DOCTORS DON'T GUESS: By Morris Fishbein, M.D.

SCIENTIFIC AMERICAN

July • 1937

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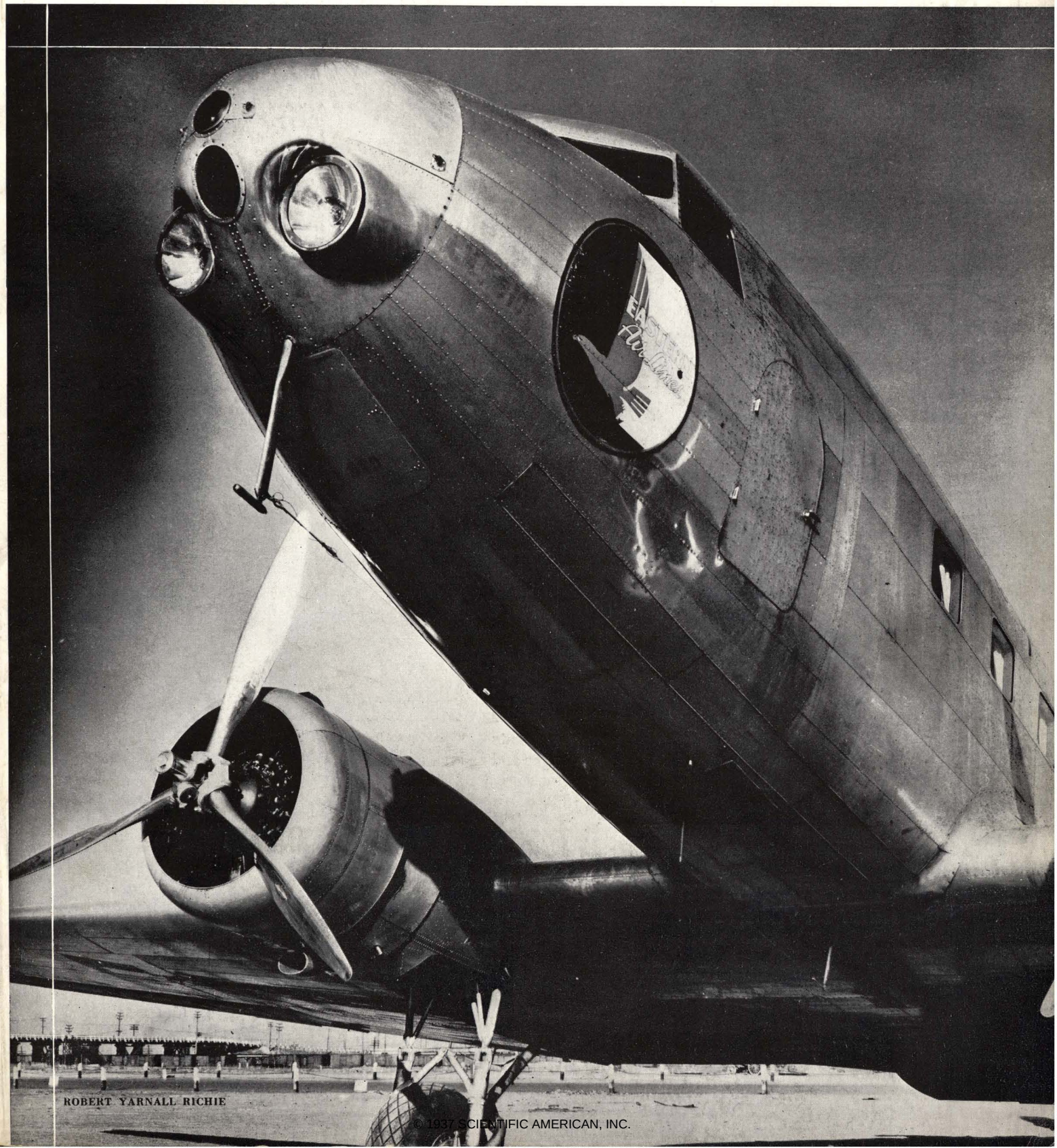

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SUPER-PRESSURE STEAM secret of liner's 200,000 H. P.

81,235 TONS of modern superliner—the Cunard White Star liner "Queen Mary."

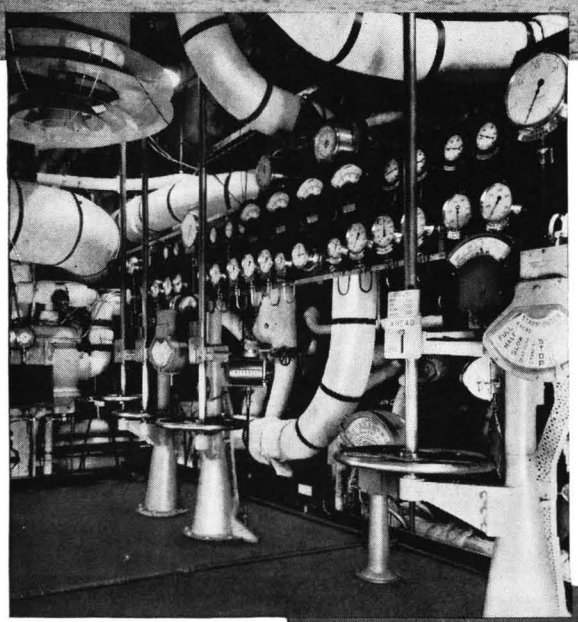
"Queen Mary" engines illustrate HIGH COMPRESSION feature of modern autos

MARINE ENGINEERS now get more power out of every gallon of fuel oil by super-heating steam—increasing operating pressures. Automobile engineers give you more from every gallon of gasoline by increasing compression ratios—building modern cars with high-compression engines.

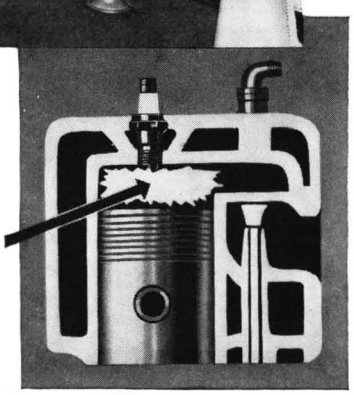
Cars in every price class today offer the extra power, extra mileage, extra responsiveness that high compression gives. But to get all these advantages you must set the spark for maximum performance and use high-compression fuel!

Where do you get high-compression gasoline? *At pumps marked "Ethyl"!* Ethyl is at least six octane numbers higher in anti-knock value than regular-grade gasoline. That's why it gives smooth, high-compression power, prevents harmful knock that overheats the engine and wastes gas and oil. Ethyl assures you of 100% performance—plus all-round quality that is *double-tested*—by the oil company and by the Ethyl Gasoline Corporation.

GIVES YOU A BETTER RUN FOR YOUR MONEY



STEAM at 440 lbs. per sq. in. and 700° Fahrenheit from 24 boilers drives the huge turbines. Here you see one of the control rooms, or "starting platforms," from which the "Queen Mary's" 200,000 horsepower is controlled.



FUEL mixture is compressed in the cylinders of the average modern cars to less than one-sixth its original volume. You need ETHYL to prevent "knock" under this HIGH COMPRESSION.

ETHYL GASOLINE CORPORATION

ETHYL GETS FULL POWER FROM HIGH COMPRESSION

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

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NINETY-THIRD YEAR • **ORSON D. MUNN, Editor**

CONTENTS · JULY · 1937

TYPIFYING modern air transport—so largely dependent upon reliable high-powered engines discussed in detail by Reginald M. Cleveland on page 14 of this issue—is the striking photograph of an Eastern Air Lines passenger plane reproduced on our front cover. This particular ship is a Douglass DC-2, powered by Wright Cyclone engines of 750 horsepower each.

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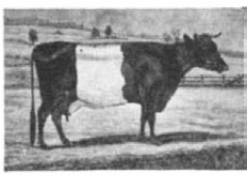
50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of July, 1887)

FLASHLIGHT—"Messrs. Goedicke and Miethe have prepared a mixture of pulverized magnesium, chloride of potash, and sulphide of antimony, which when ignited produces an explosive, lightning-like illumination of such intensity that by means of it an instantaneous photograph can be taken."

CATTLE—"We present a portrait of an excellent representative of a unique and novel breed of dairy cattle. They are natives of Holland and antedate the seventeenth century, when the cattle interests in Holland were in the most thrifty condition, and this type and color were established by scientific breeding. . . . In their native country they are owned and controlled by the nobility, and present a very novel feature in the landscape, grazing in the lowlands in Holland. In color they are black, with a continous white belt around their body, the white being pure white, the black jet, making a beautiful and imposing contrast. Their form is usually very fine, and they are wonderfully productive as milkers."



PANAMA CANAL—"The present condition of the Panama Canal was explained to the American Society of Civil Engineers . . . by Mr. T. Boulange, one of the chief engineers at the Isthmus on the great undertaking, who arrived from Panama a few days ago. . . . He said that the company had only money enough on hand to continue work for four months. The death rate among the laboring men had averaged 60 percent. Of 62 Frenchmen who went to the Isthmus from France one year ago, but 11 remain today. Forty-five died in that period, and six left on account of sickness. Mr. Boulange intends to remain in the United States. . . . Reports say that both the French and United States governments will be asked in turn to take up and carry out the project of a canal at Panama, but it is not likely that either will do so."

REPEATING RIFLE—"According to the semi-official *Berlingske Tidende*, the new repeating rifle of Captain Wadsen and Lieutenant Rasmussen is to be introduced in the Danish army. In this rifle the barrel is not fixed to the stock, but is secured by a spring. In firing, the barrel is forced backward, by which motion the bottom plate of the breech is opened, the empty cartridge ejected, and a fresh cartridge pushed forward into its place, the magazine holding six cartridges."

HIGH-SPEED PHOTOGRAPHY—"A photographer at Pesth has succeeded in taking photographs of projectiles, fired from a Werendler gun, while having a velocity of 1300 feet per second. The projectiles appeared on the impressions enveloped in a layer of air hyperbolic in form."

PATENTED—"In view of the fierce attacks sometimes made on valuable patents, it is well to remember that they represent a monopoly of but limited duration, and that their very value lies in the economy that they effect in some way for the people who use them. The use of a patented article is in every instance, we believe, a matter of deliberate choice as to a convenience, and not the resort to an absolute necessity."

STREET RAILWAY—"The longest street tramway in the world will be that which is to connect a number of towns near Buenos Ayres, South America, and which will have a total length of 200 miles."

EARTHQUAKE—"In a communication to the American Academy of Sciences, Captain C. E. Dutton gives a calculation of the depth of the Charleston earthquake centrum, which puts it at the enormous distance of twelve miles below the earth's surface."

STEAMER SPEED—"The *Queen Victoria*, the pioneer vessel of the new line intended to ply between Liverpool and the Isle of Man . . . sailed from the Tail of the Bank, Greenock, to Liverpool, in the remarkably short time of nine hours twenty-three minutes, representing an average speed of 22¼ knots, or 25.62 miles per hour."

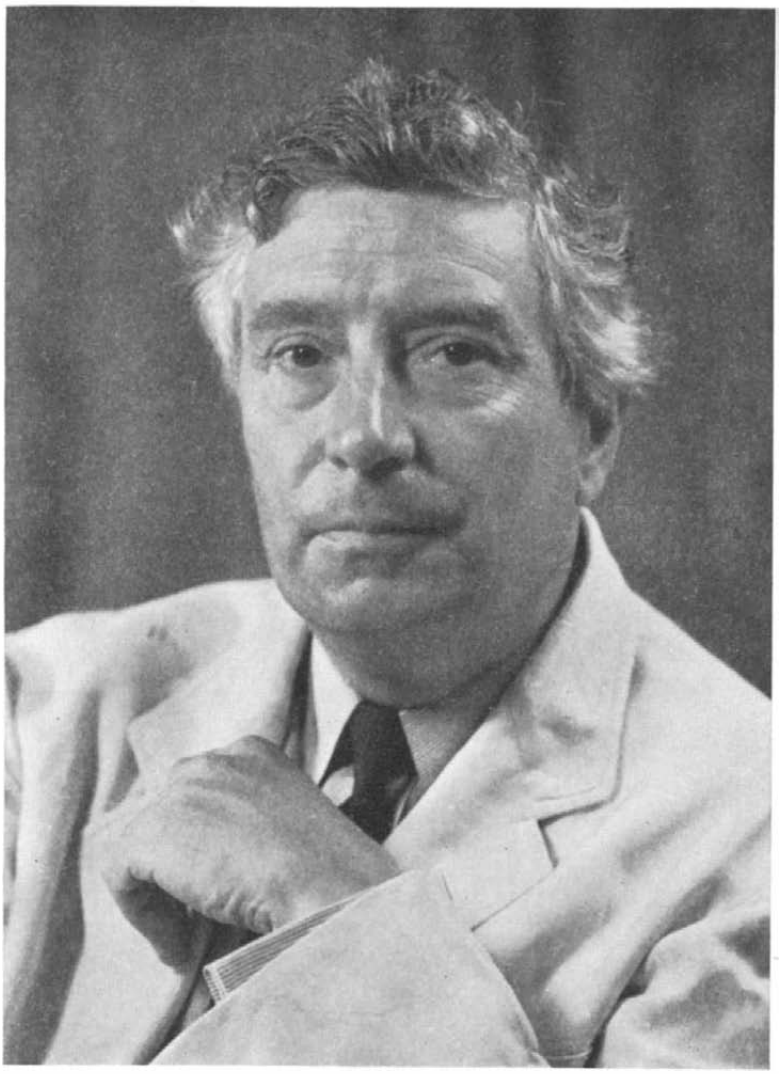
DINOCERAS—"In 1870, while Prof. O. C. Marsh was making some explorations in central Wyoming, he discovered the remains of a huge animal whose form was entirely unknown to him, which he at once recognized as an extinct form, and which he named the dinoceras. His explorations in this region, at this time and subsequently, were extensive, and remains of different parts of this type were found from time to time, and the Peabody Museum at Yale College, over which Prof. Marsh presides, now contains specimens or portions of specimens of over 200 individuals, showing how common and abundant a type this must have been during a certain period of the earth's development."

AMERICA'S CUP—"The new British yacht *Thistle* . . . left for New York on July 25. She takes a crew of forty men. Her owner and her captain are sanguine that she will win the America's Cup. This vessel appears to have sailed faster than any yacht heretofore built in Great Britain. The new American yacht *Volunteer* will probably be the competitor of the *Thistle*."

E. E.—"At a recent meeting of the Polytechnic Society of Berlin . . . the question was asked: What studies are best to fit one to be an electrical engineer? Herr Frischen, one of Siemens and Halske's experts, replied that much practical experience was required. After graduating from school, a rigid course in an advanced technical school should be taken, followed by an apprenticeship in a factory. He remarked that at present the title of electrician is used too freely, and that the claim of some to it is that they have nailed up a few wires."

WAR DOGS—"Among the thousand and one inventions, appliances and wonderful uses of men and beasts which German genius has devised to defeat France in case General Boulanger's successor becomes unpleasant, the dog plays a significant rôle."

Personalities in Science



W. F. G. SWANN

BAD memory and a natural antipathy to physics and mathematics were boyhood characteristics of Dr. William Francis Gray Swann, director of the Bartol Research Foundation of The Franklin Institute, and associate editor of the *Journal of the Franklin Institute*. Today he is recognized as one of the most brilliant physicists in the world.

An informal "close-up" account of Dr. Swann's career is given in a recent number of *The Institute News*, published by the Franklin Institute, from which the following is taken:

Told, as a schoolboy, to memorize a proposition from Euclid, he felt unequal to the task and decided to bluff when called upon. At the close of his explanation the instructor announced that he had proved the proposition—and proved it correctly—only the solution wasn't Euclid's. After this, the boy solved all his problems the same way.

Born at Iron Bridge, Shropshire, England, the lad decided that he would study medicine, primarily because it was thought to be a profession in which it was possible to make a living. Prior to this time he had considered music as a career, but decided against it because it apparently held little prospect of affording a livelihood.

He substituted for a friend in a theater orchestra, playing the 'cello, thereby earning enough money to buy a microscope for his medical studies. The conductor wanted to discharge the regular 'cellist and retain his young deputy. Young Swann did not like that way of doing things, and did not intend making music his profession under any circumstances.

Browsing in an old bookshop, he found a very old volume which contained algebra, trigonometry, conic sections, differential calculus, the calculus of variations, the calculus of finite differences, mechanics, dynamics, hydrodynamics, astronomy, geodesy, and a few other scientific subjects—all for four cents.

That was the end of the medical career, which demanded that too many names be memorized, anyway.

There followed a scholarship to the Royal College of London, where he became a junior instructor after graduation. His research in physics attained wide recognition, and he accepted a lecturing position at the University of Sheffield. Here he also served as the very individualistic conductor of the university orchestra—on one occasion composing last-act music for a college play during the first intermission.

In 1915 the Carnegie Institution of Washington called Dr. Swann from Sheffield and he was made chief physicist of the Department of Terrestrial Magnetism. Asked to give a series of lectures at the United States Bureau of Standards, the talks to be held at eight o'clock in the morning, he protested that "an Englishman seldom stays up that late!"

In 1917 he was engaged as a consultant at the Bureau of Standards, and here again he became conductor of the orchestra, having a number of now world-famous physicists as his instrumentalists. In 1918 the University of Minnesota made him professor of physics. In 1922 he accepted a similar position at the University of Chicago, and in 1923 he went to Yale, where he was made director of the Sloane Laboratory.

In 1927 he was brought to Philadelphia to become director of the Bartol Research Foundation of The Franklin Institute.

His present investigations center principally around cosmic radiations, and he is also acknowledged as an authority in thermal measurements, electromagnetic theory, electroconductivity, relativity, terrestrial magnetism, atmospheric electricity, and atomic structure.

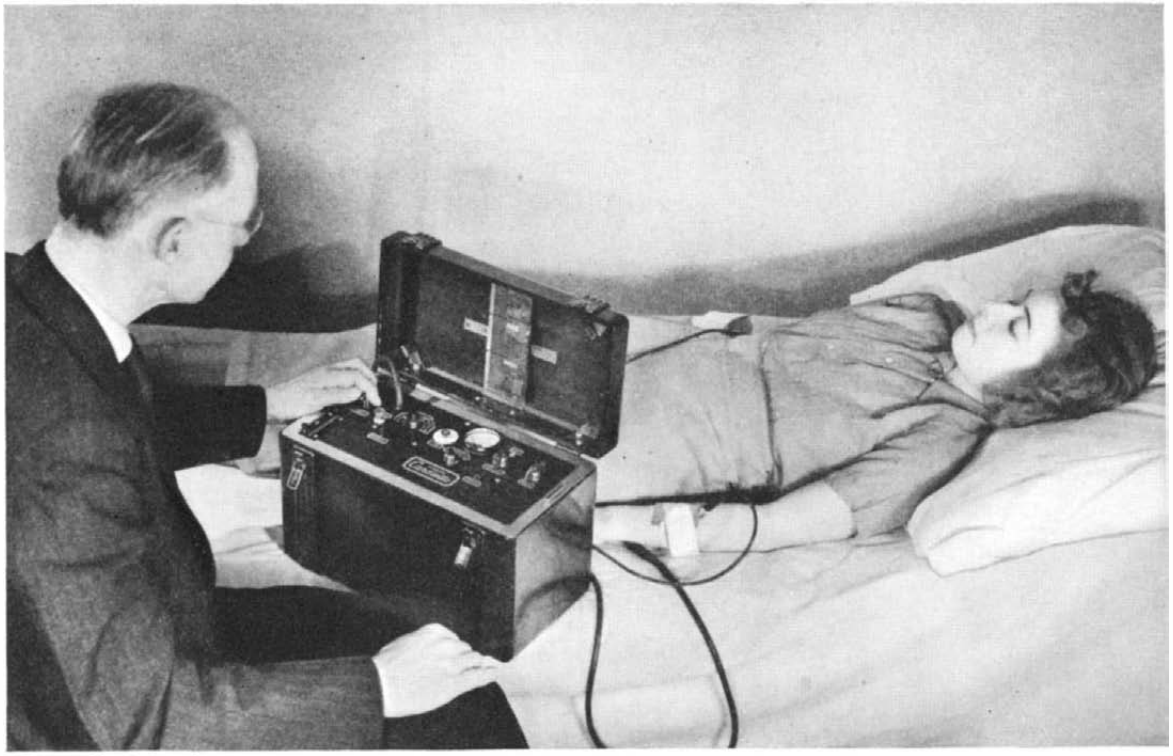
He has published innumerable research papers and several books, and is one of the contributors to the "Encyclopædia Britannica."

In his writing and his lecturing he has achieved exceptional fame because of his ability to make abstract theories comprehensible to the layman.

He is a member of learned societies here and abroad. Among other honors which have been showered upon him, he is past president of the American Physical Society.

