiency in traffic control. Here the design engineers have surpassed themselves. The Control Tower is a result of the co-operation of practical air-traffic control men at various airports, and of the skill of a group of glass, lighting, and radio experts. The walls of the tower are all of glass, with the upper and lower halves of each wall set outward at an angle of about 90 degrees to each other. This setting avoids all reflection of ground lights, plane lights, sun,

Washington Airport, upper center, as seen from the north

In the Washington National Airport control tower

Wheel of a transport plane on the round iron saucer of the turntable

moon, and stars. As one of our photographs shows, each section is fitted with a window wiper, operated manually from inside. The glass is heat-absorbing, excluding the heat of the sun and retaining inner heat. Radio equipment in the tower will provide two-way communication with planes and an automatic device which makes a record of every conversation between the tower operators and pilots. A special electric bulletin board will give instantaneous information on plane movements. The board is an adaptation of automatic stock quotation apparatus, and cryptic numbers will tell the control room everything about plane movements at local and distant points.

But reliance for local traffic control is not placed solely on radio communication. Visual instructions to the pilots for all landings are provided by a system of lights on the field. Approaching at night, the pilot will see one particular runway outlined with lights placed every 200 feet. At the approach end of the runway which he is to use there will be a large arrow in green neon lights, indicating the direction which he is to take in landing. If the pilot is to circle and wait further instructions, a flashing cross in red neon lights appears. On the illuminated runway is a plume of white smoke coming up out of a submerged smoke pot and blowing along the surface with the surface wind. The field is in complete darkness except for the boundary lights and those giving landing instructions. When he has landed, the pilot sees a string of blue lights visible only from the ground which lead him to his proper position on the loading area. This system permits simultaneous takeoffs and landings of several planes.

Visitors to airports marvel at the dexterity with which pilots maneuver huge transport planes, bringing their wheels onto narrow alleys painted on the concrete. This procedure is not difficult, but when the plane must turn a complete circle after it has taxied to the loading station, there is a severe strain on the tire and landing gear of the wheel used as a pivot. Turntables at the Washington Airport are designed to avoid this difficulty and make the correct positioning of the plane easy and efficient. Each turntable consists of a circular iron saucer, six feet

in diameter and cupped in the center. This saucer is mounted on 16 rollers resting on a supporting circular track below. The pilot places his wheel in the center of the saucer, locks it with his foot brake and then swings the plane around by giving thrust to one of the propellers only. The huge plane swings 'round readily on its saucer pivot.

There are many other products of engineering science to be seen at the Airport. Sufficient has been said, however, to indicate that American designing engineers have risen nobly to the demands of the situation, and airport design has now attained the same high level as the design of the transport planes themselves.

FLIGHT TRAINING

Man-Made Gale

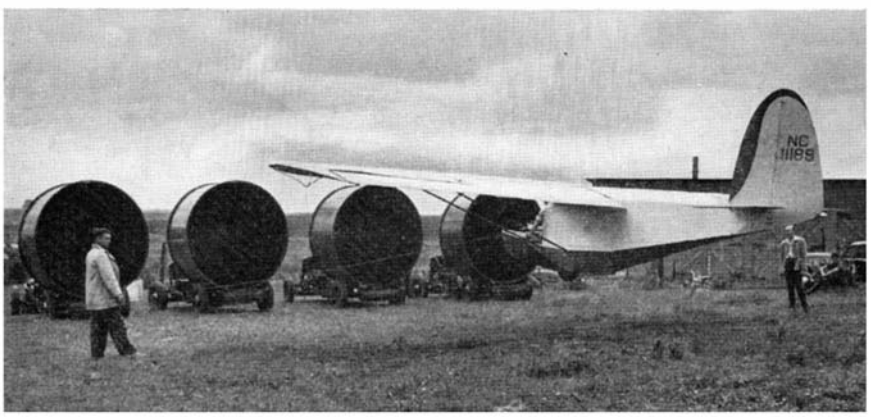
For Gliding

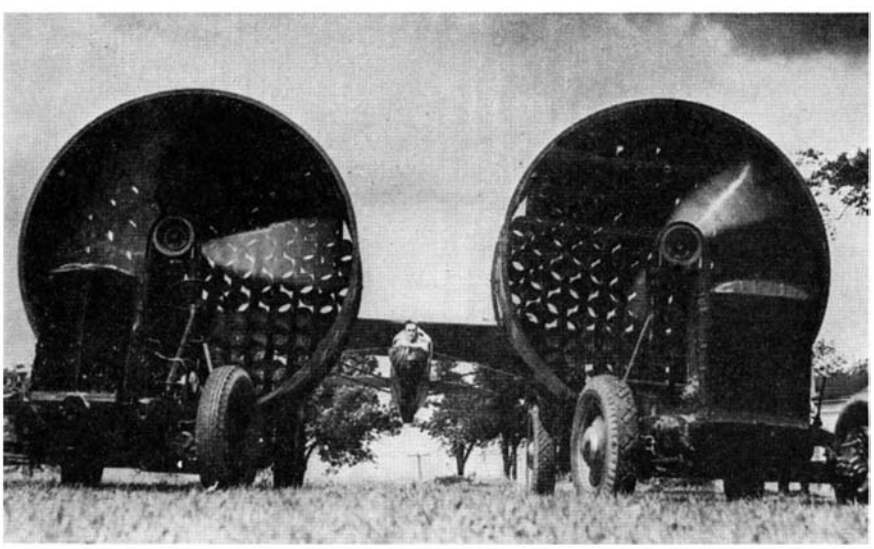
LARGE airplane propellers mounted on stripped truck chassis and driven through a power take-off are now being used to provide man-made gales to aid in training glider pilots.

As two of our photographs show, these propellers force air through a honeycombed structure which "smooths out" the air flow and prevents disturbances that might render the system ineffective.

These gale-producing units, known as Wind Charger Wagons, were invented by Commander E. F. McDonald, Jr., President of Zenith Radio Corporation and author of the article "Pilots, Pilots, More Pilots" which appeared in the July 1941 issue of Scientific American.

By the use of two or more units, a glider can be flown while anchored to the ground by 100-foot ropes. It can be maneuvered up and down in the wind stream, responding to the ailerons and elevator much as in free flight. Thus the student is enabled to learn the use of the controls and the feeling of flight without getting more than ten feet from the ground. Much of the danger of preliminary training is therefore eliminated and instruction work can be carried on regardless of weather conditions. In one test, a young woman with no





Above: **A glider taking-off in the man-made gale supplied by the Wind Charger Wagons.** *Below:* **Facing a flying glider; Wagons in foreground**

A Baltimore Medium Bomber, versatile warplane for the RAF

previous flying experience, and who couldn't even drive an automobile, was able to fly a glider alone after only ten minutes of instruction.

BALTIMORE BOMBER

Production Design Has No Prototype

THE Martin 187, or Baltimore Medium Bomber, is a splendid addition to the equipment of the RAF. According to Glenn L. Martin, president of the manufacturing company, the new bomber is expected to "prove superior to any aircraft of its type now flying in Europe and to out-perform many of the latest pursuit types in actual combat." The Baltimore is versatile: it can bomb, undertake reconnaissance, and put up an excellent fight with its heavy armament and a power-driven gun turret. It is powered with two Wright engines of 1600 horsepower each and will carry a crew of four. The nose is entirely of plastic, providing excellent vision for the bombardier.

It is extraordinary that the Martin 187 has no "prototype." The first airplane, now going through its tests, is the first of the production series, with regular delivery schedules to begin in a few weeks from a shop covering 15 acres of floor space. We did not believe it possible to eliminate the prototype. Evidently the engineers now know their job so well that "fussing" is no longer necessary.—*A. K.*

STRATOSPHERE COMFORT

A COMPREHENSIVE study of passenger cabin supercharging was recently presented by James B. Cooper, of Boeing Aircraft, in a paper read before the S. A. E.

High-altitude flying is impossible with ordinary human machinery. Normal individuals require additional oxygen if they remain for any length of time at altitudes of 12,000 feet or more. The use of the oxygen mask is clumsy and unsatisfactory. It would be almost impossible to instruct all the passengers in an airliner in the correct use of an oxygen mask. The provision of an oxygen compartment into which oxygen is sprayed is just as unsatisfactory. There is no satisfactory solution, Mr. Cooper concludes, and we agree with him, other than the use of a supercharged cabin, and the art of supercharging a cabin is quite a complicated one. A Roots blower or a centrifugal compressor is necessary. Either type of supercharger should be driven from the main engines and variable speed drives (now being developed) would be very helpful. Unfortunately, when the air is compressed for delivery into the cabin, it is also heated, so that coolers must be provided. Airline passengers would not be very happy if supplied with air 60 degrees, Fahrenheit, above normal temperature.

The cabin is not supercharged to sea-level pressure, because that would give a very high pressure differential and the structure of the fuselage would have to be very heavy. Hence, if flying is to be undertaken at an altitude of 20,000 feet, the inside pressure is equivalent to an altitude of 12,000 feet. Even this gives an outwardly bursting pressure of 2½ pounds per square inch of fuselage surface. The fuselage has to be of circular section, carefully reinforced, with plenty of tape to seal the seams. The windows, of laminated glass and Plexiglass, have to be immensely thick. All doors are provided with gaskets, self-sealing under the influence of cabin pressure. Special valves have to be provided to control the flow of air and its pressure.—*A. K.*

CAMERA ANGLES

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

Theme Sequences for Your Movies

PLANNED movie stories of an incident or home movie play can be made to run more smoothly, and with scenes tied to each other more convincingly, without abruptness or lag in interest, by the judicious use of thematic sequences. These sequences do not necessarily have anything to do with the action of the story; if they supply atmosphere and mood in keeping with the story, they will do their intended job.

Theme sequences have many places —at the start, at the end, and in the course of the film. They can, for example, be used to denote the lapse of time more effectively than a mere title, that says "The Next Morning." A scene actually showing the passing of the day and the sun rising the next morning, will be much more appreciated by the audience. In such a case, a title may often be dispensed with entirely, because the picture itself has indicated the passage of night and the dawn of a new day.

Figure 1 (above). Figure 2 (below)

Starting a film story often is a stumbling block for the scenarist. Where to begin without giving the audience the feeling they are being dropped right into the action without warning? Film makers are familiar with many devices in this connection that do the job satisfactorily. When in doubt, try some such scheme as that suggested by Figure 1. What could be more appropriate for a bird filming, for example, than to lead the viewer into the story by following a bird track? Or, in another situation, a narrow, winding road through the woods? Not only does one build up the all-important suspense so valuable in film-making, but atmosphere, mood, and locale are also identified.

Another stunt was recently successfully accomplished on a picture-making trip of a cine photographer and a still shooter. The former, using an 8mm camera and carrying little other equipment, was able to stride across the dunes at a much faster pace than his companion, who carried a large camera on a tripod slung over one shoulder, besides other equipment.

At one time, the movie man, way ahead of the other, stretched out on his tummy and aimed the camera towards his approaching friend. He started filming when the latter was quite a distance away and therefore a very small figure on the film and continued running film until the subject came within fairly close range. Such a scene might be considered part of the story, but it serves very well, too, for striking the theme of an incident about to begin. The same story might end with such a logical finish scene as Figure 2, which was photographed against the sun, the figure of the photographer blocking the actual sun as it neared the horizon.

Figure 3 would fit perfectly into the story of a fishing trip. It has the quiet, restful atmosphere congenial to the fisherman's mood. The reflection of the moving white clouds in the

Figure 3 (above). Figure 4 (below)

calm water, the grasses scattered helter-skelter throughout the foreground, the feeling of complete inactivity, might presage the start of the trip or portray the end of one. Such a scene could be used somewhere in the middle of the day's venture, with all hands out for a fish fry on the river bank. Incidentally, it would be very useful in a fishing trip story which netted little if any fishing activity, but plenty of rest and quiet!

The exciting movie story could well profit by such a sequence as Figure 4, affording a delightfully restful pause in the action to give the audience a chance to catch its breath and appreciate the beauty of the locale. Scenes like this need a filter, of course, but the all-round favorite medium yellow, if used in the later afternoon, will do the trick as well as an orange or a light red earlier in the day.

Theme sequences need not be made at the time of the actual filming of the story, but may be spliced in from parts of films made before or after the film has been made. It is a good plan to be on the lookout for thematic subjects for future incorporation into stories. Standing alone, such scenes may not amount to very much during a brief showing on the screen, but spliced into the run of a full story, will give body and movement that might otherwise be lacking.

Spotting Colors for Glossies

For testing one's patience, there are few tasks in photography more exacting than spotting a glossy ferrotyped print having small white marks all over its surface, including small hairlines. It is not often you come across such an imposing job, but when you do, it's work. Be prepared to spend anywhere from one to two hours on the one print. Despite the glossy surface, the spotting color will take without too much urging. Use a No. 2 sable brush, wet the brush on the tongue (saliva is par excellence for the purpose) round the tip of the brush into a very fine point on the edge of a card and pick up the color (a mixture of the black and the white

——CAMERA ANGLES——

pigment to the shade of gray required to match the tone of the area surrounding the white spot). Then apply gingerly, a very, very little bit at a time, until the spot disappears—that is, merges in tone with the surrounding area.

Camera Finders

DO NOT be alarmed if you suddenly discover that the finder or finder mask on your camera does not give you the full image you get on the negative. This is intentionally so designed in order to make sure that you get everything the mask reveals. It is the safety factor to guard against the possibility of error when viewing the subject through a finder. A masked field slightly smaller than the actual image on the negative is the rule.

Movie as Record Camera?

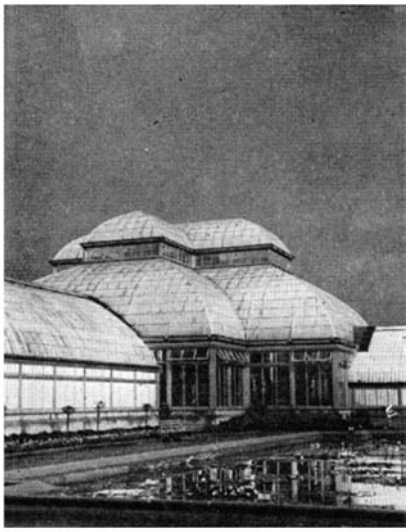
ONE chap we know, who works both movie and still cameras, frequently makes it a practice when away on a trip to make his record shots with the movie camera, using the still for pictorial work. The idea appears to have some merit for the obvious reason that if the full report of the incident is wanted, the movie camera certainly can do the job more faithfully than the still. No matter how many shots were made with the latter for the sake of telling the story completely, there still would be gaps in the story due to the lack of continuity.

Cleaning Condenser Lenses

WHEN was the last time you inspected the condenser unit in your enlarger? If your prints have lately been going rather sour on you, lacking snap and pep, it is very possible that your condenser lenses have accumulated some dust, which will get into the enlarger housing and, willy-nilly, on the lens surfaces. Take them out, remove the fine dust gently with a brush or cleaning tissue, then polish with a soft cloth. There's more than a chance that this little job will improve the situation considerably.

Polaroid Skies

FOR general use, the Polaroid screen appears to have its greatest advantage in the control of sky backgrounds and achieving clarity of detail. The commercial photographer uses it chiefly to cut glare, for which purpose it is also ideally suited. But for general amateur work outdoors, the dark or medium gray skies achieved with this screen definitely improve the results, both as to sky and as to subject-matter itself. The control of sky tone, moreover, is not limited to a single tone, but varies in effect with the degree of rotation of the screen as well as the nature of the light. When used with Kodachrome, the deep blue sky color obtained is really something, with white clouds stand-



Contrasts from the sky

ing out boldly and dramatically. A single stop wider is all the adjustment required, or, conversely, halving of the shutter speed.

Kodachrome Speeded Up

FORMERLY rated at 5 Weston, Professional Daylight Kodachrome sheet film has been boosted to 10 Weston, thereby bringing the speed even higher than the 8 rating of 35mm Kodachrome Regular. The sheet film starts at 2¼ by 3¼ inches and includes all the professional sizes.

If At Black-and-White You Don't Succeed, Try Color?

"I'M GOING to shoot nothing but color from now on," someone told us recently, "because it looks so much better." There is much to be said for this, but we still are of the opinion that if you cannot make good black and white pictures, your color shots will be bad too. This seems so obvious that it is hardly worth mentioning, yet say it we must because many workers feel this way about it. True enough, color shots have the big advantage of faithful rendition not only of the subject matter but also of the various colors of the subject matter, making the reproduction more true to life. But the mere achievement of color does not make a picture. Color or black and white, there is always composition, worthwhile subject-matter and all the other things that go to the making of a good picture. So never believe that you can step from bad to good photography just by using color film.

Substitute Measures

IF YOU are constantly using specific quantities of particular chemicals; for example, ¾ of an ounce of sodium bisulphite to mix with a quart of plain hypo for use in place of the usual acid hardener bath, weigh out this quantity on the scale, as usual, then pour it into the bottle cap. Shake the cap

gently to level the chemical and note the leveling off point on the threads of the cap. Thereafter, all you will have to do to measure out this quantity will be to pour the chemical into the cap until it reaches this level.

Cowboy Photograher

GREATER love hath no camera than that its owner is willing to forego the attractions of modern conveniences for the sake of an old friend that has been performing faithfully through the years. Back in 1909, Charles J. Belden, rancher-photographer, now famous as "the cowboy photographer," bought a 4 by 5 Carl Zeiss Minimum Palmos camera. He still owns it and uses it from the

"The Trail Herd"

unique vantage point of the back of a horse as he rides in search of pictures over the 40-mile Pitchfork Ranch that he owns in Wyoming.

"The Trail Herd," reproduced here, and one of the pictures illustrating our lead article, are typical of his work—cattle herds, cowboys, dramatic sky backgrounds. Belden invariably wears a ten-gallon sombrero. This does double duty—as a hat and as a sunshade for his camera. Shooting against the sun and in other situations where there is danger of side light striking the lens, Belden has an advantage over most photographers.

Double-Toning

WE DIDN'T like the results obtained on Cykora paper in the gold toning bath we used, so we tried this stunt: We bleached out the black image in the following bath:

Water	16 ozs.
Potassium ferricyanide	½ oz.
Potassium bromide	½ oz.

To the sepia image that remained we added more tone by immersing the print in the Develochrome Sepia bath. The result was a rich brown that we liked very much.