A FAMILY OF GUEREZA MONKEYS FROM ETHIOPIA

SHUNNING cultivated areas and subsisting mainly on a diet of leaves with occasional additions of fruits and insects, the guereza monkeys of Ethiopia are the only African monkeys for the pelts of which there is a commercial demand. Their exceptionally long hair makes the skin suitable for trimming coats; it is used by natives for decorative purposes, and is also exported. Besides the black and white species shown above, there is also a red guereza monkey. The illustration shows a habitat group recently placed on exhibition in the Carl E. Akeley Memorial Hall of the Field Museum of Natural History, Chicago



Courtesy The Sanborn Company

The doctor brings a portable electrocardiograph to your bedside for a delicate heart test

KNOWING *VS.* GUESSING IN MEDICINE

Today the Physician Augments his Senses with a Multitude of Laboratory Tests . . . Microscopic, Electrocardiographic, and Many Other Tests

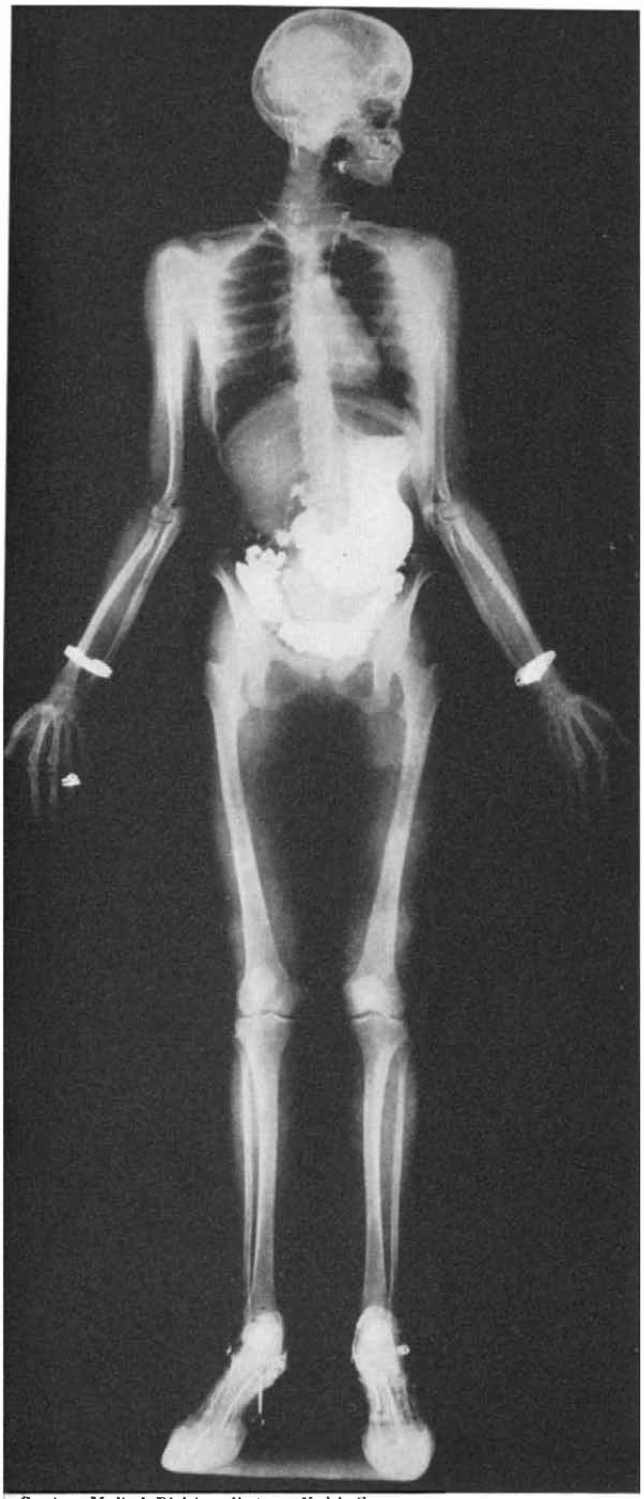
By MORRIS FISHBEIN, M.D.
Editor, *Journal of the American Medical Association*, and of *Hygeia*

THE family doctor of the horse-and-buggy era was largely dependent on his unaided five senses in making a medical examination. Solemnly he inspected your skin for eruptions, fingered your pulse, and peered into your throat or other body orifices. But the diagnosing of disease is no longer a matter of guess-work, based upon the observance of external symptoms. When you are ill today, your physician augments the testimony of his skilled senses by a multitude of laboratory tests which give him precise information about the nature and extent of your ailment. These tests enormously increase the accuracy of medical diagnosis, minimize the expense and duration of treatment, and always enhance the possibility of making a cure.

Many of these tests hinge upon ingenious devices that intensify and extend the doctor's faculties. Consider, for example, the sense of sight. With an array of "scopes," combining electricity, mirrors, and microscopic lenses, the modern doctor observes the remotest regions of your anatomy. The otoscope lays bare the ear drum; the long tube of the cystoscope lights up the interior of your bladder. By combining the gastroscope with an unbelievably small camera, the doctor can make photographs of the lining of your stomach wall and thus identify ulcers, tumors, or other changes. Guesswork is eliminated; the doctor *knows* the cause of your malady because, with these aids, he can actually see it.

The examination of tissue removed from the living body is one of the most crucial tests that the doctor makes. This scrutiny of living tissue—called a biopsy—is especially useful in determining whether or not a tumor is cancerous. Until recently, this test was a formidable operative procedure, but a new technique known as the "punch biopsy" is a vast improvement over the older method. In the punch biopsy, a hollow needle is inserted into the growth to be examined, and a cylinder of tissue is removed without disturbing the patient, or activating to further growth any existing tumor. A laboratory assistant then "freezes" this specimen, and with a miraculously sharp instrument called a microtome, cuts a transparent slice, fragile as a bee's wing. Delicately stained with chemicals, this slice is placed under a microscope; and the doctor's trained eye determines whether the tissue is of the malignant type associated with cancer.

In the detection of heart-disease, even the greatest specialist leans nowadays on the electrocardiogram—a graphic record of the changing electrical activity within the heart. As the heart contracts and dilates, five distinct "waves" of electrical energy, each having a special significance, are produced. These are traced by a complicated magnetic device on a reel of paper. By the arrange-



Courtesy Medical Division, Eastman Kodak Company

Full-sized radiograph of young woman. Stomach and intestines are outlined, due to eating an X-ray-opaque meal

ment of these waves, the physician can detect disturbances of the heart long before they make themselves visible by the processes of ordinary examination. Such disorders as heart block, fluttering of the auricles, or an uncontrolled twitching of a portion of the heart muscle, write their own records in the electrocardiogram. By means of another testing machine called the sphygmograph, variations in the pulse beat are recorded on a moving strip of paper, a method far superior to the human finger in the accuracy of its measurements.

Grave conditions of the brain or spinal-cord formerly presented insuperable diagnostic problems; locked in the bony vault of the skull, the critical secret lay hidden from the doctor's eyes. Now, however, many of his questions are answered by numerous tests made upon the spinal fluid. To obtain a sample of this fluid, he inserts a hollow needle between the lower vertebrae; attached to this needle is a delicate gauge called a manometer, which registers the pressure of the fluid in the spinal canal. Any deviation from normal pressure suggests a disturbance of the brain or spinal cord. By the Queckenstedt test the doctor determines which *side* of the brain is involved. Using his thumb, he constricts the left side of the patient's neck, and observes (let us say) that the manometer registers a normal pressure. He then repeats the performance on the right side; if the spinal fluid pressure rises, that side of the brain is affected.

AFTER the fluid is withdrawn, some of it is smeared on a glass slide and examined microscopically for bacteria. Such examination may reveal cerebro-spinal malaria, spotted fever, or sleeping sickness. Early and effective therapy can be instituted in all of these diseases. Upon another portion of the fluid, a "white-cell" count is performed; large numbers of these cells may disclose infantile paralysis or epidemic meningitis. The *color* of the spinal fluid is also noted; normal fluid is as clear as distilled water, but a canary-yellow tint indicates a cerebral hemorrhage. If the fluid is cloudy it may mean active syphilis of the nervous system. Usually no clot forms in the spinal fluid, but in paresis many small clots appear, and in tuberculosis the clot has a web formation. A Wassermann or Kahn test on the spinal fluid helps to prove the presence of syphilis, while the colloidal gold test indicates the possible diagnosis of general paralysis, syphilis, or meningitis.

Possibly the physician decides that his patient has a tumor of the right hemisphere of the brain, yet is unable to localize the exact position of the lesion. To learn precisely where it lies he performs the following test: Into the same aperture from which the spinal fluid was drawn, air is introduced under gentle pressure, and rises through the spinal column to the brain. An X ray is then taken, and the tumor is clearly delineated on the X-ray plate.

In some illnesses, notably pneumonia and diphtheria, time is all-precious; early recognition enables the physician to take swift therapeutic steps. In treating lobar pneumonia, certain valuable serums are available, but before serum therapy is attempted, the physician must know what *type* of pneumonia confronts him. By the Neufeld test, several types of pneumonia may be differentiated. The patient's sputum is placed upon a slide; then a small amount of rabbit serum (obtained from an animal inoculated, for example, with Type 1 pneumonia germs) is added, and the mixture is stained with methylene blue. If the patient is suffering from Type 1 infection, the shell-like capsule enclosing the pneumonia germs swells visibly when viewed under the microscope.

Diphtheria can now be detected by the Brahdy "rapid culture test" in four hours. Using an applicator with a small knob of coagulated horse-serum at one end, the physician swabs the patient's throat, replaces the applicator in a sterile glass tube and—if laboratory facilities are not available—puts the tube in his vest pocket. The warmth of his body causes the micro-organisms of diphtheria, if present, to grow rapidly. He then rolls the swab over a glass slide, stains the smear, and makes a microscopic examination for diphtheria germs. If these are found, therapy begins then and there.

BY the Ascheim-Zondek test, the fact of pregnancy may be established within 24 hours. Almost immediately after conception takes place, certain hormone surpluses are produced in the blood and urine; if a small quantity of the urine is injected into a female mouse or rabbit, it stimulates their ovaries. They are then killed, their ovaries are examined, and if enlargement is observed, a diagnosis of pregnancy can be made.

It is one of the oddities of medicine that a similar test is useful in detecting teratoma of the male testicle. A teratoma

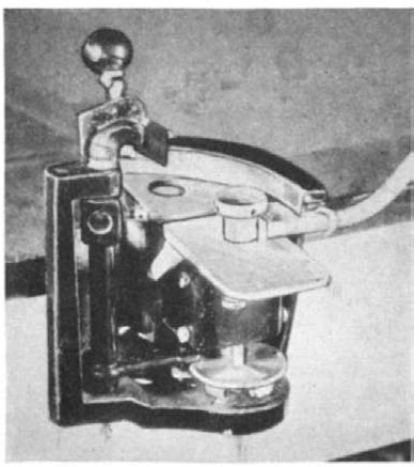


Photo American Medical Association

A freezing microtome, a kind of glorified, delicate, exact meat slicer

is a kind of cancer which may, at some stimulus, break into passionate growth, shooting its buds throughout the entire system and making castration imperative. This testicular freak creates a surplus of sex hormones in the male blood and urine. In 1933, Dr. Russell Ferguson of New York announced in the *American Journal of Cancer* that the hormone test for teratoma (based on the Ascheim-Zondek technique) was 98 percent positive, and that the tumor could be diagnosed within three weeks of its commencement.

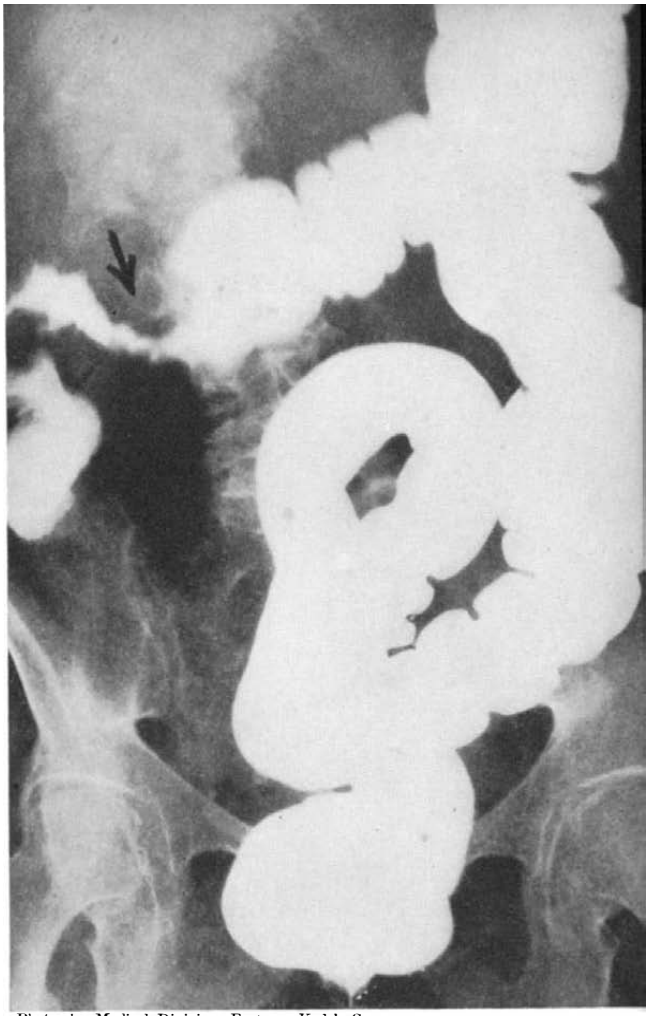
A tremendous extension of the doctor's visual power is made possible by the X ray. When this device was first used in medicine, it showed only the shadowy outline of the bones; but constant improvements in X-ray technique now permit the doctor to vizualize the lungs, heart, kidneys, stomach, and intestines. The modern fluoroscope flashes on a white screen an actual moving-picture of your vital processes! When the doctor wishes to scrutinize your alimentary canal he gives you a glass of buttermilk containing a chemical which cannot be penetrated by X rays. You stand between the X-ray machine and a white screen; the current is switched on and the doctor notes the progress of the chemical mixture through your intestines. He pays particular attention to the shape and size of your stomach as it fills and empties, and thus detects the size and location of ulcers, cancer, or intestinal obstructions.

THE simple but dramatic Swick test is employed when a detailed examination of your kidneys is required. First a dye containing an iodine compound is injected into your arm; this dye enters the general circulation and is hurried to the kidneys for excretion. At precisely the right moment, an X-ray picture of the kidneys is taken, and these organs —filled with the opaque dye—are outlined with marvelous clarity. A few moments later, as the dye descends through the ureters to the bladder, another X ray is taken, and these narrow passages are clearly "spot lighted." Five minutes later, the bladder itself is filled with the dye, and a third X ray is made. By this test, the physician gets a complete story of kidney function and pathology.

About 40 percent of so-called "indigestion" is caused by some dysfunction of the gall bladder, a mysterious little sac attached to the wall of your liver. Often the shrewdest doctor cannot tell from your external symptoms whether you have gall-stones or an inflammation of the bile ducts. To rule out the possibility of gall-stones he orders radiographs. If no stones appear in your picture, you are given the Graham test. You drink a special dye which makes a determined effort to get into your gall bladder. If it does not, the physician interprets this failure in the light of his special knowledge. If, however, your gall bladder *does* fill with the dye, you are given a meal heavy in fat-content, and another radiograph is taken to see whether the gall bladder *empties* properly. After these tests are concluded, your physician presumably knows what to do about that excruciating pain in the upper right quadrant of your abdomen.

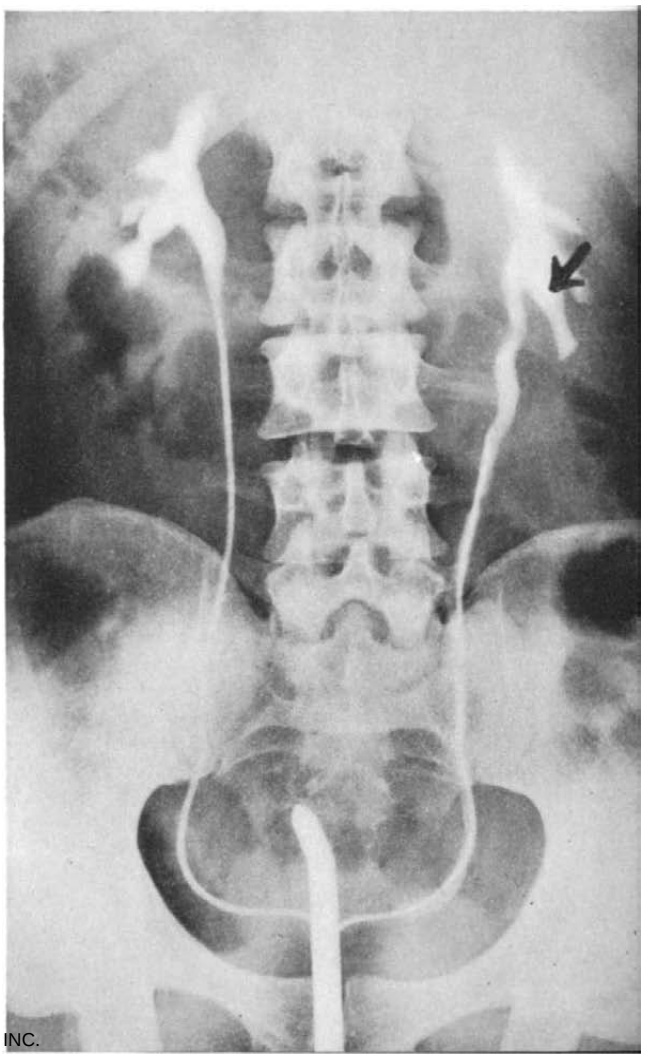
Before a surgeon performs an operation, he must know whether the kidneys are properly filtering the waste products of the body, for if these poisons accumulate, life is endangered. Kidney function is determined by several tests. A dye may be injected into the body and the rate of its excretion in the urine measured. By a complicated excursion into blood chemistry, the "urea nitrogen" test determines whether the amount of this element is normal or excessive. If excessive, the kidneys are not doing their necessary work, and the increased burden of an operation might easily be fatal.

Blood tests are a fruitful

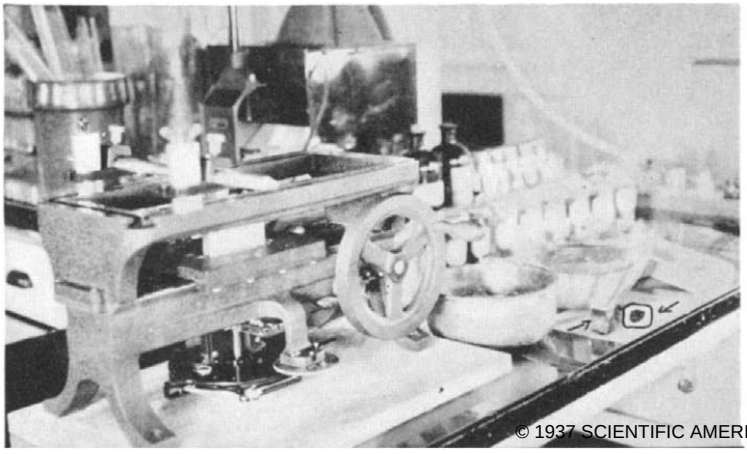


Photos by Medical Division, Eastman Kodak Company

Above: **X ray. The arrow indicates a cancer of the colon.** ***Below:*** **X ray of renal tract. Arrow indicates a stone. A cystoscope is clearly outlined in the bladder, lower down**



A paraffine microtome in which the tissue is infiltrated with paraffine instead of being frozen, before the slicing is done. Two little arrows at the right point to a block of tissue thus made ready for sectioning



Courtesy The Sanborn Company

Making a metabolism test, to determine how much oxygen the patient burns

field for diagnostic study. To examine your blood, the doctor punctures an ear or fingertip and withdraws a small amount. In cases of suspected anemia, he counts the red cells upon a hemocytometer—that is, a glass slide ruled into small squares. These red cells grow in the marrow of our large bones, and one of the latest blood tests consists in removing a small portion of marrow from a leg-bone to find out whether it is manufacturing cells satisfactorily. When the white blood cells multiply too rapidly, a serious condition called leukemia is the result; equally serious —and much more sudden as a cause of death—is the utter *disappearance* of the white cells.

BEFORE your physician pronounces a verdict of "appendicitis," he counts the number of white cells in a cubic millimeter of your blood. Why? Well, he knows that these white cells—the warriors of the blood-stream—increase rapidly in number when the body is combatting an infection. If this count is above normal, he checks with other symptoms and makes his diagnosis. Small greyish discs in the blood, called "platelets," are concerned with clotting; if there are more than 100,000 blood platelets in each cubic millimeter of blood we get along satisfactorily, but when the number falls below that amount we bruise and bleed easily. Blood chemistry has given medicine the "sugar tolerance" test, essential to the accurate diagnosis of diabetes, and the "hydrogen ion" concentration test to determine whether the blood tends toward acid or alkaline.