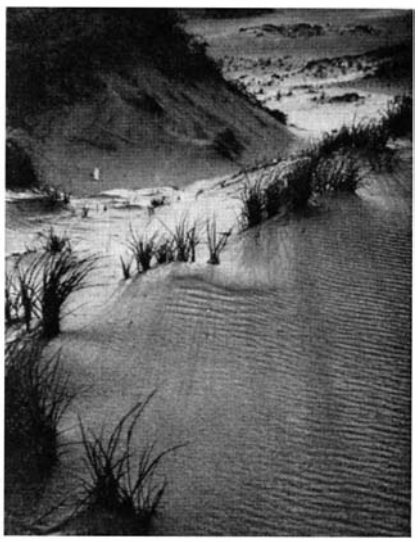
You Can Sell Your Kodachrome Slides

OUR pin-money-making colleagues who have been wondering how to cash in on some of their 2 by 2-inch Kodachrome slides will be glad to know that suitable slides in practically all subject classifications are now sought by a number of firms. These make a number of duplicates of each slide, which are sold in photographic stores to the general public at 50 cents a piece, supplying the maker with one of the duplicates plus a fee for each slide purchased.

The scheme seems to be working fairly well because it is being taken up by one store after another. Sounds to us like a pretty swell way to collect slides for a personal file in the same way movie fans buy or rent movies.

Low-Sun Pictures

OUR experience has been that some of the best picture opportunities come near the end of the day, as the sun approaches the horizon. Aside from the soft light prevailing, this is the time for beautiful sunsets, for fine tone gradations and, above all, for recording studies in texture and long, graceful shadows. The illustration shows one of the possibilities. Composition, as always, helps the picture.



"Sunset on the Dunes"

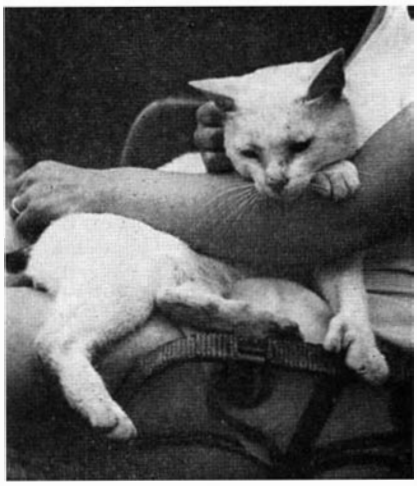
Here we have a large dark mass in the upper left-hand corner, a highlighted strip of sand making a graceful curve from right to down left, and grasses casting long shadows across the sand.

Cats Quiescent

A FRIEND of ours has a trick with cats that might be useful when you next try photographing that active feline of yours. He plays with it for a while, making it go through some of the most exciting tricks he knows, then feeds it. Being well worn out from the violent exercise and burdened with food, it is ready for sleep. This is the time for the pictures. Instead of permitting her to go to sleep, he makes her pose. Yearning for sleep, the cat will do almost anything the photographer desires, having no

will of her own at this point. He finds this routine invariably successful.

Here is another method. The cat in the illustration loves to be caressed, when it will fall into complete relaxation. Sitting in the lady's lap, enjoying the gentle scratching back of the



Feline relaxation

ear, will keep her quiet for picture purposes for some time and supply poses every cat lover will appreciate. If the cat closes its eyes during the scratching, a momentary halt will open them again.

Adjusting Temperature

IN BRINGING the temperature of the film developer up or down, as the case may be, to that required for the film used, it is always advisable to make the final thermometer test in the tank or tray in which development is to take place—not in the storage bottle. Also, give the thermometer a real chance to do its work by waiting a minute or so for the true reading to be reached.

• • •

WHAT'S NEW

In Photographic Equipment

PHOTRIX 11 by 14 PRINT WASHER ($5.95): Based on "straight-line-flow" principle permitting back and front of print to come in contact with flowing water. Made of heavy Armco Zincgrip, grey enamel finish. Water enters washer through series of apertures at one end and leaves washer through apertures at other end.

DAYLIGHT BLUE SUPERFLOOD PHOTOLAMPS NOS. B1, B2, and B4 (30 cents, 60 cents, $1.75 each, respectively): Designed for color photography. Made of natural daylight blue filter-glass acting as own self-filter to match natural daylight approximately, thus eliminating need for correction filters when taking indoor color pictures with regular professional daylight type Kodachrome film. Bulb inside-frosted to produce soft diffused type of light. Characteristics: B1—250 watts, 3-hour life, approximate lumens 6100; B2—500 watts, 8-hour life, 12,000 lumens; B4—1000 watts, 10-hour life, 23,500 lumens.

ROSS OPTICAL LENS TISSUE (35 cents package): Packaged in vest pocket size Pliofilm pouch, 100 sheets—3 by 5 inches—per package. Manufactured by special process, free from lint or filler. Highly absorbent, removes moisture, oil, grease, fingerprints, and so on. Non-abrasive, made of 100 percent linen stock impregnated with non-staining chemical. High tensile strength.

MACK WIDE ANGLE AUXILIARY 8mm CINE LENS ($21): At present available only for Cine Model No. 60. Ready for instant attachment by screwing into front of regular camera lens, which must be set at infinity. Doubles angle of view. Depth of field two feet to infinity.

MANSFIELD KWIK-WET (35 cents bottle): A few drops added to any paper developer said to result in complete and rapid coverage and even development of print. Similarly, a few drops in any film developer prevents airbells and pinholes. Small quantity in hypo accelerates fixing. As final rinse, added to tray of water, assures spot-free drying. Also aids other processing, such as toning, reducing, and so on. Available in shaker-top bottle containing sufficient material for treating 75 pints of solution.

HYPO-CHEK (30 cents bottle): Warns when hypo is exhausted. Few drops in worn-out fixing bath results in milky precipitate, indicating exhaustion. Shaker-top bottle contains sufficient material for 225 tests.

KODAK 8 by 10 METAL PAPER BOARD: Stationary mask frames paper to actual print size of 7½ by 9½ inches, leaving ¼-inch margin all around. Hinged at rear of base, mask is easily raised by tab projecting beyond base. Concealed spring device holds mask in raised position while paper is placed against guides at left and back. For prints of smaller sizes, two movable masks are used. Small lever for adjusting print margins of ¼ or ½ inch. Board finished in gray lacquer, with base of wrinkle finish. Padded sub-base prevents slipping and scratching.

BROWNIE DARKROOM LAMP MODEL B: Equipped with filter cup of molded Tenite. Lamp screws into any ordinary electric light socket. Lamp supplied with unit, 7-watt, 110-125-volt bulb. Tenite filter cups of three different colors available: red for orthochromatic films or plates; green for panchromatic; yellow for printing and enlarging papers. Easily interchangeable.

YOUR FIREARMS 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.*

Remington Solves an Old Puzzle

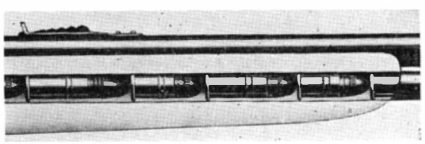
NOW, AFTER many weeks of widespread speculation by shooters, based largely on incomplete reports that had leaked out about a new gun, the inside story can be told concerning the scientific development and operation of Remington Arms Company's latest addition to its line.

It is a .22-caliber autoloading rifle, known as Model 550. Through use of feature known as "Power Piston," this gun shoots short, long, and long-rifle cartridges interchangeably and without necessity of making any mechanical adjustment. Model 550 is a 6½-pound take-down rifle with

Remington's Model 550 autoloading .22 caliber rifle

overall length of 43½ inches, a 24-inch, round, tapered barrel, crowned at the muzzle. It has a magazine capacity of 22 shorts, or 17 longs, or 15 long-rifle cartridges and is equipped with side-lever type thumb safety; full size, one-piece pistol grip stock; and semi-beavertail fore-end. Gun has white metal bead front sight, new style step, adjustable rear sight, base of which conceals dovetail slot to permit fitting of other rear sights.

The secret of the adaptability of this new gun to all .22 cartridges is

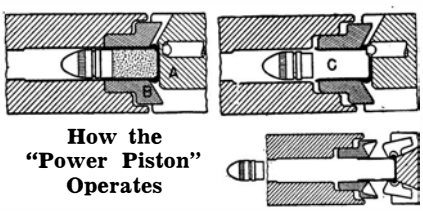


Shoots all .22 caliber cartridges

the "power piston," a feature that increases the energy of the .22 short cartridge sufficiently to operate a mechanism which would otherwise function only with the .22 long or .22 long-rifle cartridges.

The operating energy, or rearward gas pressure of the .22 short cartridge, when used in the model 550, is increased to the equivalent of the .22 long-rifle. In other .22 autoloaders the energy which operates the action is transmitted through the head of the cartridge only. When .22 shorts are used in Remington's new gun, the energy is transmitted through the the front end of the "power piston," as well as the head of the cartridge.

Before firing, the .22 short cartridge is securely held in the chamber by the breech bolt, and the cartridge case extends to the front end of the "power piston." At the instant of firing, gas pressure exerts energy on front end of the "power piston," as and on the cartridge head, and this application of the pressure to a greater area increases the rearward energy and operates the automatic mechanism, which would otherwise function only with the heavier .22 cartridges. As it is necessary to increase the operating energy of the .22 short cartridge only, and as the aid of the "power piston" is not required with long or long rifle cartridges, the chamber is so designed that the cases of the latter two extend beyond the front end

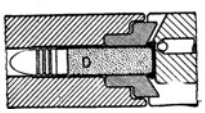


How the "Power Piston" Operates

Upper left: **Breech bolt *A* holds .22 short cartridge, case reaches to front end of power piston, *B*. *Upper right:* On firing, the gas pressure *C* exerts energy on cartridge and front of power piston, thus operating mechanism as indicated, lower right**

of the "power piston," thus blocking off the auxiliary gas pressure.