Sometimes, as a result of gall bladder disease, bile gets into the blood stream, and the characteristic yellow hue of jaundice is observed in the patient. To diagnose jaundice early, a device called a colorimeter is employed. Normal blood-serum is straw colored, but the serum of a jaundiced patient has an orange tinge. If this orange color deepens past a certain point on the carefully graduated scale of the colorimeter, the physician knows that his patient has jaundice, whether his skin is yellow or not. The value of this test, known as the Icterus Index, lies in the fact that it sometimes discloses obstructions of the bile ducts long before clinical signs appear.

When you are either nervous or sluggish, or show marked gain or loss in weight, the physician suspects thyroid disorder and decides to measure your basal metabolic rate. In plain language, he wishes to determine how much oxygen you are burning in a given length of time, under conditions of complete rest. A person undergoing this test reclines upon a sofa, the nose is pinched shut with a clip, and a tube is inserted into the mouth. Through this tube oxygen is breathed; the exhaled air passes into another tube where its carbon dioxide content is measured. After a few minutes, the test is stopped and another test is run as a check upon the first. Taking into consideration the patient's age, sex, weight, and other factors, the basal metabolic rate is determined, and the physician plans his therapy accordingly. Sometimes, as a result of this test, it is necessary to change the whole routine of the patient's life, or even to do an operation on the thyroid gland.

Chemical analysis of gastric juices is a vastly important test in determining whether a patient is suffering from ulcers or cancer of the stomach. In ulcers, an enormous rise of free hydrochloric acid is found in the stomach. But in certain malignant tumors, no acid can be found at all, because of the destruction of the acid-producing portion of the stomach wall. To determine the quantity of hydrochloric acid present, a test-meal of dry bread and weak tea is given the patient. He then swallows a thin rubber tube, and specimens of his gastric juices are withdrawn every few minutes and analyzed chemically for hydrochloric acid. When 10 or 12 specimens have been analyzed, a graph is then plotted showing the amount and rise of the acid content in response to food.

SUFFERERS from asthma or hay-fever are "allergic"; that is, excessively sensitive to some protein element in their diet or in the air surrounding them. Now these proteins are literally numberless, and range from grass pollen to fish-glue and face-powder. The task of the sensitization test is to discover the specific protein causing the trouble. Extracts of hundreds of these substances are now prepared by pharmaceutical houses; the doctor either makes a small scratch on your arm, or with a fine needle injects several extracts between the layers of the skin. An excessive redness or inflammation indicates that the patient is sensitive to a specific protein, and he then can be immunized against it.

A number of interesting tests are concerned with the diagnosis of infectious diseases and the ability of the human being to resist them. The Schick test is a measure of the body's ability to resist diphtheria; the tuberculin test indicates the susceptibility of a child to tuberculosis; and the Dick test estimates resistance to scarlet fever. If these tests show lack of resistance—indicated by redness or swelling at the site of injection—it is possible to inject toxin-antitoxin or other preparations that enable the patient to resist the disease.

These are but a handful of the tests the modern doctor invokes in diagnosing your malady. It is important to remember, of course, that none of these tests will ever wholly supplant the physician's skilled senses, nor would he dream of making a diagnosis solely upon the basis of a single test. The modern doctor correlates your symptoms, takes a careful history of your case, checks one test against another, and is thus liberated from the guesswork—often successful, but always hazardous—of the old-time practitioner.

OUR POINT OF VIEW

Yellow Jack Again

AN unknown villain has stalked forth from lush, reeking jungles to menace a world which had acquired a feeling of security, thanks to science, against the ravages of deadly yellow fever. The first villain, *Aedes ægypti*, the mosquito carrier of the disease—known in the early days as *Stegomyia*—had been so well put under control that everyone thought the end was in sight. A report of The Rockefeller Foundation indicates that a new start must now be made to identify the newcomer, an utter stranger as yet, and to find means of banning him from human society. At the outset the task promises to become a stupendous job.

To date many heroes and martyrs have left their marks on the hard, uphill highway toward eventual elimination of the disease. Longest in memory and perhaps most dramatic was the act of those soldiers who permitted themselves to be bitten by the suspected *Aedes ægypti*. The martyrdom of Noguchi, brilliant little Japanese of The Rockefeller Foundation, is fresh in the public mind, but the name Walter Reed awakens memories of tremendous gains in the fight near the turn of the century. Less well known to Americans are many others—among them Agramonte, Theiler, Lazear, Stokes, Finlay—who contributed enormously to the solution of the yellow-fever problem.

Before 1929, The Rockefeller Foundation believed that the disease was fast disappearing. Infected *Aedes ægypti* were becoming extinct—killed off at their breeding places by man's control measures. Consider Ecuador, for example. In that country since 1919, there have been no recognized cases of yellow fever, yet previously the yearly average in Guayaquil, alone, had been 259 cases! Indeed, as we knew it a few years ago, the disease *has* been brought under control.

"Jungle yellow fever," however, changes the picture. It occurs, according to the Foundation's report, "under conditions of rural or forest environment as distinguished from urban environment." Far from indicating that cities are immune, this actually provides a "source of virus for the re-infection of cities and towns where high densities of *Aedes ægypti* mosquitoes are tolerated." All the more imperative, therefore, is need for continued and intensive research to find the villain and control him if humanly possible. Fortunately, it is unnecessary now to experiment on human beings, for the Asiatic rhesus monkey can be infected. Moreover, a vaccine developed just a few years ago makes it possible for laboratory staffs to work in safety.

While awaiting the success that must eventually reward the scientists' efforts, action has been begun by health officers in the United States, in conference with the United States Public Health Service, to fight off the menace. They are concerned not with a flying mosquito but with a flying airplane, for the airplane has brought us dangerously close to yellow fever infected sections of South America. The Conference has suggested, therefore, certain restrictions as to the location of airports, eradication of *Aedes ægypti* from communities near airports, prevention of spreading of the disease after a single case is reported, and other control measures.

Because of the unknown factors involved and of the airplane, the further fight will enlist the co-operation of many outside the laboratory. But though the task is a big one, there is little question that it will be carried out to a successful conclusion. Happily, the further study will not be fraught with such danger as was faced by earlier researchers.

Enforce the Law

MOTOR-VEHICLE accident prevention presents many ramifications and great is the number of solutions that have been offered. There are, however, so many phases of the problem that it splits into many separate problems, each of which must be considered not only as an entity but also in relationship to the whole. An interesting report recently received from the Northwestern University Traffic Survey Institute shows a definite and indisputable relationship between law enforcement and automobile accidents. By law enforcement is not meant mere arrest of motor vehicle law breakers, but actual convictions. To show dramatically the relationship between convictions and accidents, the Institute has set up an "Enforcement Index" which is obtained by establishing a ratio between convictions for violations of motor vehicle laws and the number of persons injured in accidents. If, for example, a city has 250 convictions for all types of violations during a period when 50 accidents have occurred, its "Enforcement Index" would be five. The average index for 78 cities analyzed by the Institute was 3.5; a good index rating is considered to be some 10 to 12.

The matter of convictions for motor vehicle law violators is one that cannot be too strongly stressed. "Killing of tickets," "knowing the judge," "having a friend at City Hall," all serve to make motorists less respectful of laws which have been set up for their own protection. If only every motorist knew definitely that a violation would bring swift and sure retribution, each driver would be more careful, would observe the laws, and accidents would undoubtedly be reduced. It is almost like grasping at a straw to hope that such can ever come to pass but if individuals will take more pride in a careful driving record than they do in the fact that they can escape conviction for a violation, if judges and justices of the peace will be more rigid in their law enforcement, and if arresting officers will take their jobs more seriously, it is possible to go a long way toward safer highways for a greater number of drivers.

Take it Easy

WE hear a lot about cancer. We usually hear of heart disease only when someone whom we know dies as a result of it. Cancer is—and very rightly—being fought constantly with all the resources of medical science. Heart disease in its many forms is also given its share of attention but for some reason or other it does not seem to reach, in the minds of most people, the importance of the other dread disease. In view of this, it is interesting to cite a few figures. In 1933, heart diseases caused 286,360 deaths in the United States. In 1935, this figure had grown to 312,333. Cancer, during 1935, caused 144,065 deaths. And here is the peculiar thing about it: Generally speaking, cancer is a disease which is contracted through no fault of the sufferer—certain forms of industrial cancer excepted. On the other hand, heart disease can almost invariably be traced directly to the patient's mode of living. The high-speed life of the average American contributes largely to the prevalence of heart disease. Sane living, sane eating, sane drinking, and a more placid, slower speed of existence would go far toward reducing the ravages caused when the little pump so necessary to life goes awry. "Take it easy and live longer" may be trite but it is truer today than ever before.

More Game

Game Birds Reared Under Artificial Conditions Can Survive in the Wild . . . A Foreigner Holds Promise . . . Sanctuaries . . . Future Shooting

By ANDREW R. BOONE

FORTY thousand quail and Chukar partridges—guinea pigs on the wing—inhabiting 38 mountain and desert game refuges in southern California are proving that game birds reared under artificial conditions can survive in the open and reproduce in large numbers to provide for sportsmen shooting in the future where today little or none is to be had.

In an experiment* which already has passed the bounds of a modest laboratory undertaking, the California Division of Fish and Game has released from its Los Serranos Game Farm at Chino during the last four seasons California Valley and Gambel's quail and Chukar partridges in numbers sufficient to provide good hunting by 1940.

Science and nature are combined in this large-scale undertaking. Twice each season, in October and January, workmen go into the Los Serranos rearing pens, snap onto frail legs metal bands (bearing serial numbers and a request that they be returned to the Fish and Game Commission with a report of where and when found or shot), transport the birds to various refuges, and there give them over to nature.

But this is neither the beginning nor the end of the story. For the beginning, we must go back some five years for a view of game bird scarcity in California's lush valleys and on barren mountains.

IN 1932, quail in California were becoming so depleted, due to inroads of hunters, natural enemies, and drouth, that sportsmen became alarmed lest they vanish completely. Two "cures" were proposed: restock with quail, or import some variety which would thrive at all altitudes, in heat and cold, in drouth and time of heavy rainfall.

Both ideas bore fruit. Chukar partridges were imported from India, quail were reared and planted. Where they should be released and how protected were early determined. August Bade, superintendent of game farms, drove home the need for outside holding pens. E. D. Platt, assistant superintendent, and others projected a plan for sanctuaries.

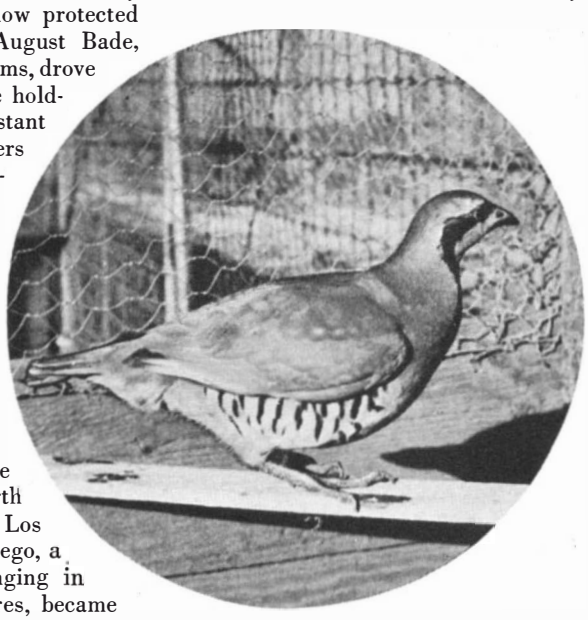
As the original stock of Chukars increased and were liberated from time to time, Platt pushed the quail conservation plan. Within three years 38 individual land owners "loaned" refuges to the Commission. Scattered in a 225-mile semi-circle from Sandberg on the north around the eastern edge of Los Angeles County to San Diego, a chain of sanctuaries, ranging in size from 640 to 5000 acres, became available as the natural laboratories where home-grown birds could test their mettle against nature.

The movement grew rapidly and organizations all over the state took an interest in the program. Although not part of the immediate banding experiment, 700 outside holding pens have been constructed in northern California during the last two years. As a definite part of the banding program, 28 holding pens have been provided on private lands in the Chino farm district in the same period. Each pen is of standard dimensions, 24 feet by 24 feet, and holds 20 pheasants or 40 quail.

Now, here's how the scheme works; and it is bringing immense satisfaction to sportsmen, for it promises plenty of fine shooting by 1940 or thereabouts:

Quail are incubated and raised at the Los Serranos farm. Since more are reared than can be handled efficiently, the young are transferred to outside holding pens when a few weeks old. The holding-pen idea, incidentally, not only permits larger production, but also stimulates interest in the various communities. Starting after the hunting season closes, the birds are released on the refuges, thus permitting them to go into natural production the following spring.

Refuges may be anywhere, in valleys, on mountain slopes, near the desert. Platt is working toward the ideal of a large number of small refuges. In each case, the refuge must supply natural quail feed, in a combination of brush and open country. Where possible, water from native sources, preferably near the center

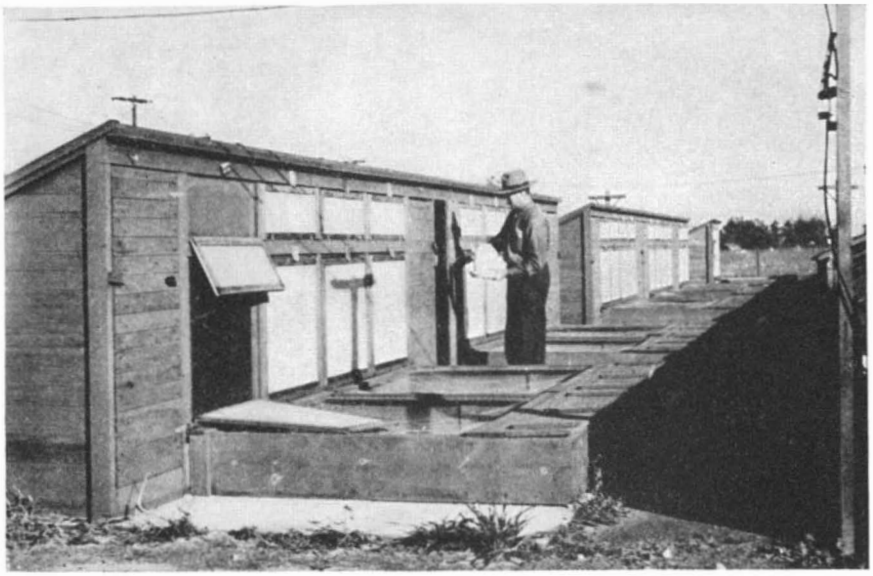


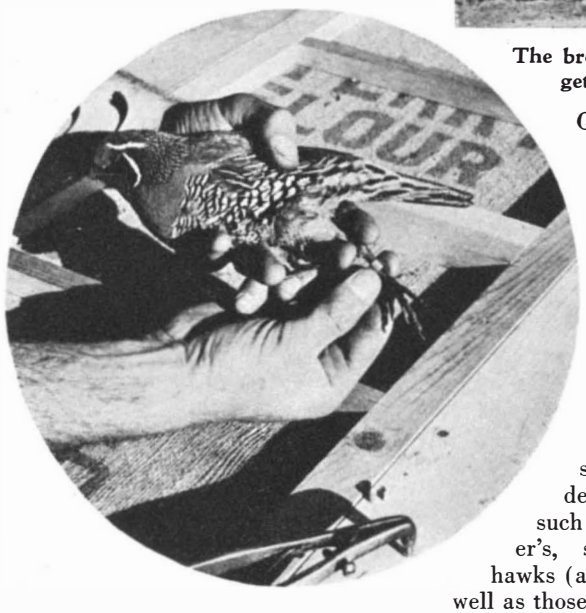
An artificial "spring" to provide water for birds where a natural supply is not available. *Circle:* Chukar partridge

*The work in California is typical of the conservation efforts being carried on by many other states.—*Editor.*

of the refuge, should be available.

In the absence of water, ingenious artificial "springs" are supplied. These are 55-gallon drums, fitted with long, shallow troughs into which the flow is controlled by an air pressure regulating pipe within the drum. In 12 of the 28 quail and Chukar refuges, artificial "springs" have been "planted." The trough, or pan, slopes inward toward the drum. Around its edges dirt is banked. Thus even the smallest birds may walk up for a drink, and step into the pan itself without danger of drowning. Caretakers service the "springs" every ten days, although it has been found that one will supply hundreds of birds and small animals for a month during hottest weather that would normal-





The brood pens at Chino, California, where young quail and partridges get their start in life. *Circle, left:* Banding a California Valley quail

ly be encountered without replenishing.

Observations on the various preserves reveal two important facts. Game-farm-reared birds thus far are doing at least reasonably well among those born and reared in the wild, and the stock is increasing.

Meanwhile, several questions puzzle authorities of the California Fish and Game Division. How long will game-farm-reared birds live under natural conditions? How rapidly will they reproduce? How far afield will they wander from the individual refuges? Can birds, accustomed during their first few months to being hand fed, forage successfully for themselves in the wild? How large should the sanctuaries be, how many are required, how should they be distributed geographically?

Answers to at least some of these questions already have been found, both as to quail and Chukars. Let's take quail first, both because the California Valley quail is California's natural bird, and sportsmen have not yet been permitted to try their skill on Chukars.

Platt, who supervises the brooding, banding, and release of both quail and Chukars from the Chino farm, and oversees the refuges in Southern California, told me that his patrolmen have found quail 20 miles distant from the point of liberation from 18 to 20 months later; on one occasion, quail had flown six miles during the first 24 hours.

Game-farm-reared quail survive thirst, drought, rodents, bob-cats, coyotes, and such birds of prey as the Cooper's, sharp-shinned and duck hawks (all of diurnal habits) just as well as those brooded in the wild. Census has been taken periodically at various refuges, and the proportion of banded birds to the known former population has remained constant, and in some cases increased. Since each hen rears to maturity in the wild an average of six quail, the 40,000 released to date are expected to provide fully 1,000,000 quail within four years, not counting the increase to follow the freeing of banded birds during that period.

ALTHOUGH 202,000 quail were reported killed in ten counties last season, this undoubtedly represents only a small part of the total. For 50 years California Valley quail have been making a gallant stand against human and other inroads. Shorter shooting seasons and restricted bag limits only served as stop-gaps. Now comes the policy of bird management, with refuges in four counties, placed strategically under a variety of local climatic conditions.

While the Chukar partridge has been released for four years, only during the last season were any liberated bearing bands. Little is known about Chukars by California sportsmen, yet they hope to be hunting them in a few years as the English do in its native land.

The Chukar (*Alectoric graece chukar*), introduced into California four years ago from Calcutta, is the Indian representative of a single species of partridge which contains 22 varieties, and which originally ranged from northern China to Mongolia, India, Persia, and Arabia to Asia Minor and Southern Europe.

With this bird the Fish and Game Commission hopes to provide both lowland and highland shooting, for the bird thrives at all altitudes from sea level to 16,000 feet, in countries with virtually no rainfall to those where 100 inches fall every year, in temperatures from nearly zero up to 150 degrees, Fahrenheit. Further, it can survive under conditions of humidity and heat which would discourage, if not obliterate, quail.

Chukars have been liberated in 26 counties in California since 1932. Heaviest plantings have been made in southern California, because in that region there is a vast area of arid land which is unoccupied by game species, and to which it is felt the Chukar will adapt itself.

They definitely are on the increase. Thirty-three Chukars were liberated in a remote section of the Mojave desert, and within three months dropped out of sight. Three years later 45 birds were counted within a few miles of the point of liberation. Some of these were definitely the young of the previous years.

California authorities give the birds every opportunity to increase. No shooting is permitted on the refuges, water is provided, predators of air and earth are shot and trapped. By thus restocking game-bird cover, officials think they will provide fine shooting within four more seasons, on lands of no value to farmers. And sportsmen are backing them wholeheartedly in the attempt.

THE FUEL OF THE

It is Now Believed that Hydrogen Transmuted into Heavier Elements is the Source of the Stupendous Energy that Keeps the Stars Shining for Eons

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society.

THE greater questions of science are not all insoluble: some of them have been pretty well answered in our day, and others are on the way to an answer. For example: Why do the stars shine? How long have they been shining? What keeps them shining so long?

The first question has been thoroughly answered. The stars shine because they are hot, outside; they are hot outside because they are very much hotter inside; and they are so hot inside because of their large masses.

Ever since Newton's days, it was known that the pressure in the interior of a body like the sun must be enormously great. As soon as the laws which govern the behavior of gases became known, it was easy to calculate that, if the stuff inside the sun followed these gas-laws, it would have to be at a temperature of many millions of degrees, if it was to stand this pressure without being compressed to more than the sun's density.

About 20 years ago Eddington completed the proof by showing that the battered fragments of atoms inside a star would indeed follow the familiar gas-laws very closely. Since then, no one has doubted that the temperatures inside the stars run up far into the millions of degrees. From these glowing regions heat inevitably leaks out toward the cooler superficial parts. The law of transfer of heat is also known, and hence the rate of supply of heat to the surface can be calculated. A body of large diameter will be cooler inside than a small one of the same mass; but heat leaks out more easily in the first case, and the whole outward flow turns out to be only a little greater for the smaller body. A large mass, however, must be hotter inside than a small mass of the same size; and here there is no compensating effect.