The design and subsequent development of the Model 550 began during the summer of 1938 at the Ilion,



Length of .22 long cartridge case precludes use of the "Power Piston"

New York, plant of the Remington Company. During the two years of research necessary to complete work on the gun the major efforts centered

around the recoiling chamber and the "power piston," and during that time seven separate models were built before the final approved working model was produced.

Science in Camping

THE RAIN pattered ceaselessly on the tent and the afternoon dragged on interminably. We'd been in camp on a fishing trip with five days of glorious weather and it was irritating to be forced to waste time under canvas when we felt we should be at our primary occupation of enticing bass. There was nothing to read and little to do but cogitate, and in the course of doing so, we came to the conclusion that the advancements of science in many fields have made the camper's life an easier one.

Take the tent, for example. Its light-weight walls, roof, and floor have been waterproofed and keep us absolutely dry; in by-gone days tents had to be made of extremely heavy duck in order to shed rain, and seldom were you dry under foot. Then, the sleeping bags—again a reduction in weight from the old-style blankets and comforters and, with zippered sides and ends, infinitely easier to get in and out of, simple to air, and far warmer if nights are chilly. As for the air mattresses, we now wonder how we ever managed without their bed-like comfort; while balsam bough beds are "romantic" and pleasantly odoriferous, we no longer spend time and energy cutting the boughs, and doubtless much of the young forest growth is saved.

There are also rubber pillows, the gasoline lantern, the electric lantern, the compact and reliable gasoline stove—mighty welcome on rainy days when all outdoors is dripping. Camp clothing has come in for a scientific rejuvenation, as have cooking and eating utensils, all to the end that outdoor life may be more comfortable and more easily enjoyed. Always the trend has been toward greater efficiency and reduction in weight, for portages can be long and weary when all one's belongings must be carted on shoulders in order to reach the desired destination.

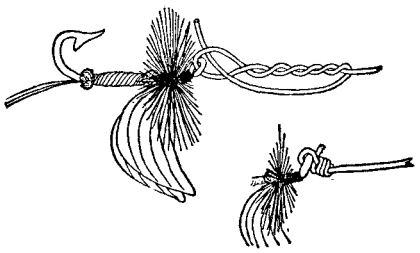
In the camp culinary department, however, is found perhaps the greatest advancement. Concentrates of all kinds are available, once more reducing weight and permitting of better and more compact packing. Latest among these are dehydrated soup mixtures, manufactured by DryPack Corporation and packed in Goodyear Tire and Rubber Company's Pliofilm envelopes. The envelopes are four by five inches, about one-half inch thick when filled, and, although they weigh but a few ounces, each holds enough concentrate to provide soup for four persons. All that is necessary is to add the water which, in canned soups may be as high as 80 percent, by weight, of the total, and cook. The average can of soup weighs about a pound and we had packed in seven packages of assorted soup mixes for the same total weight. Yes, we decided, as we lit the portable stove in the comfort of our dry tent and poured the noodle soup mix into a pan of water, camping's different than it was in Dad's day. Science has certainly helped.

• • •

POT SHOTS

At Things New

THE DU PONT COMPANY, as a tail-end-of-the-season suggestion for trout fishermen, offers a new knot for nylon fishing leaders called the "Clinch Knot." All you have to do is stick the end of the tippet through the eye of the fly, double it back against itself for four or five inches, give the fly several complete twists to wind the leader spirally around itself, as shown in upper part of illustration. Thrust



the end between the eye and the coils, hold onto it, and pull up tightly, as indicated in lower part of picture. Other good knots for nylon are the "Figure 8," the "Return," and the "Turle," all shown in the booklet we mentioned in our June issue, "What You Should Know About Nylon Leaders." Want one?

WESTERN CARTRIDGE COMPANY has made another contribution in the field of clay target shooting by redesigning its famous White Flyer target so that it is now reported to be twice as easy to break as formerly. Score marks on the target dome divide it into 16 segments. When target is hit by only a few shot pellets, at least one of the segments will fly out in a piece large enough to score a "dead" bird. Grooves, or score marks reduce thickness along the 16 strips of the dome, and just as glass, scored by the glass cutter, will break along scored line at a gentle tap, so the new White Flyers shatter, even when lightly hit by a few pellets. Re-distribution of weight by making dome segments considerably thicker than is the target at the score marks gives extra strength where stresses occur in trapping. Tumble tests, in which packed cartons were more roughly handled than in shipping, showed reduction in breakage. The new White Flyers are available in the usual wide assortment of colors, and, due to scientific method of re-designing, should enable shooters to "smoke" more targets than heretofore.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

ABOUT two thirds of the telescopes made by amateur workers from the instructions in the book "Amateur Telescope Making" are placed on fixed, permanent pedestals in dooryards. The remaining fraction are portable.

There are three kinds, or degrees, of portability—hand, trundle, and car.

Hand portability: It is pretty difficult to design a rigid reflector of the 6" aperture usually recommended to the beginner without bringing the weight above 50 pounds; usually it will run 100. By reducing the aperture to 4", which still provides an excellent telescope, the weight can be greatly reduced, on the basis that the weight of a telescope is roughly proportional to the cube of the aperture. It is possible to lighten the parts of a 4" telescope enough to permit carrying it like a violin case or midget outboard motor without much sacrifice of rigidity.

Trundle portability: In cases where no permanent pier can be set in the earth, yet where the owner wishes a telescope of 6" or 8" aperture, large casters or small wheels can be added to the mounting of a telescope weighing up to, say, 300 pounds, and it then can be trundled outdoors, set up, used,

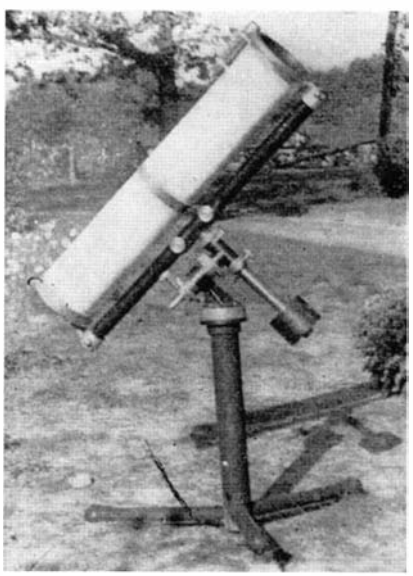


Figure 1: **Portable, for the car**

then trundled in again. Numerous solutions of this problem have been published in this column and every maker concocts another.

Car portability: Here weight isn't the main governing factor. The mounting should knock down in about three pieces, yet be settable-uppable without recourse to an erecting crane, and short of half of one night, and be knockable-downable the same. Otherwise, no great compromise on rigidity need be made and the portable can be as useful as a fixed telescope.

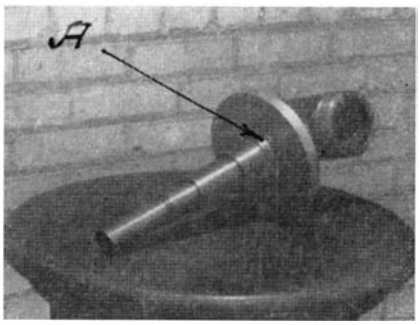


Figure 2: **Rugged polar axis**

Figure 1 shows an 8", car portable designed and made by C. R. Wassell, of the Wassell Manufacturing Co., oil purifiers, Muskegon, Mich. It weighs 150 pounds. Pedestal of 4" seamless steel tubing, welded. At its top, under the head, are beveled filler rings that permit adjustment for latitude, so that the telescope may be used about 2½ degrees north or 2½ degrees south of its home town, simply by adding or subtracting some of these wedge-shaped rings.

The axes are rugged, the hollow polar axis being 2⅜" in diameter at the point *A*, Figure 2, or point of greatest bending moment, and stepped down to 1¼" at the other end. Ball bearing.

In place of the usual central saddle for attaching the tube to the declination axis there is a full-length piece of 1" tubing. At its ends it fits into sockets in the side of cast, machined rings. In these rings the telescope tube rotates, so that stars in awkward positions may be sighted and the finder used, without neck-wringing contortions.

This, then, turns out to be anything but a makeshift type of portable; on the contrary, it is a fine piece of work requiring no small amount of machining—as would perhaps be more evident if it were not, because of its portability, associated with the chicken-foot type of pedestal often seen on less refined telescopes.

It is possible, then, to have a really refined telescope of fairly good aperture with car portability; well, anyway, provided the back-seat driver and family manager doesn't preëmpt the necessary space for other things. But why not design the interior of the tube to be used as a trunk, masculine gender, for sox, spare pants, and so on? Probably good enough for a mere man on a vacation trip.