IT follows, therefore, that a large mass of matter (say enough to make a million planets like ours), isolated in space, *has* to be a star. It cannot help shining—the more strongly, the greater its mass. A small mass (say less than 10,000 times the earth's) *cannot* be a star; not enough heat can escape from the inside to keep the surface luminous.

So far, so good; but a large mass cannot be a star forever; it is sending out enormous floods of energy into space, and it must get this energy from some source, which must inevitably be finite in amount. In the long enough run, therefore, a star must run down—something must happen to it—while there is, of course, no limit which our present knowledge can set to the time during which a smaller solid body, like the moon, or a meteoric stone, would continue an unchanged and uneventful existence.

One source of energy, at least, every star must have. Contraction, under its own attraction for itself, can liberate gravitational energy, turn this into heat, and keep the star shining. If the sun, for example, had contracted from a large size to its present dimensions, it would have gained enough heat to maintain about 20,000,000 years' radiation at its present rate. At least half of this supply must still be stored up in the sun's interior; but, even so, human history is too short to detect a change.

Geological time is another thing entirely. We know from radio-active evidence that some rocks are at least 1,500,000,000 years old, and there is strong evidence that the sun has kept the earth at very nearly the same temperature as now for all that interval. That is, the sun has radiated into space something like 100 times more energy than its past gravitational store, or its present internal heat content, could have supplied.

Now the sun is a very ordinary sort of star, with no peculiarities, and no one doubts that the other stars, too, have got rid of far more heat than can be accounted for gravitationally. Here we must fall back on Einstein's principle that energy and mass are equivalent. A simple calculation shows that the energy radiated by the sun every second diminishes its mass by 4,200,000 (metric) tons. Multiply this by the number of seconds in 1,500,000,000 years, and we get 1/10,000 of the sun's whole mass!

If, then, something happens inside the sun, by which even a small part of its mass disappears, and the corresponding amount of energy is liberated, it may keep on shining for much more than the past length of geological time.

Students of the subject have agreed, for a good many years, that this must be the explanation, and two possibilities were discussed; first, atoms may disappear altogether, and corresponding amounts of energy take their place; second, heavy atoms may be built up out of light ones, and, in particular, out of hydrogen. Why hydrogen? Because hydrogen atoms are heavier in proportion than any others. It is now a familiar idea that four hydrogen atoms might be taken apart, and the four heavy positive nuclei (protons) and two of the electrons lumped together into a single helium nucleus, leaving the other two electrons to make the outer part of the atom. But the mass of a helium nucleus (which can now be measured with extreme precision) is 4.0039 standard units of atomic weight, while that of a proton is 1.0081 such units. If one could be built up out of four of the others, 0.0285 units of mass, or 1/140 of the whole (not counting the small masses of the two electrons), would have to vanish—and appear as energy. If the sun were originally composed of hydrogen, and could turn into helium, the energy liberated would be enough to keep it shining, at its present rate, for more than 100,000,000,000 years. The formation of heavier elements out of hydrogen would liberate a little more energy, but not much—it is the first step which counts. The greatest effect would come from the formation of atoms of iron and similar elements. The largest atoms, like uranium, are heavier in proportion, and so can unload energy by radio-activity. But this supply, huge by any ordinary standards, is small in comparison with that of formation from hydrogen.

A DOZEN years ago, both of these possibilities were purely hypothetical. One of them remains so. Not the slightest evidence has yet been found that it is possible for an atom to be

STARS

annihilated, and its whole mass to appear as energy. But, in the last few years, an extraordinary variety of processes has actually been realized, by laboratory experiments, in which *transmutation* of hydrogen into other elements occurs. For example, a lithium nucleus (charge 3, mass 7.0180) struck by a proton (charge 1, mass 1.0081) produces something which instantly breaks up into two alpha particles, or helium nuclei. These have each a charge of 2, and a mass 4.0039, so that 0.0185 units of mass disappear in the reaction. The alpha particles—whose tracks have been observed—fly apart with enormous velocity, and the energy of this motion exactly accounts for the loss of mass. There can be no more doubt, then, that hydrogen is not only "the raw material of the universe"—as Eddington called it years ago—but the fuel of the stars, which keep shining by building up heavier atoms out of it.

BUT here an alarming question arises. What keeps this process, with its terrific potentialities, under control? What prevents its ending in explosions of unimaginable violence?

Fortunately for the stability of the universe, the process of transmutation does not go on automatically. A hydrogen atom and a lithium atom, at rest side by side, can remain at peace indefinitely. Even if they were jostled about by thermal motions in the gas hard enough to knock off the outer electrons, and strip both atoms to the bare nuclei, nothing more would happen; for the nuclei themselves both have positive charges and repel one another strongly. They do not get close enough together to make trouble. It is only when the protons are shot at the lithium atoms with very high speed that one in 100,000 or so of them escapes from lateral deflections, makes a direct hit on the lithium atom, and gets by the barrier of repulsion, so that at last the two nuclei coalesce.

Atomic collisions of equal violence will occur in a heated gas only if the temperature is measured in tens of millions of degrees. The insides of the stars, so far as we can calculate, are just hot enough to permit such atomic encounters to occur occasionally, and the supply of heat from transmutation will be gradual. Nevertheless—suppose it was more rapid than could be carried off by leakage to the surface. We might expect the inside of the star to get hotter. Atomic collisions would then be more violent; transmutations would happen oftener; heat would be developed still faster, and an explosion would not be long delayed.

Gravitation saves the situation this time, by a reversal of the contraction process already described. If the star contracts, at least half of the gravitational energy must be expended in heating the gases of the interior; only the remainder is available to keep it shining. It loses heat into space, but gets hotter inside—both stores of heat coming from the contraction. Conversely, to put heat into the star forces it to expand and to put so much energy back into the gravitational store that the interior grows cooler. This tends to shut off the supply of heat from atomic interactions, and the star is thus self-regulating. After some possible initial oscillation, it will settle down into a steady state in which just enough heat is produced from the atoms to balance the leakage to the surface, and in such a state it may remain for a very long time.

In the course of ages, the hydrogen would be gradually exhausted, and at long last the star would contract until it could contract no farther, and become a white dwarf like the companion of Sirius. But the sun appears to have traversed hardly a hundredth part of this long road during geological time.

ATOMS with small nuclear charges, such as lithium and beryllium, would be very susceptible to transmutation, and these elements are very rare in the sun. Helium, which has a still smaller charge, is abundant; but this is probably because some of the transmutations, instead of building up heavier atoms, result in a breakdown into two or three helium nuclei. With larger nuclear charges, as for oxygen or neon, the repulsion of the proton is so great that at stellar temperatures it should hardly ever score a hit on the nucleus. Atkinson and Houtermans calculate that, inside the sun, a lithium atom would, on the average, suffer transmutation in a minute, while one of neon would last for a billion years. Weizsäcker, in a recent and interesting discussion, points out that we now know almost enough of the properties of the lighter atomic nuclei to follow the process of transmutation in detail. Only one step is lacking. Nuclei of mass 5—which should be isotopes of helium or lithium—have not yet been detected in the laboratory. When once these have been observed, and their masses exactly measured, it will be possible to work out the way in which they can be built up, or will break down, and deduce the whole story.

But there are many heavy atoms in the stars, with nuclear charges so great that a proton has no chance at all of disturbing them. To build these up requires heavy particles without charge—that is, neutrons.

Once again, we know that such things are possible. The last few years have shown that almost any heavy atom, struck fairly by a neutron, may be changed into something else. We can detect these artificially produced atoms when they are unstable and radio-active—and they change into stable ones, heavier than the originals. Great amounts of energy are liberated in these reactions, for a neutron is slightly heavier than a proton, and its "packing" into a heavier atom leads to a decrease of mass.

THESE reactions happen so easily that, if there were originally a host of neutrons inside a star, they would all be captured by heavy atoms in a few seconds. To provide a steadily operating process, neutrons must be continually produced from the lighter elements, and as regularly taken up by the heavy ones.

Weizsäcker gives reasons for believing that, among the types of unstable nuclei which may be built up from protons and light atoms, some will break up with the liberation of deuterons (nuclei of heavy hydrogen); and it is known that deuterons may break up into protons and neutrons. It is probable that a sufficient number of neutrons will thus be produced to permit the gradual formation, step by step, of the heavy atoms.

All these extraordinary things should happen only in the very core of the star, a small, exceedingly hot region. The gas in this region would be so much heated that it would rise toward the surface—other material descending to replace it. The resulting circulation should keep the star stirred up, so that its whole material was gradually transformed.

These conclusions are still tentative—though founded in general on a sound physical basis. They lead to interesting conclusions regarding the history of a star. For example, as the amount of heavy elements, formed from hydrogen, increases, the chances of collision between protons and heavy atoms increase. Hence, a lower temperature would suffice to provide enough transmutations to keep the star shining, and, as a star grows older, it should at first slowly expand.

In a few years more, if nuclear physics advances as it has been doing, we may at last have a reasonable basis for working out the history of a star.—*Mt. Wilson Observatory, April 22, 1937.*

More Horses in the Air

A 50-Fold Increase in Airplane Engine Power Within 34 Years . . . Basic Advances . . . Skill in Design and Research . . . End Not Yet in Sight

By REGINALD M. CLEVELAND

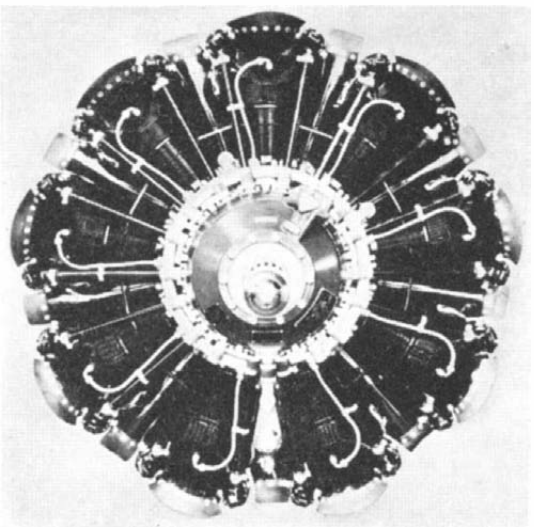
WHEN, in December, 1903, Orville and Wilbur Wright made the flight which ushered in the Air Age, their flimsy biplane was powered by a home-made engine of 30 horsepower. In less than 34 years, the genius of the engine builder has multiplied this power 50-fold and at the same time has so enormously improved the reliability, the smoothness, and the all-around performance of the aircraft engine that it would indeed be difficult to recognize it as something akin to that which made history at Kitty Hawk.

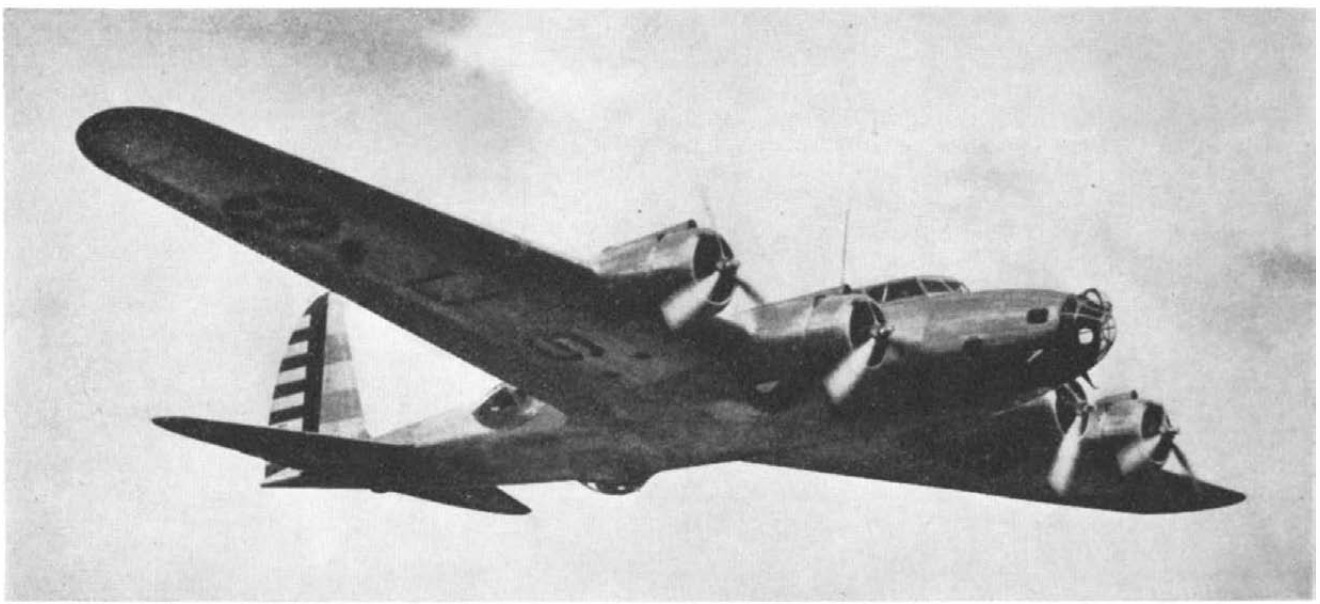
While every acknowledgment must and should be made to the skill of the aircraft designer and to those more obscure skills which lie in the efforts of the research engineer in aerodynamics, it can fairly be said that none of the remarkable performance of speed and load and range which characterizes aviation today would have been even remotely approached if it were not for the basic advances which have been made in power plants.

So startling, even to the men who live with them, have been the recent gains in horsepower of the larger air-cooled radial engines made in the United States that definite predictions of limits cannot be obtained even from responsible heads of engine companies. Guy W. Vaughan, president of the Curtiss-Wright Corporation, has recently declared that it is impossible to say what maximum horsepowers will be attained. He pointed out that in six years powers have gone from 600 to 1500 and that a limit could not be fixed. The engine division of the United Aircraft Corporation holds that take-off horsepowers of from 1500 to 1800 seem feasible in the period immediately ahead and that, in the not too distant future, take-off powers of from 2000 to 2500 horsepower could be made available if airplane development requires them.

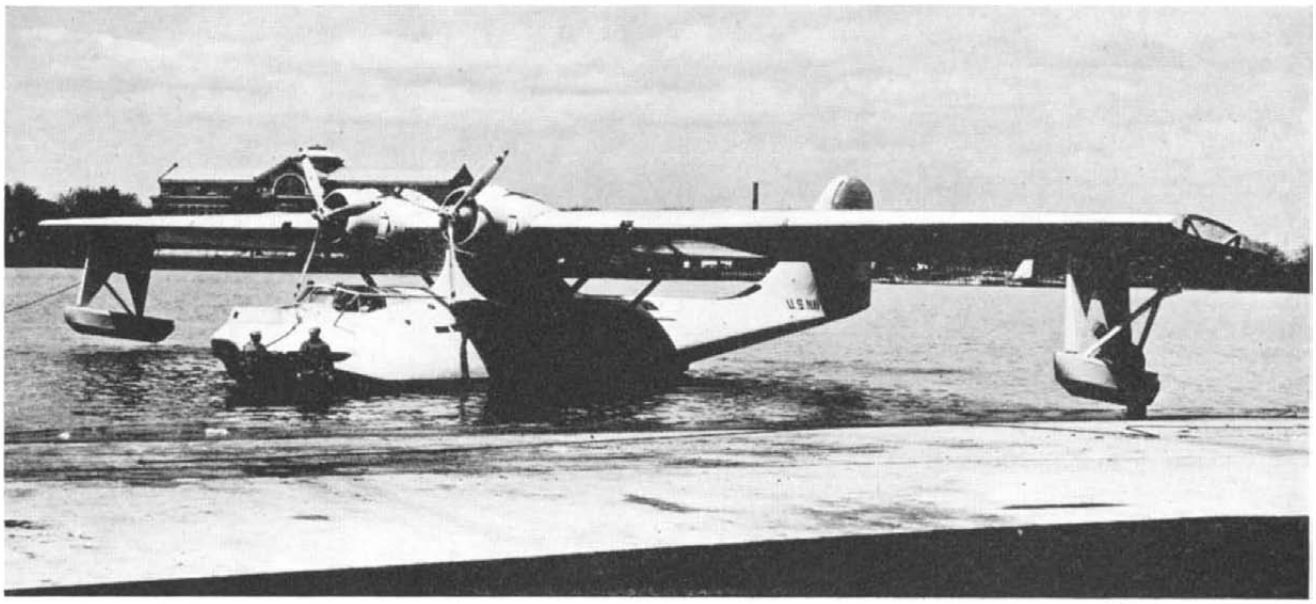
Indeed, engines with horsepowers of the order of the lower of these figures are in existence. A few details were recently released on the largest production aircraft engine in the world. This is the Wright Cyclone R-2600, a 14-cylinder, twin-row engine of new design, developing 1500 horsepower. Although the Navy has purchased only one, and the Army two, of these new engines, while Pan American Airways has purchased 26 for their new three-decker 72-passenger Boeing transatlantic flying boats and Transcontinental and Western Air has purchased 32 of them, the fact that the services are using the engine still keeps many of its details secret. The cost of the engine to commercial users is estimated to be 13,500 dollars each.

It is also known that the Pratt & Whitney Aircraft Corporation, which has long been an advocate of the twin-row



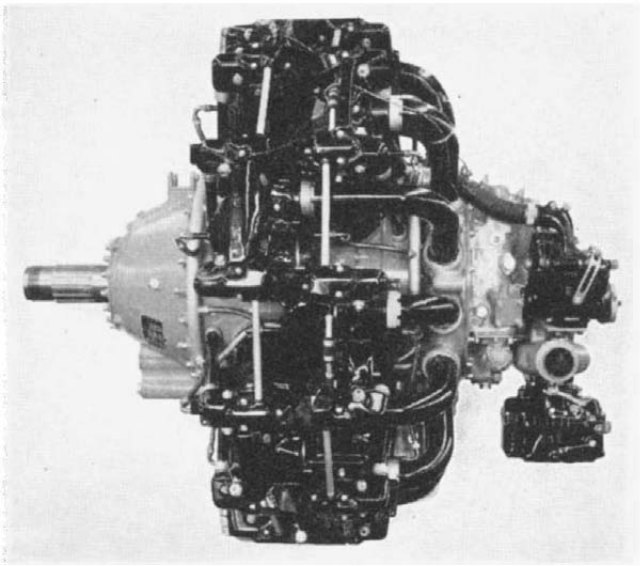


A fleet of 13 of these Boeing bombers is being produced for the United States Army Air Corps. Ranked as the fastest bombing planes in the world, they are powered by 1000-horsepower Wright "G" Cyclones. One of the engines is shown at right above

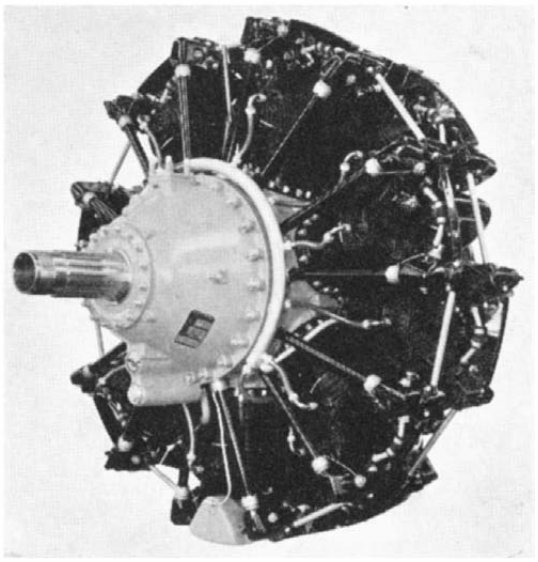


Equipped with Pratt and Whitney Twin Wasps, this Navy Consolidated Patrol Boat is one of 172 that have been ordered

type of air-cooled engine, has power plants of a similar power rating ready. Wright Cyclones of the 9-cylinder, single-row type, developing 1220 horsepower as an emergency rating—the most powerful motors of their type in the world—will be used on the four-engine Boeing land planes of Transcontinental and Western Air, and Pratt & Whitney twin-row Wasp engines of more than 1200 horsepower are expected to be mounted in the Douglas DC-3 sleeper planes which will be delivered to United Air Lines by the time this article sees the light of day.



This enormous development in available horsepower in air-cooled radial engines has been the result of a long series of technical improvements involving design, metallurgy, super-charging and, above all, cooling. There has been a cumulative effect from the combined research of the National Advisory Committee for Aeronautics, other technical laboratories, and the engineering staffs of the engine builders themselves. This has served to increase the pace at which power, dependability, and economy of fuel could all be increased, so that the gains in the last year have been far more spectacular than in the two previous years, while those of the past three years have far outstripped those of the preceding five. One hesitates indeed to set a limit, in view of this accelerated rate of improvement and that what seemed impossible half a decade ago is today an accomplished fact.



Above and in center of page: **Three-quarter and side views of the efficient Twin Wasp engine in which 14 cylinders are arranged in two staggered rows around the central crankcase, as best shown in the center photograph**

Not only have the engines themselves been so greatly improved as to be almost unrecognizable, but development has kept pace in at least three correlative fields to make available to the full the improvement in the power plants.

Even the astonishingly fine radials of today could not perform as they do for both military and commercial aircraft and could not make possible the astonishing performance of American domestic and international airlines were it not for the strides which have been made in propeller design.

The variable-pitch propeller and its younger brother, the constant-speed propeller, have implemented the modern engine of whatever type, so that it is now equipped with an automatic gear shift, adapting it to the highly variable conditions of altitude and load under which it must perform, and enabling it to operate with equal satisfaction for takeoff, climb, and cruising conditions. The Hamilton Standard constant-speed propeller assuredly has been one of the major contributions to air progress of the last few years. Another constant-speed unit, the Curtiss electrically controlled feathering propeller of more recent introduction, also bids fair to play an important rôle in this field.

Associated with propeller development has been the important study of vibration in both engine and propeller. For a time, a few years ago, a number of serious accidents in both military and commercial flying were attributed directly to propeller failures. Now a propeller

failure is almost unheard of, and instances like that untoward one which nearly cost the life of the famous designer of racing planes, Ben O. Howard, and his wife in the Bendix Transcontinental Race of last year, when a blade flew off, are so rare as to be exceptions which more than prove the rule.

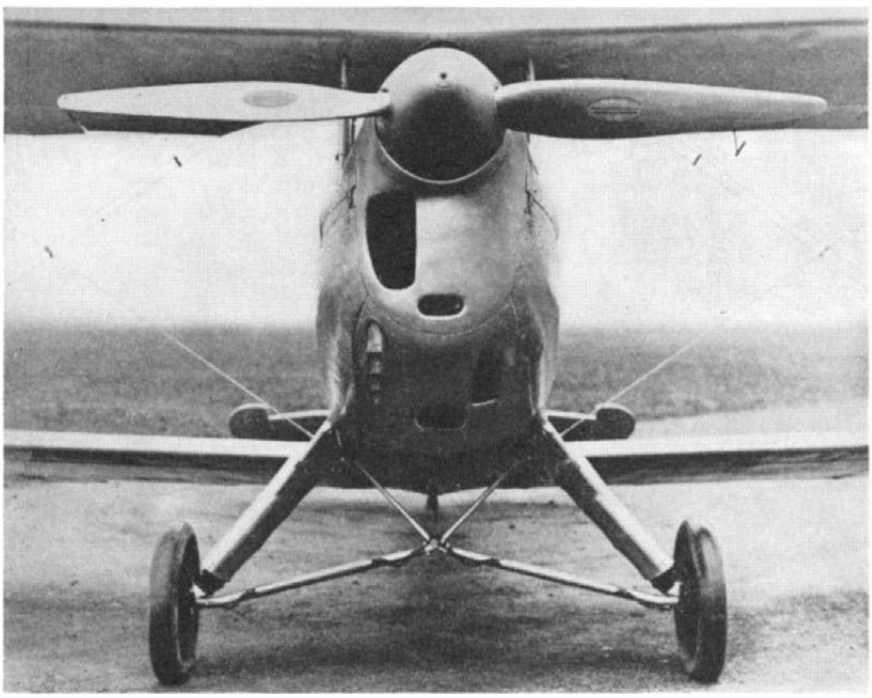
The cure for propeller failures was composed of a number of elements but the most important was certainly the study of vibration made by the N.A.C.A. and the National Bureau of Standards. This exposed the astonishing fact that harmonics of vibration were set up in certain cases between parts of the engine, such as the crankshaft, and parts of the propeller, such as the hub, causing, when the note of what might in truth be called the "dance macabre" was reached, the flaw which led to failure. The cure was then comparatively simple. The vibration frequency in the two parts was merely kept out of tune.

Vibration in the engine itself has also been greatly lessened by recent developments. Rubber shock mountings are now general practice. Torsional vibration, present to some degree in all conventional aircraft engines, and destructive critical torsional periods which have made their appearance in rigid crankshaft systems, have been eliminated by the introduction of the dynamic damper.

This device, developed by the Wright Aeronautical Corporation, for which E. S. Taylor, now of the Massachusetts Institute of Technology, received this year the Sylvanus Albert Reed award, is in principle a pendulum counterweight which is mounted on the crankshaft in place of the conventional, rigidly-mounted counterweight, the pendulous mass being free to oscillate in a restricted arc and in the plane of rotation. When disturbed, the restoring force and the frequency of the given pendulum, which is so mounted, is determined by the acceleration due to the centrifugal force of rotation of the weight. The magnitude of the acceleration is in turn determined by the speed of the rotation of the crankshaft.

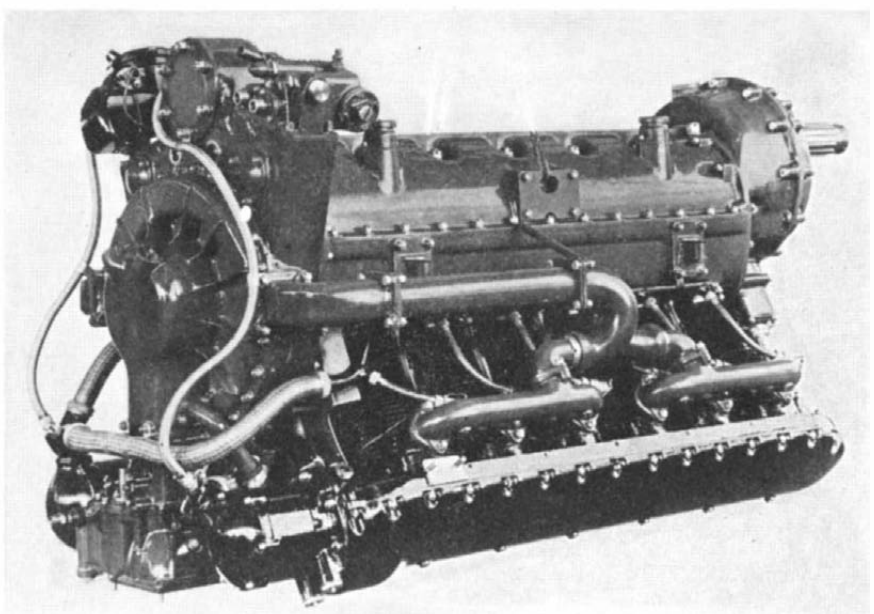
In operation, the pendulous weight is of such dimensions and so mounted that it oscillates at explosion frequency, but out of phase with the explosion impulses. It thus applies a counter-torque to the crankshaft which balances out the periodic torque fluctuations arising from the explosion impulses. The dynamic damper dissipates essentially no energy by friction. It acts by introducing a balancing force which is opposite in direction and equal in magnitude to the disturbance force at all speeds.

The third correlative development which has helped to bring power plants to their present high state has been in fuels. The contribution of the oil industry to aircraft fuel improvement also has been of a cumulative character and has gained impetus with each succeeding year. It was only two years ago when the Army, through the Matériel Division of the Air Corps at Wright Field, made the first flight tests of fuel of 100 octane rating. This high anti-knock rating provides an increase of approximately 30 percent in the horsepower of a given engine. Development has not stopped at 100 octane rating, however, and fuels of an anti-knock rating considerably higher than this arbitrary figure have already been produced and can now be produced in commercial quantities from what have hitherto been waste by-products in refinery practice. The latest development in this field was the announcement at the last annual meeting of the Institute of the Aeronautical Sciences, by Major E. E. Aldrin of the Stenavo Specification Board, that "safety fuel" of 100 octane rating was now in sight.



Above: **A Focke-Wulf powered with a Menasco inverted engine of 150 horsepower.** *Below:* **Three-quarter view of the Ranger inverted air-cooled engine**

TWO factors in the development of high horsepower spark-ignition engines have led to a situation in which it becomes doubtful, to say the least, whether oil-burning engine development will be carried in this country to a point where it will become a serious contender for aircraft. The first of these factors is that of the just described improvement of fuels for spark-ignition engines. Should the so-called "safety fuel," or gasoline of a very high flash point, become commercially available in anti-knock ratings of 100 or better, the safety

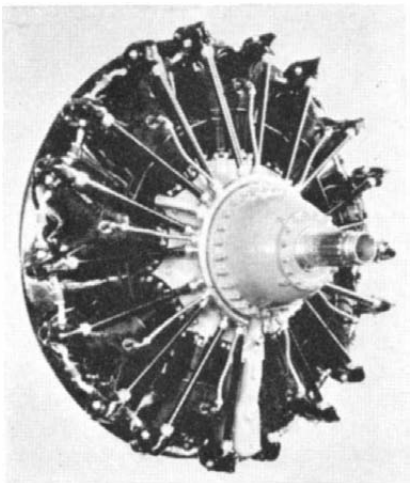


argument for the heavy oil engine would be nullified.

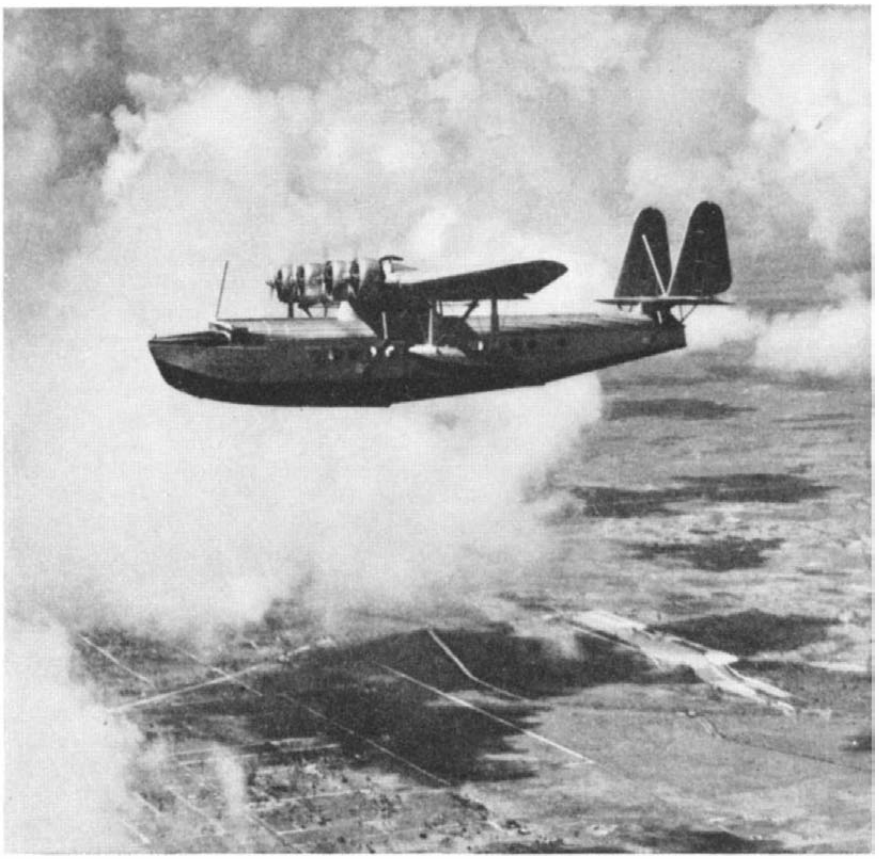
The second factor has been the improvement in fuel economy of the gas engines themselves. Whereas, only a year or two ago, gasoline consumption of the order of .55 to .60 pounds per brake horsepower per hour was the rule, as contrasted to Diesel consumption of .35 to .45 pounds, today gasoline engines on the block have shown consumptions below .40 pounds and it is freely predicted that .37 or .36 will be reached.

Then too there seems every probability that the advantage of the cheapness of fuel which now lies with the Diesel would be largely lost as soon as the demands for Diesel fuel became more general and as soon as it was widely taxed. While it is true that recent Diesel developments, especially in Germany and France, have reduced the weight disadvantages of the oil-burning engine as compared with the gasoline engine, this handicap has by no means been overcome, and it seems improbable, because of the necessary pressures, that the Diesel can be brought to the very low weight per horsepower now shown by the large radial air-cooled engines, which is below 1.25 pounds.

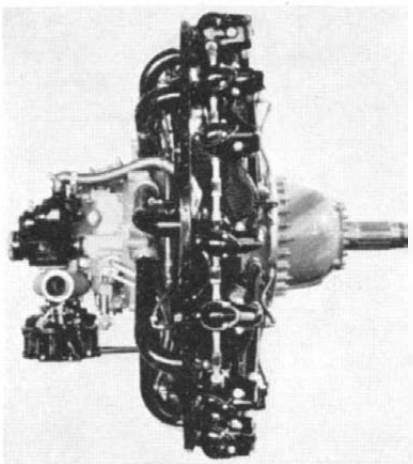
Engine development, however, has not been confined to the large size radials



suitable for the large flying boats and giant land planes which already fly the airlines and give striking power to the services, or the still larger ones in the offing. There has been steady development also in in-line, air-cooled engines. The Ranger engine, built by the Fairchild Aircraft Corporation, has already received an approved type certificate for powers up to 600 horsepower. A development is now in process which will put two of these six-cylinder engines together in the form of an H. There is much interest in this thought, both for military and commercial practice. For pursuit ship use, the H engine permits the introduction of a large caliber airplane cannon which will fire through the crankshaft, thus obviating the necessity of synchronization with the propeller.



Above: **Sikorsky Clipper Ship built for Pan American Airways. It is equipped with constant-speed propellers and Hornet engines, two views of which are at left and below**



For transport use, the in-line engine, either in its simple form in smaller sizes or in the H form, presents a smaller frontal area than the radial of comparable power and offers less drag.

Notable development has also been made in the Menasco in-line engines, which have made such a good name for themselves in racing airplanes. Engines of this make have recently been purchased by the Bellanca Company to power five-place private planes designed to cruise at 200 miles an hour on 220 horsepower.

For the private flier desiring to use the smaller airplanes which are aimed at a market within the class of a moderate price automobile, there have been a number of interesting engine developments. Notably, the automobile engine has invaded this field. In the Arrow sport plane, the Ford V-8 motor is used with success. Another of the private airplanes uses the Plymouth engine, and an amphibian now under development by Charles S. (Casey) Jones makes use of a Terraplane engine with propeller driven through six V belts.

SMALL sizes in radials and in-line engines in the low price, private-plane field have also stepped ahead within the last year in quality and performance to a remarkable degree. The largest single commercial engine order, in point of numbers, ever placed was that by the Taylor Cub manufacturers for 1050 Continental 40-horsepower engines.

All along the line, therefore, of engine development the United States is striding ahead. All along, that is, except in the field of the liquid-cooled engine which many experts believe should not be dropped in view of the high-altitude operation which seems to be ahead, and in view of certain advantages of streamlining which cannot be obtained in the air-cooled engine and certainly not in the radial type.

Last-minute news, as this article goes to press, tells of an interesting development in the liquid-cooled engine field. The Air Corps has just issued an approved type certificate for the Allison liquid-cooled V-12 engine of 1000 horsepower, weighing 1275 pounds.

RADIUM—
NATURE'S ODDEST CHILD

Becquerel Passed Up the Chance to Discover Radium . . . Nobody Knew Marie Sklodovska . . . Few Knew Marie Curie . . . She Held Out

By JOHN A. MALONEY
The Museum of Science and Industry, Chicago

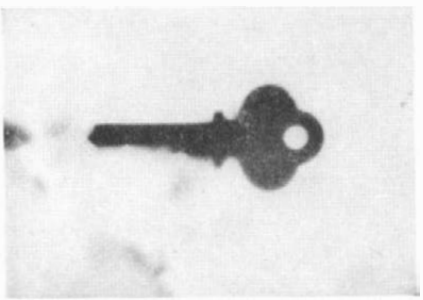
(In Four Parts—Part 1)

RADIUM! Forty years ago that word would have meant nothing, whether it was shouted from the housetops or broadcast in the press of the world. Today it is the magic cry that may arise from the burning sands of Colorado, from the stagnant lands of the Belgian Congo or from the frozen shores of northernmost Canada. Today it comes laden with meaning, for it conjures up in the minds of bed-ridden cancer victims a glimmer of hope for a new lease on life that no other word can bring. In the minds of the prospector, the engineering chemist and the miner it denotes months of toil, and in those physical laboratories of the world that will be fortunate enough to receive even the smallest share of it, the announcement of the discovery of radium-bearing ore renews the interest of the staff in the research that is making of radium one of the greatest tools of this scientific age.

Of all the substances known to man, radium is the most costly and precious. The very mention of its name creates an air of mystery and value. Gold? Gold fades into insignificance by comparison. Gold is worth about 35 dollars an ounce, while radium, if it were possible to buy an ounce, would cost about 1,500,000 dollars. Radium has been selling in the world market for about 70,000 dollars a gram, and a United States one cent piece weighs about four grams!

Of all the building blocks or elements of this old world of ours, none present such difficulties to the men who attempt to wrest them from the clutch of nature as radium. It is a substance that can best be described by the word "odd." Radium stumbled on the cosmic stage 39 years ago in an odd way. Its behavior is so odd that it sets it apart from other elements in a most emphatic way. Secured by man after much labor, it passes through a very long life and performs one of the oddest feats that an element could perform, namely, the transmutation of itself into another element—lead. The results of its most ordinary and prosaic uses are replete with the oddest kind of contradictions. And last but not least, men in general have formed some odd ideas about it, with the result that many popular conceptions about radium strike the man schooled in its properties and uses as very, very odd.

In the following we will set down the simple story of radium—a story so full of startling happenings in the discovery of the element itself, in its properties, in its man-made history of less than half a century, and in its future possibilities through that ever-changing science of modern physics, that if its simple narration will afford a brief and pleasant venture into a field that is as yet untrodden by the layman, we will have achieved our purpose.



Radiograph of a key, taken with a rich piece of carnotite, an ore of radium. This is about what happened in Becquerel's laboratory

Let us begin to trace the life and works of radium by projecting ourselves in imagination back into the year 1895 A.D. We find ourselves in a scientific world that smacks of smug complacency. The electric light, the telephone, the telegraph, and a score of other inventions of this busy period have been in use long enough to prove to mankind in general that the subjects of physics and chemistry are, after all, capable of producing things that can be used in a workaday world and of making it a better place in which to live. The scientist, himself, is coming to be regarded less and less as a seedy individual who gazes abstractedly hour after hour into test tubes filled with foul concoctions or chases butterflies through endless acres on balmy afternoons. For this benevolent person, the scientist, life is becoming more and more a bed of roses. Recognition of his merits and his achievements is bringing rewards in the attitude of capital toward his laboratory. Industries are beginning to see in him a wizard who, by some semi-mysterious "hocus-pocus" can create new products and rehabilitate old ones, provided he is let alone long enough and kept well fed in the interim.

ASK this wizard for his version of the future of science. This 1895 genius would tell you that the world is made up of atoms which are in reality the building blocks of everything we see and feel, and with most of these blocks he is quite familiar. The few that are still left undiscovered will be merely grist for his mill when they arrive. With these materials he and his colleagues were prepared to do the work of the world. By the simple procedure of tearing matter apart and building it up again, in a manner quite different from that of nature herself, science was becoming for him the nursemaid of industry and the creator of an artificial environment unlike anything the world had ever known. It was the era of synthetic stuff.

But it was an era of calm preceding a terrific storm, the results of which will not be finally seen even in our own age and probably not for many ages to come. On the fourth of January, 1896, a serious looking German physicist arose before the Berlin Physical Society and made a momentous announcement. William Conrad Roentgen had discovered radio-activity! So new and startling was his find that no word was available for its description and so it was temporarily called the "X ray." Before that august body left the meeting hall,

the last vestige of smug complacency disappeared from the scientific world. What had been dogma became heresy, and what had been as certain as the dawn became as doubtful as the night. Here was a discovery that could not have been depicted by graphs, charts, or wild imaginations. Even in those early days of this new-born science, there were visions of the coming upheaval, of changing concepts concerning the nature of the physical world. But Roentgen's amazing discovery was as the report of a pop-gun compared with the discoveries which followed.

Time intervened, however, between the day when Roentgen played the rôle of iconoclast in the drama of modern science and the day when the decision was reached that science must begin to rearrange her house. During that time there were various contributing discoveries, of which the first and most important was the discovery of a form of radio-activity in nature quite different in some respects and similar in others to Roentgen's artificial production of radio-activity in a tube. It is that discovery which will occupy us now and prepare us for a peep into the topsy-turvy world of 20th Century physics in which the ideas of the microcosm contained within the atom and those of the macrocosm which is the universe march to the music of the spheres.

Baby Irène was but a week old when Marie Curie went back to work to discover radium. Years later Irène has grown up and helps the aging mother in her laboratory. Only a year ago Irène herself won the Nobel prize for new discoveries

ANTOINE Henri Becquerel missed the opportunity of receiving a page in posterity's biography because he was too busy with other things to become the discoverer of radium. We can forgive him, for he passed the honor along to one of the most delightful characters in the history of science, and perhaps the most eminent scientist of her sex—Marie Curie. Born in 1852, Becquerel was descended from a family of well known scientists. His father was Alexandre Edmond Becquerel, who occupied the chair of physics at that progenitor of the technical museum of the machine age, the Conservatoire des Arts et Mètiers in Paris. His grandfather, Antoine César Becquerel (1788 to 1878) was an electro-chemist of no mean ability and one of France's most prolific scientific writers.