IT's a lot of fun, as any amateur telescope maker will tell you, to invent, design, and then build gadgets to save labor, even if the actual labor saving is a minus quantity. You get your pay when you can step aside and watch them function automatically, with a self-satisfied grin on your face. Who cares about time, anyway

Top-flight position as Public Gadgeteer No. 1 undoubtedly has now been won by Kenneth Richter, 33 Clarence Ave., Bridgewater, Mass., whose star camera works while he sleeps. It is in storage just now, as Richter is away at Harvard and in summer is running a "Chromocinemataudiographic Expedition, Ltd." (possibly "limited" refers to the funds) somewhere between Hudson Bay and the N. Pole. Nevertheless we invited him to remove the bushel from off its light, so the rest of us could see its glimmer. So — — —

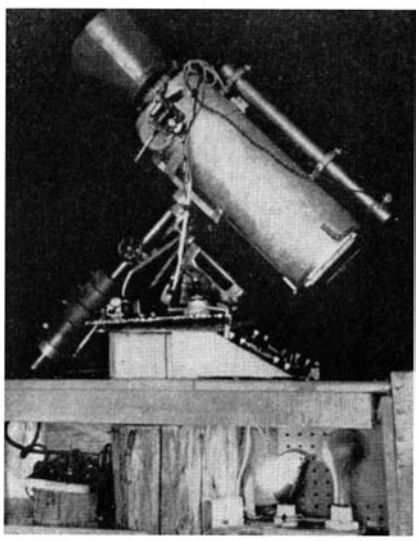


Figure 3: **It thinks for itself!**

"The desire for the instrument was born of the fact that we have but two seasons in Bridgewater—the cold season and the mosquito season, and both are too uncomfortable for visual guiding of an astronomical camera. Therefore, about a year's work was spent overcoming the discomfort of attending the camera throughout the night—the exposure is made automatically.

"At about dark, I go out, lift the cover off the instrument, and pull out the plate holder slide against a stop. Next, I go in and set a clock by my bedside for the time I want the exposure to start, also for the length of time it is to run. Then I work on a mirror, take the girl friend to a movie (though building the thing kept me so broke that this is just wishful thinking) or I go to bed.

"At, say, 2 A.M., the clock turns on the power. Outside, the camera springs to life. A small motor swings

the flap shutter open, and an electromagnet holds it thereafter when the small motor has shut itself off by breaking its own circuit just as the shutter strikes the magnet. The latter is energized by a radio 'A' eliminator, to avoid the vibration of the camera that would result from the use of an A.C. magnet. This is a satisfactory source of 6-v., D.C., well filtered. Meanwhile a synchronous motor drive, using one of the hen's-teeth 4-watt Warren motors, has started to apply the diurnal motion.

"Extra features include a Nichrome wire wrapped around the lens barrel, with thermostatic control to keep the entire lens about 10° C. warmer than the outside air. This is adjustable for more heat, in case of heavier dew than usual, but it effectively prevents the condensation of moisture on the glass, and there is not enough heat to distort the image to any measurable degree.

"The 500mm f.1, *f*/6 lens is an anastigmat that would cut a good figure in any company.

"The cross-hairs in the finder have bright or dark line illumination, of which both the color and intensity is variable; color by cellophane filters placed before the bulb (usually red), and intensity by a rheostat swiped from my radio-enthusiast brother's stock of parts.

"Well, the camera purrs along until the clock tells it to shut up. Then the power goes off, the shutter magnet is released, and the shutter closes. The spring that holds the plate holder slide is released, and the slide snaps into place. The drive motor and heater shut off, and, to cap the climax, a counterbalanced cover claps shut on the whole works.

"But suppose I am sound asleep and it rains? Two copper strips placed 1/64" apart and liberally sprinkled with table salt are placed in an exposed position on the baseboard, but at the bottom of a hole so that wind will not blow the salt away. Each of the strips is a terminal in a relay hookup, so that the salt will dissolve in the first drop of rain water, complete the electrical circuit through the adjacent copper strips, and the machine will automatically and instantly close up and go to sleep. A pointer operating in conjunction with a scale on the rim of the polar axis gear also tells, within a minute, how long the camera had operated before the weather forced a shutdown.

"While almost all the gadgets are simple enough to be foolproof in operation, the drive frequently messes up the work. Other than that, one might say that it saves me probably 2 hours' work a week. The number of hours required to build the machine would, of course, swallow up this saving for several years. However, I don't even try to justify it as a net, over-all time saver. It isn't.

"But it was fun; and, after all, that seems to be the real purpose of telescoptics."

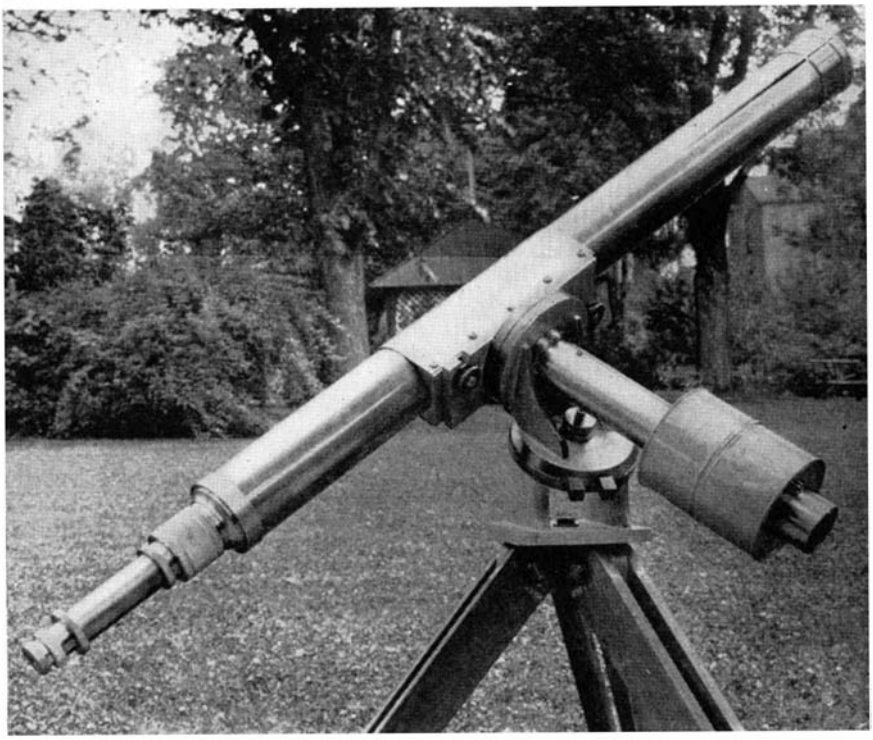


Figure 4: **Taylor's 100-pound refractor with 3″ triplet lens**

CLEAN is the word that characterizes all the telescoptical work of D. Everett Taylor, 191 Prospect St., Willimantic, Conn., some of which has been described here before, also in "A.T.M.—A.", in his chapter on "The Refractor—Metal Parts and Mounting." No exception is his newest telescope (Figure 4) a 3″ with a triplet objective of his own make. Invited to describe it, he writes:

"The objective is a rectilinear 3″ triplet of 50″ f.1., Chance Bros. glass, beautiful stuff. The curves are very flat, the wide field is good to the edge, the diffraction rings are round and concentric, the objective is achromatic and is automatically self-centered. Reason for this type of triplet: reduction of spherical aberration. [So far as is known, Taylor is one of only three amateurs who have made triplets, others being Selby and Grandmontagne.—*Ed.*]

"The 100 pounds of brass shown constitutes a mounting. Base owes its main inspiration to the Springfield mounting. Designed for a permanent base, it is, however, a success on a solid tripod.

"Base of the central sleeve over the main tube is a heavy casting with stud and thumbscrew at either end. Thus the telescope can be disassembled, taken indoors and stored. Note the slot in the *side* of the nearer end of the rectangular declination plate; other slot is in the *end* of same plate. Thus, engage first one stud, then swing into other, tighten up. All set.

"The three layers of the main tube are very heavy, ⅛″ wall thickness. All were machined, then lapped to a sliding fit. Draw and focusing tubes ride on the felt in the stuffing boxes." [Explained in "A.T.M.—A."—*Editor.*]

The proportions of this mounting are impressive, and, as usual, Taylor takes a sharply focused photograph that reveals rather than half camouflages the telescope.

LET's say you wanted some old astronomical book—for illustration, Lowell's "Mars," published 1896—but found it was out of print. You could start out searching all the second-hand bookstores of the nation. This, however, would be something of a job! There's a short cut by which you can do it systematically for something under a dollar and send your feeler into every second-hand bookstore in the land. Have your bookseller or your librarian insert a tiny "book wanted" notice in the weekly book exchange of *The Publishers' Weekly*, wait a fortnight or so and if the desired book is on the shelves of the second-hand bookstores, your bookseller or librarian will begin receiving postal-cards with bids—competitive bids, which keeps the prices down. Then take up the bid you like best and chuck the rest. Your scribe has found it works well.

We did this recently for a reader in the Philippines who wanted to get hold of Lowell's books, "Mars" (1896), "Mars and Its Canals" (1906), and "Mars As The Abode of Life" (1908). We received 11 bids, at prices from $1.50 to $3.50 per book. We selected the ones that looked best and the rest would have gone into the w.p.b., except that it occurs to your scribe that these books ought to be in amateurs' hands instead of gathering dust in musty second-hand stores in various parts of the nation, ultimately to be lost. Interested?

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 ARMED FORCES OF THE PACIFIC

By Capt. W. D. Puleston, U.S.N.