We find Antoine going about his duties at the École Municipale and we watch him as he unthinkingly lays a piece of uranium ore in a drawer of his laboratory table directly over a sensitized photographic plate. He shuts the drawer and turns his attention to another experiment on phosphorescence which he must complete. Two weeks pass by and Becquerel searches for that sensitized plate. Thrusting the ore aside he passes the plate over to his assistant to be developed. The next morning his assistant is apologetic. The greatest care has been taken in developing the plate and yet it shows a great blotch of light in the center. Had Becquerel been less familiar with photography, his assistant might have been severely reprimanded for carelessness and a great discovery lost to the world for many years. But Becquerel knew that plates are sometimes "light-struck" around the edges, due to a leak in the camera, but "light-struck" in the center alone—never! It was one of those happy moments, such as that which Goodyear had when he accidentally dropped rubber on a hot stove and discovered vulcanization or that Edison had when his ear caught the musical note given off by the stylus of his paper-embossing telegraph repeater and led to his invention of the phonograph. It required no great intellectual effort for Becquerel to go from effect to cause. The uranium ore was giving off invisible rays!

Conclusive as this accidental discovery was, Becquerel was enough of a scientist not to jump at conclusions and he decided to perform the experiment deliberately and satisfy himself that the uranium did give off invisible rays. At first tempted to believe that the uranium itself was the cause of the rays, he repeated the experiment several times and found that other ores gave off radiation but in different quantities. Pitchblende from Bohemia, for example, registered its output of energy on a sensitized photographic plate far too forcefully in proportion to its uranium content to satisfy him that uranium was solely the cause of this phenomenon. There was but one conclusion. Uranium contained another element of great potency. Becquerel knew enough about metallurgy to realize at once that the search for that hidden element would be a time-consuming task. He must find someone else to carry on that work so that he would not be distracted from his other duties. One wonders whether, if Becquerel could have foreseen the effects of his decision, he would have been so willing to let this opportunity slip through his fingers. At all events he did. And that brings us to the story of a 17-year-old Polish girl, Marie Sklodovska, whom we find hard at work in her cousin's chemical laboratory still blushing from a compliment paid her by the great Mendeléev, a giant among contemporary scientists, who had stopped long enough by her side to note the precision and care which she exercised in carrying on a chemical experiment.

Marie's mother had died while she was but an infant and her father had become her constant companion. Two things burned constantly in this young girl's soul. One was chemistry. The other was the sad plight of her fatherland under the Cossack's whip. And so Marie spent those years that other girls give to more frivolous pursuits in preparing herself for a career in science and in plotting with secret societies to free Poland forever from Russian domi-

nance which had long been bitter as gall.

During the winter of 1891, at the age of 24, Marie fled in haste from Warsaw to Paris, which was then, as now, a haven for the political exile. It is here that her real story begins. There is nothing in these first few years in Paris that differs from the oft-told tale of the struggle of great minds. In a garret room she lived on the most frugal rations while she carried on her studies

Drawing by Percy Hale Lund

"They were confronted with scintillating streaks of light glowing like fingers beckoning to continue"

at the Sorbonne. Mendeléev had been bold enough to prophesy for her a great future in the world of science. Yet no one realized better than she that science was, at that time, a closed field so far as women were concerned.

IN 1894 she met the reticent, studious Pierre Curie at the home of a mutual friend—the same Pierre who, a few years before, freely announced his belief that "women of genius are rare, and the average woman is a positive hindrance to the serious minded scientist." If his dictum were true, then Pierre must have found genius in this Polish girl, for he secured permission for her to work at his side in the École Municipale. It was not long before this shy physicist wrote to Marie that "It would be a lovely thing to pass through life together, hypnotized in our dreams, your dream for your country, our dream for science. Together we can serve humanity." In the mirror of subsequent history, we can see reflected the truth of this statement, the brain child of a scientist touched by Cupid's dart. The world does not know a more pathetic figure. They married.

Becquerel selected Marie Curie to undertake the arduous research necessary to discover the unknown element. Marie talked it over with Pierre. The only obstacle was the money needed to carry on the work. True to the tradition of scientific genius, they swept this obstacle aside by the simple procedure of borrowing the money. From Austria they secured a ton of pitchblende. In a shed they then began the work of refining, of boiling, of testing, of gnawing away, bit by bit, each known part of that stack of ore, looking for a needle in a haystack without even knowing what the needle was.

They worked from the early hours of the morning until far into the night, taking turns in cooking the ore and checking the results. So much attention to cooking ore and so little to cooking victuals soon took its own toll. Marie went down with pneumonia but Pierre carried on until she recovered. Next their task was interrupted by the birth of a daughter—but not for long. Baby Irène was but a week old when Marie went back to the shed to help Pierre. Grandpa Curie solved the problem and saved the day by coming to live with the little family and caring for Irène during the day.

A year went by and the ton of ore dwindled to a hundred pounds. Again Marie fell ill, and Pierre, worn out by his labors in the home and in the laboratory, was ready to call a halt. No one would help them in their mad search for a product that might well prove to be a will-o'-the-wisp. That a scientist had seen the footprints of a mere wraith upon a photographic plate was not sufficient to merit such a waste of time and money. But Marie held out.

Pierre had been offered the chair of Physics at Geneva, and Marie sadly watched him depart to investigate the offer. He was not away long and on his return he announced his decision to finish the work in the shed first. Marie's good example was beginning to pay dividends. Again they went on with their boiling. Now they had reduced the pile of pitchblende to a handful of bismuth salts which showed a great amount of activity. Out of this Marie isolated a substance that resembled nickel but proved to be a new element which she named "polonium" in honor of her native country. This element was many times as active as uranium, but Marie was sure that there was something else there which they had missed, and the work went on.

With the working capital in pitchblende now brought down to almost microscopic amounts, they strolled one evening after dusk into the shed and were confronted with scintillating streaks of light glowing like fingers beckoning to the pair to continue their search. They accepted the challenge and Marie finally isolated a few crystals of radium salts. When Giotto finished a painting, all Florence was jubilant and a holiday was declared. But when Marie Curie gazed for the first time on radium there was none but she and Pierre to rejoice at the end of a heart-breaking and back-breaking task.

Then came five more years of research before Marie presented her epoch-making thesis on radium and its discovery to the examining committee of the university as a modest condition for her degree. Then happened an event that would gladden the heart of almost any college senior. The committee, composed of most of the eminent scientists of the day, sat in awe during the narration of her work, and were at a complete loss when the time for questioning this modest woman arrived. Then the news rang throughout the world! A woman had discovered a potent substance called radium, that killed mice, shone in the dark, emitted 250,000 times as much heat as an equal amount of coal, produced sores on the skin, sterilized seeds, and killed microbes. Here was news that was news!

THE rest of their story is that of honors heaped upon the Curies by every country in the world; of another daughter born of that happy union;

Marie Curie in middle age, when her fame had spread to a world that adored her as its foremost feminine character. Adulation did not spoil her natural simplicity

of the tragic death of Pierre in 1906 under the wheels of a truck on the Rue Dauphine; of the shameful littleness of the men who fought against Madame Curie's election to fill the chair vacated by Pierre, and her election to the Academy of Sciences of France; of her valiant work as an ambulance attendant in the World War; of the gifts of radium to her by the women of America, and of her gift of these to the Universities of Paris and Warsaw; of the establishment of the Curie Institute and of her retirement behind its walls, and of her death on July 4, 1934.

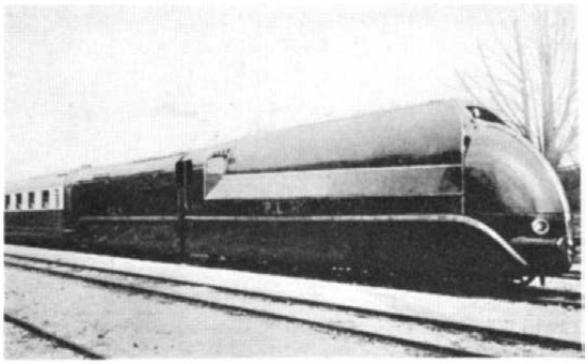
(To be continued)

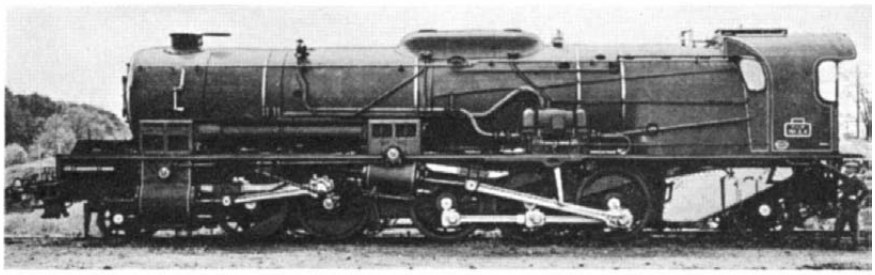
Locomotives Abroad

WHILE American railroads have been busy streamlining locomotives and glorying in their performance, foreign locomotive designers have not been idle; quite the reverse. Outstanding work has been done by several nations of Europe as shown by the streamlined trains on this page. And even those that are not streamlined are both powerful and speedy.

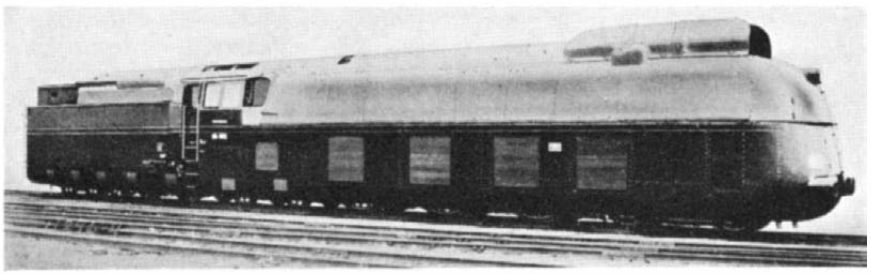
In Europe, as in the United States, steam seems to be the principal concern of railroads. From France, particularly, have come some of the most advanced theories on steam locomotives and the most far-reaching applications. Yet it is understood that France, having perfected and invented better steam engines than her neighbors, is behind both England and Germany in adding new locomotives. Both the latter countries have adopted programs not only calling for many new and modern steam units, but also for overhauling and modernizing their old ones for greater efficiency.

Right: **A speed of 157 kilometers (97.5 miles) an hour is made on the Paris-Dijon run with a train of 200 tons and this steam locomotive of the Paris, Lyons, Mediterranean Railway. It matches, in streamlining, anything America has done**

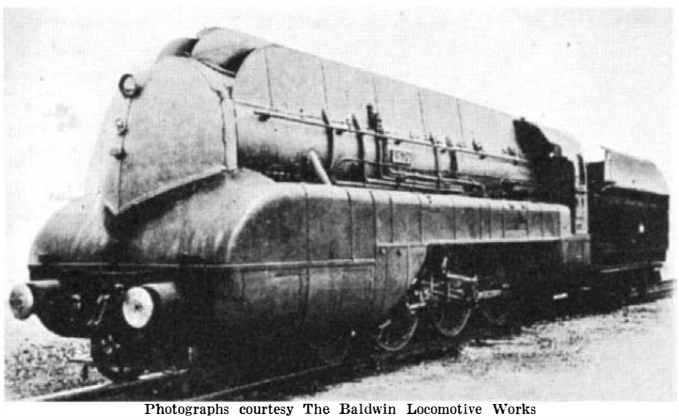




Above: **Freight locomotive of the same road as that at top of page. Locomotives of this type can develop 3000 horsepower at a speed of 75 kilometers (46.6 miles) per hour, and are probably the most powerful engines of their kind in all of Europe**



Above: **A German type which holds the world's speed record for steam. With a train of 200 tons, 192 kilometers (or 119.2 miles) per hour is the record of this speedy engine**

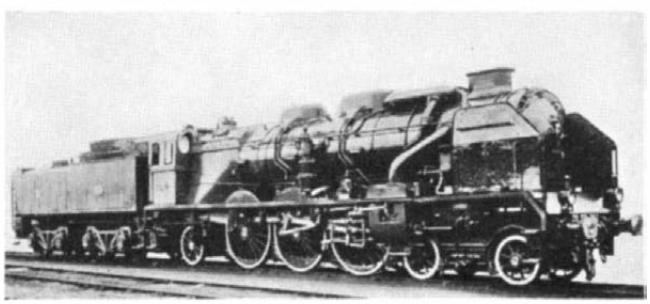


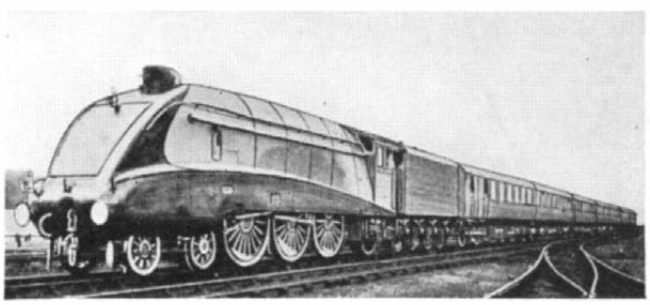
Left: **Another French example of steam locomotive streamlining which indicates experimentation in an attempt to determine the ultimate form**

Below: **French, Pacific type locomotive. They have exceeded 93.2 miles an hour with a 400-ton train but regularly make 66.4 miles per hour hauling an express train between Tours and Bordeaux**

Photographs courtesy The Baldwin Locomotive Works

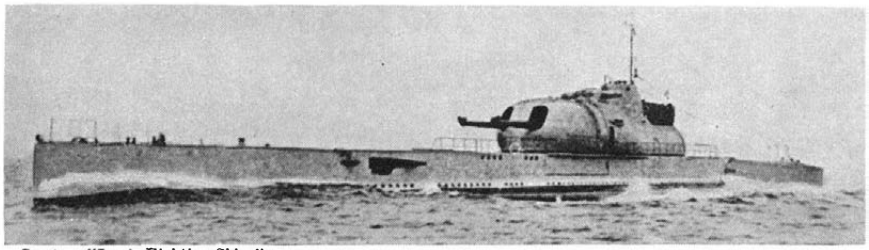
Below: **A fast British train, the Silver Jubilee of the London and North Eastern Railway. For these trains, the 268-mile trip between London and Newcastle is four hours**





THE SUBMARINE

By WALTON L. ROBINSON



Courtesy "Jane's Fighting Ships"

World's largest: the French *Surcouf;* 2880 tons (surface), 4300 tons (submerged); two 8-inch, two 37-mm., and four machine guns; 14 21.7-inch tubes

EVER since its inception, the submarine has been subjected to all kinds of abuse. It has been denounced on numberless occasions as a cruel, cowardly, inhumane weapon. Such criticism has been made chiefly by Great Britain. For years that country has tried to bring about, by international agreement, the abolition of the submarine. At the Geneva Naval Conference of 1927, she was tireless in her attempts to bring the other naval powers around to her way of thinking, but her efforts in this direction were in vain. France and Japan declined to support any such proposal, while Italy listed several conditions before she would consider the British viewpoint. Only the United States sincerely backed England.

It is not difficult to understand the British desire to have the submarine abolished, for it was Germany's U-boat campaign during the World War which nearly was successful in bringing Great Britain to submission. Even now, despite the tremendous advances made since the war in anti-submarine tactics, the undersea boat remains one of the two most serious threats to British sea power. The other is, of course, the airplane. Britain's condemnation of the submarine and her desire to have it abolished prove better than could any other argument its potential effectiveness in the next war.

A few months ago, Great Britain's diplomatic policy in regard to Italy and the Ethiopian War was governed very largely by the respect the British Admiralty had for Italy's powerful air squadrons and strong submarine flotillas. The great Royal Navy is not quite sure of its ability to cope with these comparatively new weapons of warfare at sea. No longer can naval might be calculated by the simple process of comparing battleship tonnage. Other purely military factors must now be included in comparing one nation's naval strength with that of a possible enemy.

In the early period of the World War, the triumphs of the submarine were both numerous and spectacular. This is always the case with a new weapon, for effective means of countering it do not exist and have to be developed. But methods of combating the submarine were found: improved underwater protection was given battleships and cruisers; large warships and convoys of merchantmen were escorted by destroyers, sub-chasers, and so on; depth charges were dropped on the submerged U-boats; and mine fields were laid close to the bases from which they sallied forth on their cruises of death and destruction.

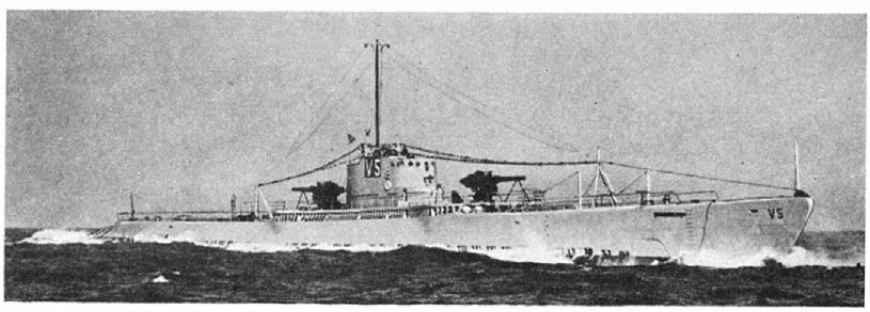
THAT these methods were effective is proved by the fact that in the four years of the war, 199 German submarines were lost and with them perished 5132 officers and men, the very flower of the personnel of the Kaiser's navy. By far the greater part of these losses occurred in the last two years of the war, by which time the various anti-submarine devices and tactics had reached an advanced stage of development. Before the end of the conflict, the task confronting the U-boats was indeed hazardous. The business of getting to the open sea and returning to port after a cruise was full of grave danger, due to the presence of the mine fields, while it was extremely difficult to attack successfully a large convoy escorted by numerous anti-submarine craft.

Despite the fact that the German U-boat campaign was finally conquered by the Allied navies, the submarine emerged from the war with greatly increased prestige. Previously it had been considered an experimental craft of doubtful value, suitable, at best, only for coastal defense. Even Germany, who later was to place such boundless faith in her U-boats, possessed only 27 of them ready for service at the outbreak of hostilities. On the other hand, Great Britain, France, and Russia had, respectively, 75, 64, and 30 in a completed condition. Moreover, each of these three powers had under construction more undersea craft than had Germany. Today, France possesses the strongest submarine force in the world. She has, built and building, some 80 modern submarines, among them being the world's largest: the 2880-ton (surface) *Surcouf.* When submerged, this huge undersea warcraft displaces 4300 tons.

The submarine, like the airplane, has progressed enormously since the war. In the next conflict involving naval powers, both will have far more important and interesting missions to fulfill than they had in the past one, in which they merely gave a small idea of what they will be capable of doing in the future.

By the end of 1918, the submarine had become specialized into three distinct types: one, which used as its principal weapon the torpedo (the true arm of the submarine); another, which was equipped, in addition, to lay mines; and a third, usually referred to as the submarine-cruiser, which depended in large measure upon the gun for its offensive power. Of these three types, the last is the least adapted to the conditions of real submarine warfare, for an undersea boat which attempts to attack on the surface in order to use its guns is always at a great disadvantage; the slightest injury, which would not seriously affect the fighting ability of a surface ship, carries with it for the submarine the impossibility of submerging, thereby causing it to lose its *raison d'être* and only real defense.

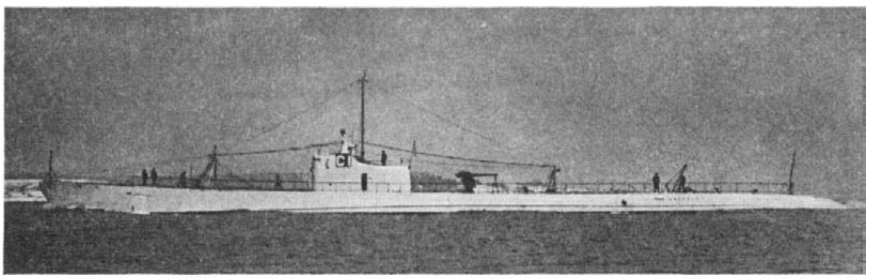
On the other hand, the ordinary submarine (that is, one which relies upon the torpedo to carry out its work of



Fleet submarine *Narwhal* (U. S.) has two 6-inch guns, six 21-inch tubes. Slightly smaller than *Surcouf,* she is of the "cruiser" type, now passing out of favor

IN THE NEXT WAR

Submarines are Here to Stay . . . In Most Modern Navies . . . Many New Ones Building . . . Their Mission Has Changed . . . What They Can and Will Do



The *Cachalot:* one 3-inch anti-aircraft gun, six 21-inch torpedo tubes. Submarines now building have 1330-ton surface displacement against *Cachalot's* 1110

destruction) and the mine-laying submarine are able to work submerged, and therefore in secrecy. In other words, these are submarines pure and simple. Aside from their regular and legitimate mission of torpedoing hostile warships and laying mines in enemy waters, they are well suited to carry out scouting and observation operations. Moreover, in the opinion of some foreign officers, they can make poison-gas attacks upon the enemy's warships at anchor in port and upon his naval bases, though in carrying out this latter mission the lives of the enemy's civilian population would, of course, be jeopardized.

As regards its value as a scouting vessel, the submarine suffers from two very severe limitations: its low speed, both surface and submerged, and its inability to see any considerable distance, due to its lowness in the water. In spite of these disadvantages, however, the submarine's ability to remain undiscovered for long periods at a time in a comparatively small area must not be overlooked.

A submarine operating submerged outside a hostile port could observe constantly for many days the enemy's movements without ever being seen and possibly without its presence even being suspected. It will be realized at once that this is an excellent quality and one possessed solely by this type of naval craft. During the war, both the British and Germans employed their submarines on such missions of vigilance, and in both cases the results obtained were very satisfactory.

As pointed out in a previous paragraph, the effectiveness of this scouting is limited by the low freeboard of the submarine. This inability to see any great distance is increased when the submarine is submerged, as it must be at all times during the day while closely observing an enemy naval base. At such times, the submarine's visual capacity is perforce limited to that of its periscope, which extends at most only a few feet above the surface of the sea. In such types of scouting, high speed is not really as essential as it is, for example, in tactical scouting at sea with the fleet. This is so because, in the case under consideration, the submarine's task is not so much one of *scouting* as it is of constant *observation* of the enemy's movements and reporting them as soon as possible by radio. This latter is the most important and the most difficult task of the observation submarine, for it is obvious that the information obtained is quite valueless if it is not promptly and accurately transmitted to the proper authorities. In making her radio report the submarine must at the same time endeavor to keep the enemy in ignorance of her presence off his base. During the World War, the position of many German U-boats became known to the British through the careless manner in which they wirelessed their reports.

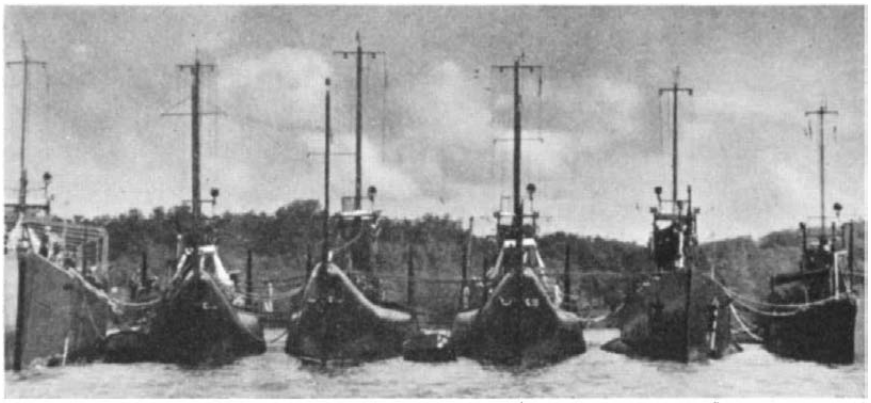
Attacks against the enemy's merchant shipping doubtless will be one of the most interesting aspects of the naval operations of the next war, just as they were in the past one. For this kind of warfare the submarine possesses admirable qualities, as was evidenced by the successes of the German U-boats against Allied sea commerce. The submarine's cruising radius is wide and is constantly being increased in the new boats. During the war, the length of time which the Kaiser's undersea boats were able to remain at sea was limited primarily by the cramped living conditions on board, which caused the early exhaustion of the crews. The scant number of torpedoes which could be carried was another limiting factor. These two defects served to increase greatly the number of returns to and departures from port, and it was while making these that the submarines ran the greatest risk of destruction.

It is not likely, however, that the strategic conditions of the past war will be repeated in the next, and they certainly would not apply in any war in which this country became involved. Moreover, the submarines of today, due to increased size and the use of weight-saving metals in their construction, are able to provide more habitable quarters for their crews, thus making possible longer stays at sea, from the standpoint of the health and morale of personnel alone.

The mission of the mine-laying submarine is frankly an offensive one. It is that of laying its death-dealing cargo in front of the enemy's ports and naval bases. In this work the submarine has the incalculable advantage over the surface mine-layer of being able to operate in absolute secrecy. It is true that the mines laid by a submarine can never be numerous, but the small groups of them thus laid can be placed in locations carefully selected beforehand by the very submarine which lays them, thus assuring that they are placed along the route most frequently used by the enemy's ships. This same submarine can also report the movements of the hostile ships, although, as has already been seen, in doing so she runs serious risk of revealing to the enemy her presence and that of the mines she laid.

Having now seen what the ordinary torpedo-submarine and the mine-laying submarine can do, let us for a moment

Our Navy has 45 submarines of this *S-45* type, though some are smaller. She is of 850 tons (surface), carries one 4-inch gun, and has four 21-inch tubes



Photographs official, U. S. Navy, except one noted

Fleet submarines. At left is one of our largest, the *Nautilus;* next are three oldest—the *Barracuda, Bass,* and *Bonita.* At right are the *Dolphin* and *Cuttlefish*

consider the large submarine-cruiser, which carries a number of relatively heavy guns as its principal armament. (All submarines, of course, have torpedo tubes.) Unlike the torpedo or the mine, the gun is not a suitable arm for the submarine, due to reasons explained earlier in this article. For the submarine the gun should always be regarded as an auxiliary weapon, just as should torpedo tubes on a battleship or cruiser be subordinated to the gunnery armament. In the past war, with the exception of the British submarine-monitors of the *M* class, which carried a single short caliber, 12-inch gun and was designed for a special task off the Belgian coast, guns were placed on submarines largely to compensate for the scarcity of torpedoes; the cost of a torpedo was and is very high, and a submarine has stowage for only a small number of them.

Submarines, nowadays, are provided with one or more anti-aircraft guns. These are for beating off airplane attacks, although in such attacks the undersea boat's best defense is to dive to as great a depth as possible. In the war of the future, as in the past one, it will indeed be dangerous for the submarine to remain on the surface and attempt to sink a merchant ship by gunfire, much less any type of naval craft, no matter how small. Doubtlessly many readers recall how, on several occasions, German U-boat commanders received unpleasant surprises from inoffensive-looking Q-boats—merchant ships with cleverly concealed armament and usually manned by regular naval personnel.

Following the failure of the effort to have the submarine condemned and abolished as a legitimate weapon of naval warfare, an attempt was made to impose upon its use certain restrictions which it could not possibly respect. The fact should be plainly evident that to force a submarine to come to the surface to exercise the right of search is to place it at once in a situation of inferiority in respect to the merchant ship, which quite possibly may have been armed at the very commencement of hostilities. In war, every stratagem is fair and it would be childish to believe that agreements which fail to take into account the imperative necessities of war will be respected once a conflict breaks out. Every such international agreement should be drawn up with a clear understanding of the exigencies of war. If this is not done, the accord will become but a scrap of paper at the sound of the first gun. Perhaps for a time the submarines would abide by the rules laid down for their operations, but just as soon as one of them was sunk by an armed liner, tramp steamer, or Q-boat, reprisals would follow at once, and the situation would be the same as that which existed in the last two years of the World War.

THE abolition of the submarine is a very remote possibility indeed. Great Britain is almost alone in her desire to have the submarine outlawed; the United States is her only supporter. The faith which the world's navies have placed in the submarine is made clearly evident by the fact that practically every nation which maintains any navy at all possesses a number of submarines. Including the five leading naval powers, no less than 25 nations have submarines in their naval establishments. These possess between them about 575 submarines built and building. Some 15,000 officers and men, the pick of the personnel of the world's navies, man these undersea fighting craft.

The submarine will continue to figure prominently in the future naval programs of all the sea powers for the very simple reason that it is far too valuable a weapon to be discarded. To second-line navies, and to very small ones, especially, it offers one of the most effective means of defense for the scant amount of money that can be spared for such purposes. France or Italy, for example, cannot compete in battleship strength with Great Britain, but the fact that both countries possess a large number of modern submarines, as well as a powerful air force, makes the British Admiralty quite apprehensive.

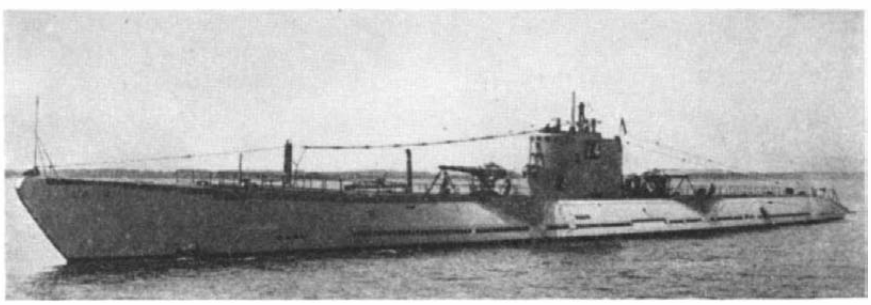
Britain's naval history is replete with victories over French fleets, victories won in the 18th and 19th Centuries when it was simply a question of ship-of-the-line against ship-of-the-line and frigate against frigate. In those days it was easy to calculate comparative naval strength —just a matter of adding up the number of line-ships and frigates and the guns they carried. But today, with submarines and aircraft very much in the picture, the task is a great deal more difficult, for with a little luck a submarine displacing only 500 to 1000 tons quite possibly could send to the bottom a huge 35,000-ton dreadnought.

It is evident, therefore, that a very small country, if it possesses a few modern, efficiently manned submarines, can command a degree of respect from even the largest sea powers. In view of this fact, is it at all surprising that those navies other than the two largest have steadfastly refused to consider the abolition of this comparatively new naval weapon?

The submarine is the most unusual type of warship ever to be evolved. Naval history does not record any other class of ship which, considering its relatively small size, ever exercised such a profound influence upon fighting at sea as did the submarine in the last war, and there is every reason to believe that its influence in the next will be equally as great, if not indeed greater—especially in the case of a European conflict.

●

If we are to credit newspaper estimates, Russia now nears the top of the list in total submarines built. Who knows? Russia remains the enigma of modern nations.—The Editor.



Our only mine-laying submarine, *Argonaut.* Displacement 2710 tons (surface), 4080 (submerged). Armament: two 6-inch guns, four 21-inch tubes, and 60 mines

TEXTILE GLASS

What Are the Future Possibilities of Glass Fibers Produced by High-Pressure Steam? . . . Already in Wide Use for Electrical and Thermal Insulation

WHAT are the possibilities, if any, of glass as a textile fiber? Much of the fanciful has been written about so-called glass dresses, and hats and hosiery of glass, but thus far nobody seems to be wearing them, and apparently nobody knows anyone who is actually producing such Aladdinesque articles.

Glass for textile application is here, however, and although its real value is perhaps less sensational than some of the stories it has inspired, it is undoubtedly destined for remarkable achievements. Discovered long before the Birth of Christ, glass is, nevertheless, thanks to a scientific America, in some respects as new as tomorrow's newspaper.

Recent research and development have made glass the most amazing of all examples of industrial diversification of a basic material, and textile glass is not only the newest instance of this, but in many ways it has the more alluring potentialities.

Broken into tiny filaments by steam under terrific pressure, glass is being assembled into strands, spooled into thread and yarn on modern textile machines, and woven into cloth of pure glass. Such fabric finds its greatest use at this time as an insulating and filtering material.

In its new fibrous rôle, glass for thermal insulation is beginning to be a factor of vast financial significance in the saving of power and heat in industry, in making it possible to use smaller units to create more energy, to add greater efficiency to present equipment, and to add to the life-span of usefulness of that equipment by reducing operating strains that hasten replacement.

Glass thread is being woven into tape —varying in width and resembling rolls of ribbon—to insulate electric wires, cables, and armatures; and is provided in spools of thread or yarn to wrap individual small wires.

Glass, as everybody knows, does not burn and, in textile form, it retains all its other inherent characteristics—stability; high resistance to moisture, acids, salts and vermin; and non-conductivity.

Fiber for fiber, glass has greater tensile strength than steel, and while that characteristic cannot be utilized fully at this time, it is a highly important factor for insulation glass both in textile and pack form.

Textile glass tapes for high-temperature electric insulation, for example, have a tensile strength of 250 pounds per square inch, which allows for tighter wrapping. Other insulations average only 50 pounds for a tape of the same dimension, and only one half the thickness of glass tape is needed to supply a comparable insulation.

AS a filtering medium, glass cloth is rapidly moving into many types of industry for varied utilization. Recently it was discovered that a glass cloth used to filter certain acid remained efficient for 40 days while one of another kind of fabric commonly used for the purpose breaks down in from eight hours to ten days.

Fibrous glass in mat or pack form for insulating buildings and ships has been in use for some time, but it is now being applied to insulate streamlined passenger trains, railroad refrigerator cars, airplanes, buses, domestic refrigerators, electric kitchen ranges, electric broilers, pipes and ducts of all kinds, and industrial boilers and furnaces.

With its development now as an insulating material in thread, yarn and cloth form, it is not unreasonable to assume that the day is not far distant when textile glass will be successfully combined to assist the commoner fibers, and to weave all-glass draperies, curtains, and tapestries for theaters, ships, and hotels to reduce fire hazards.

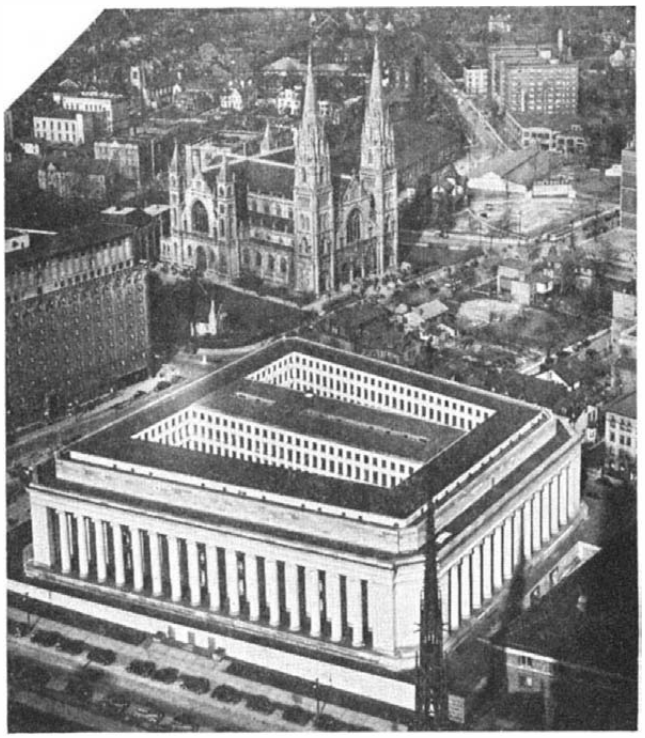
Fibrous glass is not new, but its practical commercial application and constant refinements today have been made possible by the high-speed production process discovered by the Owens-Illinois Glass Company.

Its fibers produced at a speed greater than the muzzle velocity of a rifle bullet, each less than 1/20th the diameter of human hair but stronger than steel, a 12-ounce bottle enough to make a single strand nearly 5000 miles long, the fascinating present of glass is rivaled only by its future possibilities.

Courtesy Owens-Illinois Glass Company

All glass, from the milk bottle to the spools of threads and yarns, the pipe insulation rolls (left), the tape (center foreground), and the filter cloths (right)

RESEARCH BY

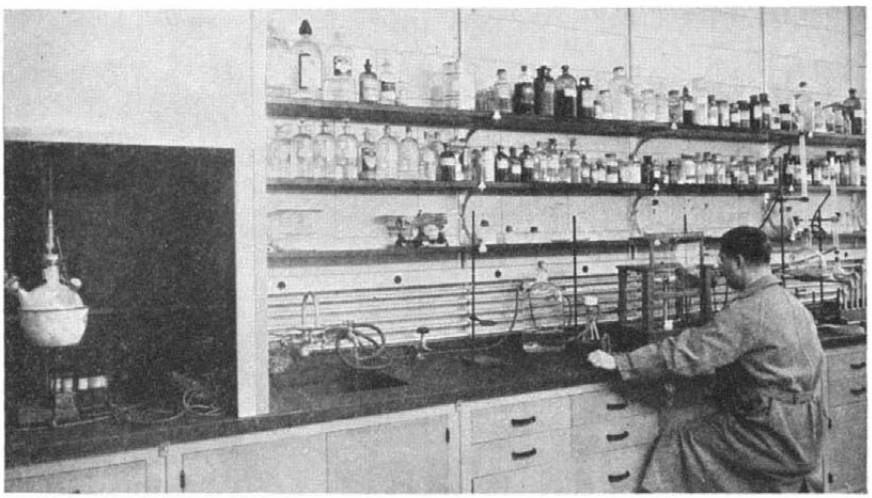


Even the roof of Mellon Institute's handsome new home is scientific. There are no projections since fumes are disposed of by an inset arrangement. Weathering tests may be conducted on certain sections of the roof

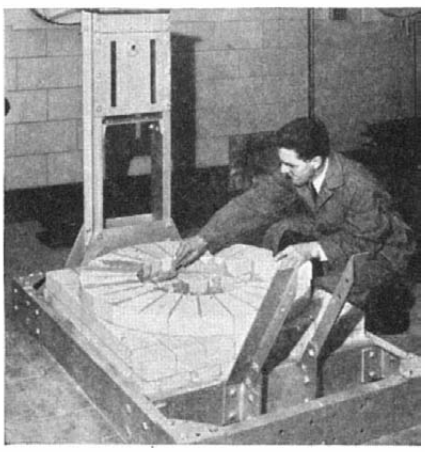
THE "National Asset" that is Mellon Institute officially dedicated its Ionic-pillared new home on May 5 to 9. Not only are its research facilities thus enlarged so that research fellows have more space and equipment for fact-finding; the building and all its appurtenances are products of the latest scientific knowledge.

As guest speakers at the dedication there were three Nobel laureates: Dr. Irving Langmuir (General Electric Research), Dr. H. C. Urey (heavy hydrogen), and Dr. W. P. Murphy (pernicious anemia treatment).

According to Dr. E. R. Weidlein, Director of the Institute, its function is four-fold. It is an industrial experiment station, a training school for young scientists, a center of investigation in pure and applied science, and a clearing-house for specific scientific information. Founded in 1913 as a result of the fellowship system inaugurated by Dr. Robert Kennedy Duncan at the University of Pittsburgh in 1911, Mellon In-

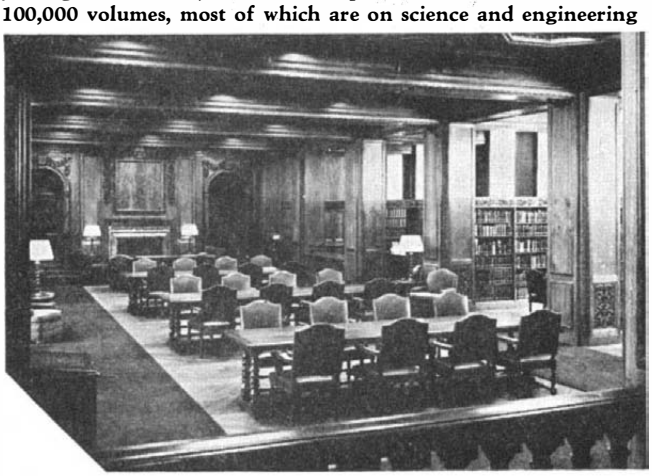


All unsightly features such as piping and ducts are concealed in this pharmaceutical laboratory in the new building. Note ample space in neat drawers, the adjustable shelves, and hood for carrying away fumes

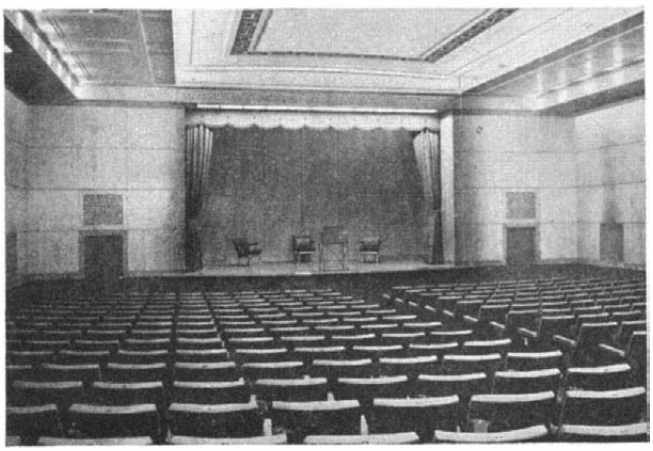


Broad research in refractories is conducted through the use of small kilns such as this will be

One of the most impressive rooms is the library which is carried out in the style of the Renaissance. In this room and the adjoining stack-rooms, facilities are provided for a collection of 100,000 volumes, most of which are on science and engineering



The auditorium which will be used for lectures and other meetings of a scientific nature. Seating capacity is 350. Motion picture and stereopticon equipment is provided for demonstration purposes in connection with many activities of the Institute

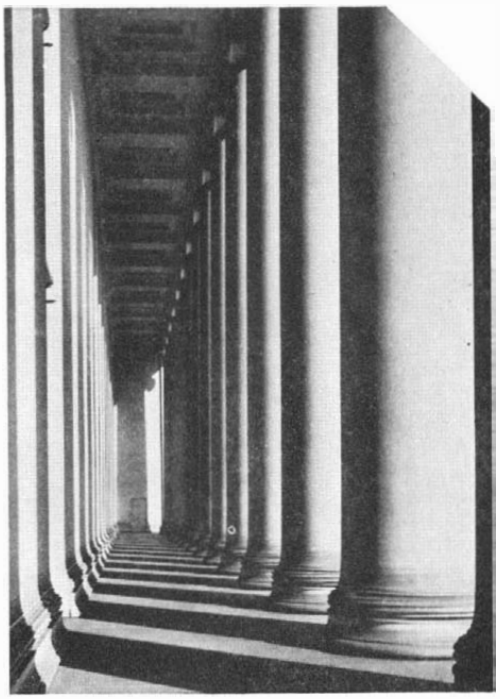


PARTNERSHIPS

stitute functions as a working partnership between science and industry. Companies in any given field can band together to finance mutual research, the results of which become the common property of participating firms. Most of the industrial investigations, however, are sustained by individual companies.