COMPARISON of the military and naval power of the United States and Japan, by a naval officer of mature, experienced judgment, one who has been Director of our Naval Intelligence Service and who also has served in the Asiatic Station and who is a graduate of the Naval War College. These qualifications have weight, since such a writer has responsibilities and evaluates carefully all that he writes. Capt. Puleston does not belittle the Japanese Navy as some jingoes do; nor on the other hand does he exaggerate its powers, as others do. He estimates it objectively, and he concludes at the end of a step-by-step, careful analysis of the strategy and tactics of such a war, with its probable phases of major and minor combat and the locales of each, that "whatever temporary successes Japan might have in the western Pacific, her final defeat would be inevitable." (273 pages, 5 by 9 inches, map.)—$2.85 postpaid.—*A. G. I.*

THE CHEMICAL ACTION OF ULTRA-VIOLET RAYS

By Carleton Ellis and Alfred A. Wells

REFERENCE book on photochemistry, for workers in theoretical and industrial chemistry, biology, and medicine. It is divided into four parts, respectively on: Sources of U-V Radiations (a wide canvass); Photochemical Processes; Applications to Industrial Products; Applications in Biology. A technical, not a popular work. The authors are from the Institute of Scientific Research, University of Cincinnati. (960 pages, 6 by 9 inches, 158 illustrations.)—$12.00 postpaid.—*A. G. I.*

PENCIL BROADSIDES

By Theodore Kautzky

FOR those who have a feeling for pencil sketching, this volume will be extremely helpful in working up a technique that has tone and vigor. The artist has divided it into 12 lessons, beginning with fundamental strokes and carrying through textures of various kinds of materials and objects which include brick and stone work, roofs, trees, shrubbery, and the like. Besides discussion and pictures illustrating points of technique, the book also has a dozen or more complete scenes done in pencil by the author. (9½ by 12 inches, board covers with plastic ring binding.)—$2.10 postpaid.

WIN YOUR WINGS

By Jean H. DuBuque and Colonel Roscoe Turner

IN two volumes are presented what really amount to a primary and an advanced course in aviation training. Book One presents up-to-the-minute facts on aviation which, coupled with actual practice, should enable the reader to go a long way toward obtaining a private pilot's certificate. Book Two gives advanced instruction and is intended for those who have had preliminary training and are interested in obtaining a commercial pilot's certificate or instructor's rating. (6¼ by 9 inches; Book One, 656 pages; Book Two, 426 pages; a large number of illustrations.)—$3.60 per volume, postpaid. —*A. P. P.*

AMERICANS

By Webb Waldron

CHARACTER sketches of people who in this too-tense nation have discovered serenity. They escaped into the forgetfulness of a hobby. Or they cut loose from dull vacations to make new and paying ones from their hobbies. Or else they earned a feeling of self-justification by starting new enterprises that helped others. Opening chapter is about Russell W. Porter, world serenity champion. Author is on the staff of *The Readers Digest* and a writer of rare skill. (268 pages, 5¼ by 8½ inches, unillustrated.)—$2.10, postpaid.—*A.G.I.*

SCIENCE IN THE GARDEN

By H. Britton Logan and Jean-Marie Putnam. Consultant: Lloyd Cosper

WHETHER amateur or commercial grower, anyone interested in plant life will find much to fascinate him in this unusual volume that discloses secrets and tells how the layman may perform wonders in ex-

——OUR BOOK CORNER——

perimenting in flower pot, greenhouse, or garden. The scientific investigator, too, will find much to interest him of new developments. For the practical gardener, new fields of exploration are opened, profitable fields of investigation are indicated. This is a book to encourage both scientist and layman to fresh effort, as well as to give the armchair investigator many a delightful hour's reading. (255 pages, 5⅜ by 8⅜ inches.)—$2.60 postpaid.—*C. F. G-C.*

THE ART OF HANDGUN SHOOTING

By Captain Charles Askins, Jr.

PACKED with thoroughly practical advice and suggestions, this publication is a necessity in these national defense days for all who shoot or would learn to shoot handguns. Stripped of technicalities, the book outlines in simple, straightforward style the methods used by the author in winning, at one time or another, practically every worthwhile pistol championship. Police forces, home guards, state guards, and pistol clubs should make this book available to members. (219 pages, 6 by 9 inches, 100 illustrations.)—$2.60 postpaid.—*A. D. R., IV.*

PRACTICAL ELECTRICITY FOR HOME STUDY

By Frederick C. Raeth

COMPLETE instructions in the fundamental principles of electricity and its multitude of applications are here presented in a four-volume set which constitutes as comprehensive a survey of the entire field as can be given in the space available. Theory and practice are presented side by side throughout each one of the four volumes.

Simple fundamentals are first given. Then the reader is shown how to apply them to such uncomplicated problems as dry-cell connections and door bells. Then come chapters on storage batteries and charging, telephones, house wiring, electrical calculations, meters, D.C. machinery, X-rays, and alternating current theory and practice. (All four volumes are in uniform binding, 6 by 8½ inches, completely illustrated.)—Volume 1, $2.10 postpaid; Volume 2, $2.60 postpaid; Volumes 3 and 4, $2.85 each; or the complete set for $9.00 postpaid.—*A. P. P.*

LIGHTING FOR PHOTOGRAPHY

By Walter Nurnberg

A TRULY A-to-Z guide to the all-important subject of what lighting means in photography, its technical aspects and its application in specific instances, by a noted practicing photographer. The book covers, in three general sections, the theory, the principles, and the application

of lighting, under such headings as "Photographic Light Sources," "Building up the Lighting," "Light and Shadow as Applied to Face and Figure," and "Light and Shadow Applied to the Inanimate." Many drawings, diagrams, and actual photographic reproductions illustrating the various points covered, add immensely to the book's clarity and to its value to all photographers, whether serious-minded amateur or professional. (7 by 10 inches, 172 pages.)—$3.60 postpaid. —*J. D.*

ARMAMENT PRODUCTION POLICIES

IN QUESTION and answer form is given specific information for industrial executives and engineers on matters pertaining to armament production for the United States government. The content of this book constitutes a record of a forum conducted by the New York Post of the Army Ordnance Association. In this compact form is much authoritative information which cannot elsewhere be obtained so quickly. (8½ by 11 inches, 57 pages, unillustrated.)—$1.00 postpaid.—*A. P. P.*

BATTLE SHIELD OF THE REPUBLIC

By Major Malcolm Wheeler-Nicholson

SOME of the chapter titles of this book will give an idea of its tenor: Horse and Buggy vs. Blitzkreig; Bush-League Battles; Our Army in 1917-18; Our Army Today; Bureaucrats vs. Battle Leaders. Such chapters take up the first half of the book. From there on the author discusses the War Department and analyzes the various departments of our military forces. His general tone is that of constructive criticism, and, if we are to take his word for it, there is need for just this kind of appraisal of our national defense program. (212 pages, 5½ by 8¼ inches.) $1.60 postpaid.

A FIELD GUIDE TO WESTERN BIRDS

By Roger Tory Peterson

COMPANION volume to the author's "A Field Guide to the Birds," this is the first practical guide for outdoor identification of birdlife regularly found west of the Rocky Mountains. Employing the author's system of identification through diagramatic drawings which emphasizes distinguishing characteristics of birds when seen at a distance, the book will prove an excellent reference to bird fanciers everywhere and an authoritative guide for the western United States. Shapes and color effects of birds are faithfully shown; confusing details are omitted. (258 pages, 4¼ by 7¼ inches, 6 pages in full color; halftones, line cuts.)—$2.85 postpaid. —*A D. R., IV.*

The Editors Recommend

Best Sellers in Science

COMPLETE GUIDE FOR THE DEAFENED—*By A. F. Niemoller.* The ear, impaired hearing and causes, diseases, drugs, ear discharges, hearing tests, everything worth knowing about the ears and hearing. **$3.10**

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA. Grand old standby for the automotive technician, garage man, and technically minded automobile owner. 1483 pages, 4600 illustrations. **$6.50**

SCIENCE EXPERIENCES WITH HOME EQUIPMENT—*By C. J. Lynde.* A book of 200 simple home tricks based on physical laws, each experiment being illustrated and its principle explained. **$1.45**

THE ENGINEER'S SKETCH-BOOK OF MECHANICAL MOVEMENTS—*By Thomas Walter Barber.* Working drawings of practically every conceivable movement, device, appliance, and contrivance employed in the design and construction of machinery for every purpose. Nearly 3000 illustrations. **$4.35**

SUPERSONICS—*By Prof. R. W. Wood.* A great deal of data on science of inaudible sounds, their every aspect, physical and biological, by a noted physicist-inventor. Has bibliography of articles on subject in many journals. **$2.10**

OH DOCTOR! MY FEET!—*By Dudley J. Morton, M.D.* Help for foot sufferers, Scientific treatment which makes possible discarding of arch supports and special shoes and stopping of exercises. **$1.60**

HOW TO THINK STRAIGHT—*By Robert H. Thouless.* A book that will definitely clarify your thinking and show you the argumentative tricks of others. **$2.10**

THE COMPLETE GUIDE TO SOILLESS GARDENING—*By Dr. William F. Gericke.* The man who invented soilless gardening has prepared this comprehensive and authentic guide covering all phases of this fascinating work. For amateur and professional. **$1.95**

NEW HANDBOOK OF THE HEAVENS—*By Bernard, Bennett, Rice.* Introduction to astronomy for those who do not want an outright textbook. Painlessly covers stars, planets, moon, sun, comets, meteors, asteroids, nebulae, and so on. **$2.60**

The above prices are postpaid in the United States. Add, on foreign orders, 25c for postage on each book.

FM—AN INTRODUCTION TO FREQUENCY MODULATION—*By John F. Rider.* Deals with those things which it is necessary to know in order properly to understand frequency modulation transmission and reception. **$1.10**

HANDBOOK OF CHEMISTRY AND PHYSICS. Includes 520 pages of physical constants of organic compounds, many new data on plastics, a 65-page table on industrial organic compounds, and so on. 2564 pages.
In U. S. A. and Canada **$3.60**
Elsewhere **$4.10**

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

PERSPECTIVE MADE EASY—*By Ernest R. Norling.* For draftsmen and artists, this volume tells the things they should know but often don't—all the details of perspective, simply explained and illustrated so that all rules may be easily grasped, progressively, from simple to complicated forms. **$1.85**

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons and cosmic rays, in plain language. Also transmutation of the elements and manufacture of artificial radioactivity. **$2.35**

THE METER AT WORK—*By John F. Rider.* Describes fundamental types of meters and their operating principles and mechanisms, also practical applications. For workers in radio and electronics. **$1.35**

INDUSTRIAL CHEMISTRY—*By Emil Raymond Riegel.* An intermediate text for those who wish to survey the field and acquaint themselves with the fundamentals of chemical processes and products. **$5.85**

HANDBOOK OF MATHEMATICAL TABLES AND FORMULAS —*By Richard Stevens Burington, Ph.D.* Elementary and advanced mathematics. Practically all tables needed by mathematicians and actuaries. **$1.35**

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* With four other scientists, Dr. Strong has assembled a wealth of useful data of a wholly practical kind for the constructor, experimenter, and skilled craftsman. **$5.10**

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE — *Lincoln Electric Co.* Sixth edition of a famous book covering every phase of arc welding in detail. Limp leatherette. 1117 pages, several thousand illustration.—
In U. S. A. **$1.50**
Elsewhere **$2.00**

MODERN PLASTICS CATALOG —1941. More than a mere catalog; covers the whole field of plastics, discussing and illustrating, with hundreds of pictures, the entire industry—engineering, materials, molding and fabricating equipment, plastic castings, synthetic fibers, and so on. **$3.50**

MACHINERY'S HANDBOOK — *Tenth Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. **$6.10**

TOOL MAKING—*By C. B. Coles.* Instruction for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. **$3.60**

A SURGEON'S AUTOBIOGRAPHY—*By Hugh Young, M.D.* A candid, frank book by a famous urological surgeon at the Johns Hopkins Hospital. Deals with prostate troubles, bladder tumors, and so on, with 91 illustrations. A chapter on prostitution. **$5.10**

PLASTICS, PROBLEMS AND PROCESSES—*By Dale E. Mansperger and Carson W. Pepper.* For hobbyists and experimenters, this volume gives a large number of detailed plans and instructions for making all kinds of useful and ornamental articles from tubes, rods, sheets, and blocks of plastics. **$2.70**

VITAMINS—*By Henry Borsook.* Authoritative, general treatise on all the vitamins, for those who want dependable, up-to-date, scientific, not too technical and not too superficial data. **$2.10**

TURRET LATHE OPERATOR'S MANUAL—*By Longstreet and Bailey.* Expert lathe operators are needed in national defense work. This book gives a thorough course in lathe operation. **$2.60**

THE HANDY MAN'S HANDBOOK—*By C. T. Schaefer.* Fourth edition of a very popular book—a practical manual on the use of tools and how to do all sorts of odd jobs around the home. **$1.10**

Write us for information on books on any subject which interests you. We can supply any book in print.

For Sale by: **September, 1941**

SCIENTIFIC AMERICAN, 24 West 40th Street, New York City

I enclose $..... for which please forward at once the following books:

.....

.....

Name .....

Address .....

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

LESSONS IN ARC WELDING is a 176-page illustrated book, bound in semi-flexible simulated leather, which contains comprehensive data for beginners who are learning to arc weld as well as for experienced welders and shop supervisors, foremen, and so on. The text is arranged in a series of 60 lessons. It carries the reader through from preliminary instructions to practical applications. *The Lincoln Electric Company, 12818 Coit Road, Cleveland, Ohio.—50 cents in United States, 75 cents elsewhere.*

GOOD-BYE TO FUSES is a pamphlet published to acquaint home builders and remodelers with "multi-breakers," a new device that eliminates fuses in home electric circuits. *Cutler-Hammer, Inc., Milwaukee, Wisconsin.—Gratis.*

VENTILATION AND EXHAUST FANS is a 16-page illustrated catalog describing a complete line of fans for commercial, industrial, and domestic installation. Information is given on where and how to install fans for maximum benefit, how to determine the most effective size of fan to use, and other phases of modern ventilation. Request this bulletin on your business letter head. *The Emerson Electric Mfg. Company, St. Louis, Missouri.—Gratis.*

JESSOP NEW PROCESS COLD HEADER DIE STEEL is an eight-page illustrated booklet describing a non-porous steel developed especially to meet the severe service conditions encountered when cold-heading bolts, screws, rivets, nails, buttons, and other small metal objects. Complete information on the heat treatment of this steel has been included. *Jessop Steel Company, Washington, Pennsylvania.—Gratis.*

SUPPLEMENT TO "OUR COLORFUL WORLD," Filmosound Library, brings total of titles under this head to 37 single reels, for the most part silent, dealing with various geographical regions. The list includes a series of five on National Parks, one on Indian life today, and one on Porto Rico. Another series of nine new reels deals with wild life, mostly birds, each reel covering either a single species or a habitat group. *Bell & Howell Company, 1801 Larchmont Ave., Chicago, Illinois.—Gratis.*

SPEED REGULATION AND CONTROL ON RURAL HIGHWAYS, by Raymond G. Paustian, is an 88-page report of a special investigation of measures used in various states in attempting to increase highway safety for both vehicles and pedestrians. Phases covered are speed studies, legislation, night speeds and visibility, speed zoning, law enforcement, speed-measuring equipment, and so on. *National Research Council, 2101 Constitution Avenue, Washington, D. C.—$1.*

MANUAL ON INSULATING VARNISHES is a 34-page booklet designed to assist the industrial user in the proper selection and application of insulating varnishes. Included are descriptions of 31 insulating varnishes, paints, and enamels, giving characteristics, uses, applications, and types. *Irvington Varnish & Insulator Company, Irvington, New Jersey.—Gratis.*

ALEMITE PROGRESSIVE LUBRICATING SYSTEM FOR INDUSTRY is an eight-page illustrated pamphlet giving details on a centralized system which has been designed to permit "one-shot" high-pressure grease lubrication to a number of bearings on a given piece of industrial equipment. Any type of manually or power-operated grease gun can be used. *Alemite, 1826 Diversey Parkway, Chicago, Illinois.—Gratis.*

IT SANDS, SAWS, HONES, FILES is a four-page illustrated leaflet describing in some detail two models of reciprocating multi-purpose hand tools for use in either intermittent or continuous production operations in various types of machine work. Complete specifications and prices are given. *H & H Research Company, 1925 W. Buena Vista, Detroit, Michigan.—Gratis.*

WESTERN ELECTRIC 6B AUDIOMETER is a 14-page illustrated bulletin giving general details of this newest device for swift and sure diagnosis of hearing defects. The Audiometer is so simple in operation that a nurse or doctor's office assistant can readily become competent in its use. *Graybar Electric Company, 420 Lexington Avenue, New York, New York.—Gratis.*

TIPS ON BETTER CHILD PICTURES, by Ruth Alexander Nichols, is a 12-page illustrated brochure giving succinct yet comprehensive information on child photography. Most of the data are concerned with how best to pose children; the last two pages deal with lighting and exposure meter work. Request publication GES-2730. *—General Electric Company, Schenectady, New York.—Gratis.*

MAGNESIUM FIRES AND INCENDIARY BOMBS is a folder describing a new type of dry fire-extinguishing powder of particular interest to defense industries. *Pyrene Manufacturing Company, Newark, New Jersey. —Gratis.*

THE CHANGE TO PLASTICS is a folder giving 12 industrial case histories in which plastics have been used for making items formerly made of other materials. *Plastics Department of the General Electric Company, Pittsfield, Massachusetts.—Gratis.*

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

Books on Psychic Phenomena

• • •

Extra-Sensory Perception After Sixty Years

By J. B. Rhine, J. G. Pratt, Burke M. Smith, Charles E. Stewart, and Joseph A. Greenwood

A COMPLETE account of the research conducted to date on extra-sensory perception. This book is a summary of what has been achieved so far, a reference work covering the field as a whole, a treatment of all the evidence, a guide to the literature of the subject, a condensation of the greater bulk of it, and a handbook of methods. It includes a digest of 56 articles of criticism of experiments in extra-sensory perception, mainly as made by psychologists, in which these are dealt with without emotion. A solid, serious study. (463 pages, illustrations.) —$2.85 postpaid.

Forty Years of Psychic Research

By Hamlin Garland

AFTER a lifetime spent in investigating spiritualistic phenomena, the author presented the facts as he observed them. He theorized little, witnessed without emotion, and after a clearly stated, factual presentation, he permits the reader to draw his own conclusions. (394 pages.)—$3.60 postpaid.

Cavalcade of the Supernatural

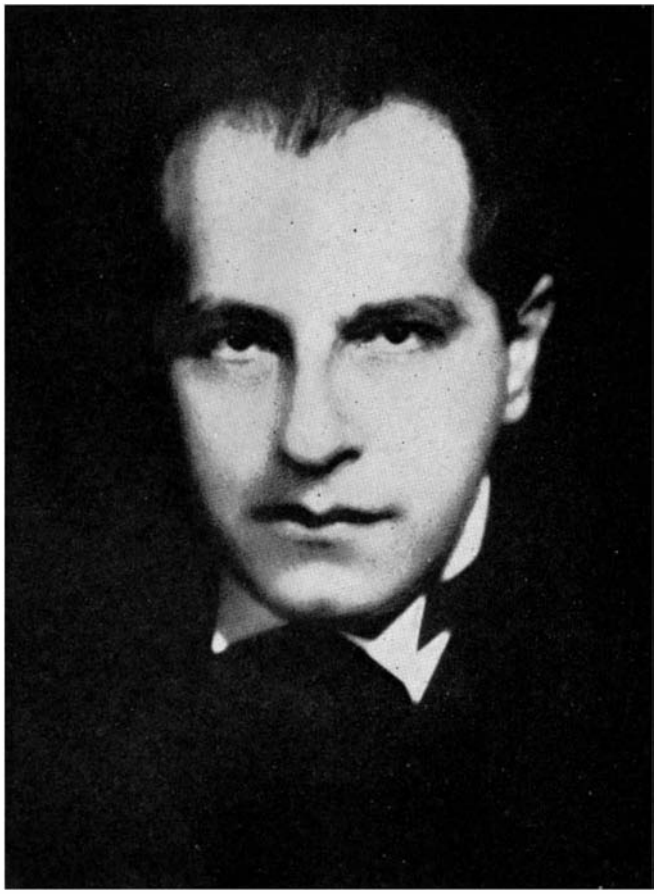
By Dr. Harold H. U. Cross

HIGHLY valued as one of the clearest, most convincing volumes dealing with manifestations all over the world of water divining, luminous effects, materializations, spirit photography. Illustrated with authentic pictures.—$2.10 postpaid.

Experiments in Psychics

By F. W. Warrick

INTENDED for experienced students of psychic phenomena, this book records the results of years of systematic investigation of direct writing and psychic photography. A large number of experiments, accompanied by photographic studies, all made under test conditions, seems, in view of the convincing nature of results, to rule out the possibility of fraud in the majority of cases and to offer strong evidence in favor of the types of psychic phenomena dealt with. (600 illustrations.)—$7.60 postpaid.



DUNNINGER

YOU, TOO

Can Investigate The

SUPERNATURAL

IN our April issue we announced our intention of exploring the realm of the psychic in an endeavor to determine whether, through mediums, we can communicate with the dead. We want to know if such things as phantoms, ghosts, spirits, or vampires actually visit us. We seek the facts concerning ectoplasmic and other supernatural demonstrations of a physical nature. To aid us in our search, the Scientific American Committee for the Investigation of Psychic Phenomena was formed under the chairmanship of Dunninger, whose world-wide reputation as a telepathist, magician, and psychic investigator is unequalled.

In the course of our search the Committee will welcome sincere and bona fide assistance. Should your interest in the psychic lead you to try to discover for yourself a basic, truthful, scientific explanation, you will wish to follow the reports of the Committee as they appear in ensuing issues of Scientific American. For correlative reading, the books listed on this page will be found informative, helpful, and interesting.

—The Editors

Books on Psychic Phenomena

• • •

Inside the Medium's Cabinet

By Dunninger

A DARING exposé of trickery practiced by fraudulent mediums in presentation of so-called supernatural phenomena. In an exciting series of revelations, this internationally known authority on spiritistic matters divulges the secrets of certain mediumistic personalities who have come within the scope of his experience. Every statement of fact is based on the author's first-hand investigation. (228 pages, profusely illustrated.)—$2.60 postpaid.

Psychics and Mediums

By Gertrude Ogden Tubby

A MANUAL and bibliography for students, this is also an important guide and source book, presenting a scientific analysis of all types of psychic research, both objective and subjective. (210 pages.)—$2.10 postpaid.

Science and Psychical Phenomena

By G. N. M. Tyrrell

IF the world is to be saved from the advance of materialism, the author points out, knowledge of man's psychic processes must be extended. This splendidly informed, thoroughly scientific examination of a controversial but increasingly important subject is a unique addition to the literature on psychical research. Brilliantly concise, carefully evaluated, the history of research and the method of collective experiment are described. —$3.85 postpaid.

Beyond Normal Cognition

By Dr. John F. Thomas, Ph. D.

THIS is an intensely interesting study, evaluative and methodological, of the mental content of certain trance phenomena. The author was for some years associated with the Boston Society for Psychic Research. (319 pages, bound in cloth.) —$3.10 postpaid.

South American BOOM!

IN TRADE AND TRAVEL

Offers You Amazing New Opportunities

Map, Courtesy of NBC Short Wave Service

OWING to world conditions and the "Good-Neighbor" policy of the U. S. never before have South and Central America held out such opportunities to Americans who want to get ahead. Practically every day our newspapers announce new loans; trade pacts; the opening of new branch offices in South America by U. S. firms, etc.

American salesmen, engineers, secretaries, stenographers — business and professional people of every kind — are already increasing their chances *because they can deal with South Americans in their own language.* Opportunities are RIGHT HERE NOW — waiting for you — IF you know Spanish! And now you can learn it (without difficult or tiresome study) by this most practical and fascinating of all methods!

Just Listen to This Record!

Speak SPANISH AT ONCE!

EASIEST OF ALL LANGUAGES

Count Rafael Diez de la Cortina, inventor of the phonographic method of teaching foreign languages.

What Others Say:

RUDY VALLEE *says* . . . "delighted with results from Spanish and French Cortinaphone Courses . . . invaluable in broadcasting and recording."

FRANK LUTHER *says* . . . "Pronunciation on records remarkably clear."

"Anyone Can Learn" "Your clear records make it possible for anyone to learn the language of their choice." — *Mr. Tom White. Muskogee, Okla.*

"A Good Investment" "Have just returned from Mexico and found that my Cortinaphone Course was a good investment." — *Phillips B. Iden.*

"The Best Way" "I believe your method the best way to acquire a working knowledge of a foreign language in the shortest time." —*Louis A. Smith, Fort Kent, Maine.*

THE quickest and surest way to learn Spanish, or *any* language, is by *listening* to it—as children do! That is the *natural* way to learn, to listen, then repeat what you hear until speaking the language becomes *natural* with you.

Cortina "Learn by Listening" Records bring the clear, cultured voice of a native Spanish instructor right into your living-room. He talks to you whenever (and as often) as you wish in faultless, idiomatic Spanish. He converses with you just as any Spanish-speaking person would, on the streets, in shops, in the offices of a South or Central American city. Your instructor never tires, never complains.

EARN More and ENJOY More —Through a Command of Spanish

You'll be amazed how quickly you can pick up the ordinary conversation! Business and commercial terms soon become second nature with you! With Cortina "Learn by Listening" Records, you can progress as fast, or as leisurely as you wish!

Spanish opens up to you new business opportunities. It will also win you new and interesting Spanish-speaking friends. And imagine the thrill of being able to stray away from the "beaten paths" of the conducted travel tours—and truly *enjoy* out-of-the-way corners of Havana, Panama, Lima, Buenos Aires, San Juan!

For over 50 years, the Cortina Method has helped people in all walks of life realize their cherished ambition of learning another language. Today, when Spanish, especially, can mean so much financial gain and travel pleasure, the Cortinaphone system is more than ever adapted to the needs of busy Americans who must learn quickly and save time. In fact, many men and women who already have a knowledge of Spanish have become Cortina students to "brush-up" and improve their word fluency!

FRENCH, GERMAN, ITALIAN Also Taught

Cortinaphone Courses in French, German, Italian and English (for Spanish-speaking people) are as effective in teaching you a new language as the Spanish course described here, and are sent on the same 5-Day Trial Offer. Regardless of present world conditions, there are still limitless advantages, both business and cultural, to be derived through a knowledge of these tongues! Check the language of your choice on coupon below.

FREE BOOK DESCRIBES 5-DAY TRIAL OFFER.

Without obligation, we will send the Cortina Academy's free book, "The Cortina Short-Cut to Speaking Spanish and Other Foreign Languages." In 28 fascinating pages, this book tells about the easy Cortinaphone method and how it can open up opportunities to you today.

This booklet will also explain about the Cortina 5-DAY TRIAL OFFER. For, if the Cortinaphone course does not prove, *in the very first five days,* that it can quickly and thoroughly teach you the language of your choice, just return it, without cost or further obligation. It is to your advantage to add a knowledge of Spanish to your accomplishments as soon as possible. So send coupon for this Free Book at once!

CORTINA ACADEMY (Language Specialists Since 1882)
Dept. 159
105 West 40th St.
New York, N.Y.

CORTINA ACADEMY (Language Specialists Since 1882)
Dept. 159, 105 West 40th Street, New York, N. Y.

Please send me—without obligation—your free book, "The Cortina Short-Cut to Speaking Spanish and Other Foreign Languages," and full facts about your special "Proof-in-5-Days" offer.

(Check language in which you are interested)

☐ Spanish ☐ French ☐ German ☐ Italian

Name .....

Address .....

City ..... State .....