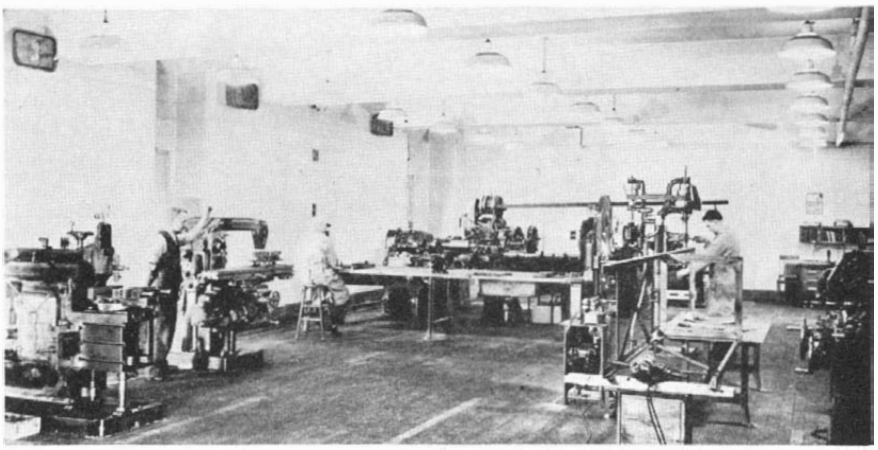
In the splendid new building illustrated on this page, the fifth to eighth floors, inclusive, are devoted to laboratory use, though each floor has special rooms. Standard services include air; gas; cold, hot, and distilled water; single- and three-phase current; and currents of special characteristics.

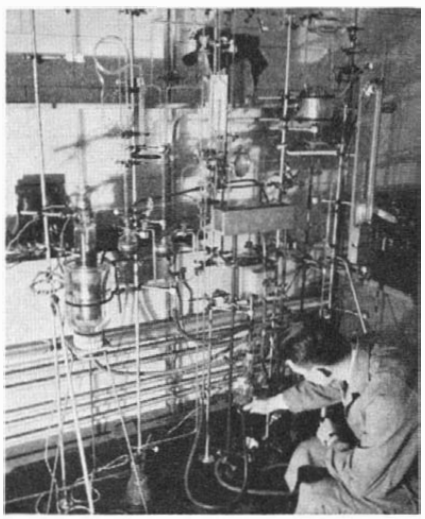
Practically any conceivable type of research can be conducted with these new facilities. Mellon Institute has already brought ten new industries into existence through applied research, and has developed or invented 650 new processes and products. These have ranged from medicines to edible sausage casings, from steel flooring to razor blades.



Marvels of craftsmanship, the 62 limestone monolithic columns in the building were turned on huge lathes. Only three workmen could do this exacting work. Each column has an average diameter just under six feet, is over 42 feet high, and weighs 60 tons; they have no seams

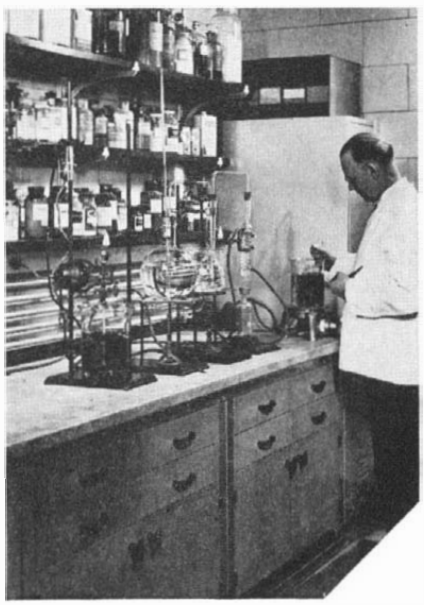
Frequently a research fellow prefers to perfect his own equipment for some special purpose where precision is paramount. He is then allowed to use an adjoining shop





Complicated and elaborate indeed is much of the equipment needed today in modern research laboratories. The complex set-up shown here is an excellent example —it is used in glass technology research

A corner of one of the laboratories emphasizing the clean-cut design of all facilities. This one is the scene of a discovery in insecticides likely to have industrial and agricultural possibilities



Part of the human side of the Institute: the largest of a suite of rooms reserved for recreational purposes, informal conferences, and for social activities of the Institute's Robert Kennedy Duncan Club

SHERLOCK HOLMES OF THE

The Microscopic Identification of Wood by Forest Laboratory Experts Solves Crimes and Convinces Juries . . . as in the Famous Hauptman Murder Case

By MARY BRANDEL HOPKINS

A BUILDER suspects his contractor of using a substitute where pine is specified. . . An equally serviceable native wood is sought to replace a wood previously imported for a given purpose. . . A home-made bomb filled with shavings kills the recipient. . . Grapes or other fruits packed in sawdust, butter and cheese packed in wooden boxes pick up a peculiar taste. . . A young married couple buying furniture is confused by the similarity in appearance between mahogany and mahogany-finished birch or gum wood. . . Inspectors with years of experience differ in their opinions as to whether a given lot of railroad ties is of the more desirable white oak or the less durable red oak. . . Musicians or antique furniture collectors desire to repair rare old pieces with the same wood originally used. . . School children making collections of wood are puzzled about specimens.

The solutions to these and more than 1000 other cases which yearly perplex laymen the country over all hinge on the identification of wood species, for which the Silvicultural Relations Department of the United States Forest Products Laboratory at Madison, Wisconsin, is the center. There samples from all over the United States, having an important bearing on extending and improving the use of wood or originating in controversies incident to marketing of forest products of all kinds, are handled for the United States Department of Agriculture.

Costly litigation frequently hinges upon the result of an examination of a little sawdust, wood flour, or a few slivers. Identification of wood in the Lindbergh kidnap ladder by Arthur Koehler, in charge of this department, has become a classic example of this remarkable government service which is offered without charge to its citizens. As a matter of fact, Sherlock Holmes was not abler than Mr. Koehler, his colleague, Dr. Eloise Gerry, and their skilled assistants. They have added microscopic equipment to Sherlock's magnifying glass, and are proving day after day, beyond the shadow of a doubt, that woods which appear as like as two peas to the naked eye may be of an entirely different species. While color, odor, weight, and hardness help in identifying woods, such qualities as a rule are too variable to be used singly in distinguishing a large number of woods. Definite and dependable distinguishing characteristics of species, which make positive identification possible, are revealed only by the microscope. When photographic enlargements of the microscopic sections are introduced as evidence in the court room, they afford for the jury, among other things, indisputable proof or disproof of the fulfilment of a contract.

A case in point is that of a Chicago buyer of railroad ties. The dealer claimed to have sold him white oak ties. The purchaser sincerely believed them to be the less valuable red oak. Called upon to settle the matter, the tie inspectors representing both sides claimed they could tell red from white oak by looking at the side of the tie through a pocket magnifying glass. Neither would accept the judgment of the other, but agreed to submit the case to the Forest Products Laboratory. Together they brought to the laboratory experts 90 samples of disks of wood from the ends of the ties. Under the microscope, the distinction is so evident between the few round, separate pores of the red oak summer wood (Figure 1) and the numerous fine, angular pores which form patterns in the white oak summer wood (Figure 2) that there was no room for dispute. It happened that buyer and seller both had been partially wrong and partially right in certain of their contentions.

At times wood identification goes a step beyond the mere settlement of disputes by affording the key to the solution of crime. Aside from the more recent Lindbergh case, there is the rather well known example of the "Christmas gift bomb." The explosive received in the guise of a Christmas box by a highway commissioner killed his wife as she cut the cord on the package. Ballistics experts traced the metal used in the home-made bomb to a particular man's

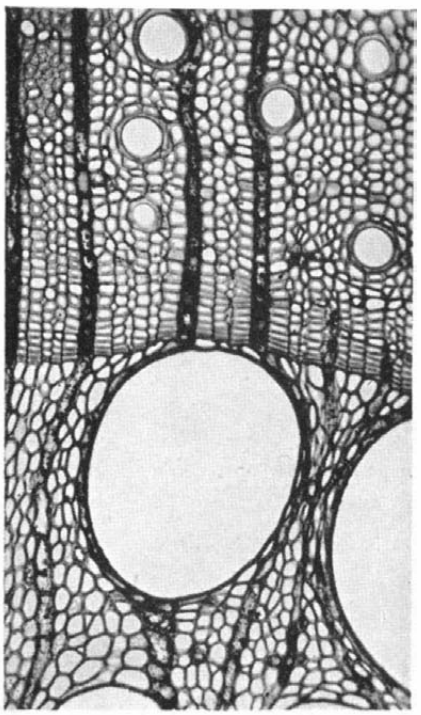


Figure 1 (at left): **Upper half shows summer wood of red oak. Note in this the pattern of round, separate pores**

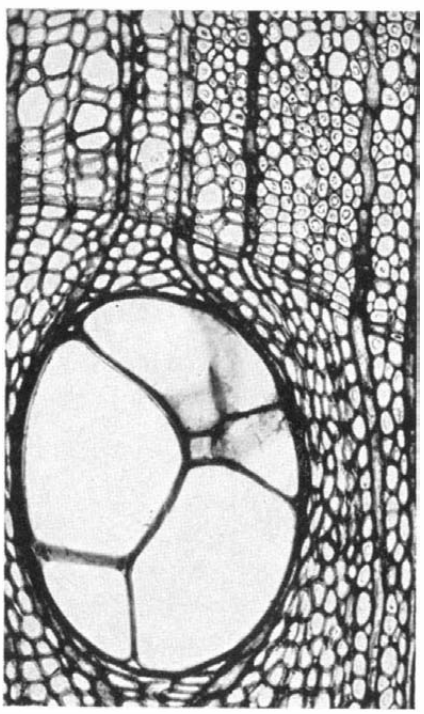


Figure 2 (at right): **Upper half shows summer wood of white oak, with patterns of numerous fine, angular pores**

workshop. That alone was not sufficient evidence. When the Madison laboratory identified the shavings inside the bomb as having come from the same workshop, the substantiated evidence was fairly conclusive proof of guilt.

After the tree is cut and lumber sawed, nothing short of a microscope will indicate what portion is strong and which is weak and should be withheld from use where it will not serve adequately. In southern swamps, the lower part of the tree which grows in the water often produces a swelled butt, with light, soft, weak wood. The wood from the under side of leaning trees has different properties from normal wood. Such differences can be detected microscopically, and the wood put to service accordingly.

Difficult as it sounds, it is also possible for laboratory experts to identify wood in the form of paper! The microscopes are called upon for this feat when it is desirable to know from what species or mixture of species and pulps a given paper was made. More difficult because of the small fragments available, but not impossible, is the identification of wood from sawdust. That becomes desirable, for example, if fruit packed in sawdust acquires a peculiar taste. The species from which the sawdust came can then be held accountable and barred from that particular use in the future. The same is true of wooden containers which impart an unusual taste to cheese and butter packed in them.

When the search is for substitutes to serve equally as well as a more costly and less available wood, microscopic investigation is called upon to determine the woods with the greatest promise of giving the required service.

The ultimate in identification is probably achieved in determining the species of wood flour, a very fine sawdust used in linoleum, phonograph records, and for polishing jewelry. The purpose is to detect undesirable substitutes for the species recognized as most satisfactory.

In the laboratory, the process of identification of wood samples is to cut off with a sharp razor a paper-thin slice and place it under the microscope. With their distinguishing characteristics thus revealed, it is a simple matter to single out oak, elm, pine, or birch. The nature of wood structure being very conservative, it is possible to distinguish even between each of the approximately 100 species of oak. Yet the microscope cannot always be depended upon to differentiate between the many varieties in the same species, as among the different birches or true firs. On the other hand, for easier wood samples, a hand glass magnifying 12 to 15 diameters identifies them. For comparison with samples submitted, thousands of accurately classified wood specimens as well as permanent microscopic slides made from them are on file at the laboratory.

THE value of wood identification extends even to the retail purchaser. For the wary buyer of furniture, it is no trick to distinguish between mahogany and birch or gum wood which may be stained to resemble the costlier wood. In that instance no laboratory test is required to set him right. He need but remember that in mahogany (Figure 3, left) the pores of the wood are readily visible to the naked eye. In birch (Figure 3, center) they are barely visible, and in gum (Figure 3, right) they are visible only under the microscope.

Three basic structural divisions are the starting point for the identification of wood samples. Either the wood has vessels or pores which are diffused rather evenly throughout each year's growth (Figure 4, left), or are arranged in a ring at the beginning of the annual growth ring; or it has no vessels or pores (Figure 4, right).

The oaks are "ring-porous woods." And while it is impossible to distinguish individual members of the white oak group from each other, white oak (Figure 2) is easily distinguished from red oak (Figure 1) under the microscope. Both have a layer of large pores in the *springwood* (lower parts of both illustrations) of each growth ring. The characteristic which distinguishes them, and which settled the differences of opinion between the railway tie inspectors, is the size and shape of the pores in the *summerwood* (the outer portion of the annual growth ring, at the top in Figures 1 and 2).

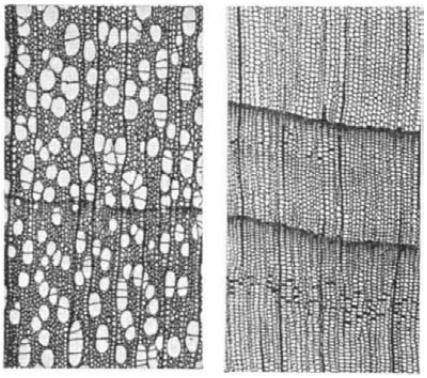


Figure 4 (left): **Aspen or popple, a diffuse, porous wood with uniformly scattered pores.** ***Right:*** **Red cedar** ***(Juniperus v.),*** **a type of wood which has no pores or vessels**

One of the means of dating Indian ruins and cliff dwellings in America's Southwest has been by identifying and determining characteristics of groups of a tree's annual growth rings, which is a science in itself. In these rings are preserved the record of the tree's annual growth, which, of course, is largely affected by rainfall and other climatic conditions. In so dry a region as the Southwest, good rainfall shows markedly in the annual growth rings. Even in fossil wood samples, buried deep in the earth, it is usually possible to identify the wood, thus gaining information about the vegetation of the period which helps to date the deposits. Likewise in petrified wood, where minerals have infiltrated the cells, much of the arrangement of the tissues and the distinguishing characteristics of the cell structure may be seen and identified.

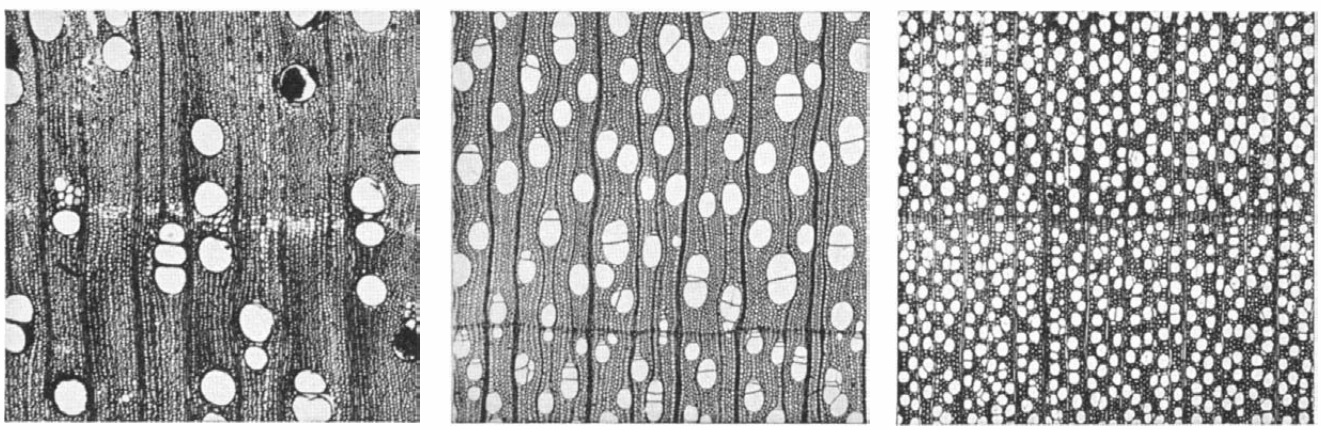


Figure 3: **Mahogany, birch, and gum magnified 25 diameters, to show relative aspect of pores. In mahogany** ***(left)*** **the isolated pores are readily visible when examined with the unaided eye. In birch** ***(center)*** **they are confused but in gum, invisible**

Is Nature Kind?

Throughout Nature's Realm the Almost Universal Rule is Tooth and Fang, Whether We Like it or Not, and Most of Us Don't . . . Fact Versus Fancy

By S. F. AARON
Illustrations by the Author

IN the imaginative mind of man, pleasing delusions are too often given place as the findings of scientific observation. Numerous examples of error are apparent everywhere; notably, the "joyous songs of birds," the "music of the spheres," the "peaceful" woods and many other poetic allusions and illusions—"There's never a leaf nor blade too mean to be some happy creature's palace."

Now, in many such beautiful fancies there is a sufficient element of truth to make them the more appealing, and who that are worthy among us, however addicted to seeing things exactly as they are and not just as they seem to be, will not fairly snatch at the semblance of beauty, rather than sordid and gruesome facts?

The poet and the naturalist, however, look at nature through vastly different eyes, even though the naturalist may have a poetic streak and the poet be a close observer. The truthful, careful lover of nature simply avoids the imaginative that goes beyond truth; the poet more easily ignores hard facts for the sake of beauty.

Yet, above all, we must face the truth, which is too often crushed to earth by beauty. The truly scientific aspect of nature, of physical and mental forces, demands an adherence to facts and the expression thereof in terms exactly coinciding with that which has been and may again be observed; and so it may readily be observed that in nature there is a general rarity of happiness, also that any evidence of joyousness is imaginary, and that peacefulness is almost totally absent alike among creatures that seek their food or are sought for food.

THE face of nature, instead of being one large, happy visage, as the nature-lovers-minus-scientific-acumen would have us think of it, is one large, deep scowl resulting from murderous impulses. Instead of peacefulness and content throughout, it is an arena of injury, torture, and death. Everywhere that the student turns to observe animal life closely, he sees among the almost innumerable species a continuous effort to maintain existence. The frequent failures of individuals in nature to survive, or to continue in comfort, accounts for the total lack of what humans may correctly term happiness as derived from and appreciated by the more highly developed mentality of man.

When a poetically-minded observer speaks of the songs of the happy birds he expresses a very common error easily corrected by trivial observation, but an error which, nevertheless, has generally been overlooked. All birds sing with exactly the same motive as crowing roosters and gobbling turkeys; that is,

The weasel barely misses chickaree, the red squirrel, for dinner

as a challenge to others of their species and sex. Their song is merely an expression of ego in relation to possible rivalry. Just so is the soft, almost inaudible trill of the grasshopper sparrow and the mocking-bird's brightly varied performance, the twitter of woodland warblers, and the peculiar cadences of the veery; there is not a note that does not express the candid notion that "I am monarch of all I survey, and let all others keep off." There is also another and more practical purpose: the loudly singing bird near the nest, far from caroling to his lady-love, attracts swiftly moving winged enemies to his whereabouts and thus away from the nest.

These impulses, derived from rivalry and the need of protection of the young, may be observed in male birds that sing the very loudest and most beautifully when fighting, and before and after coming to grips with a competitor because of the very common disloyalty of his mate.

Two Carolina wrens will sing nearly every moment that they are bill to bill in a stupendous effort to destroy each other, often falling to the ground, half with exhaustion, but still musical. Cardinal grosbeaks, orioles of several species, vesper sparrows, and brown thrashers follow the same practices; and so varied, lively, and more rapidly given are the notes of the latter, especially, that it is a duet very much worth hearing. Another proof of the purpose of song is when our yellow-breasted chat, the yellow-throat, the veery, and the European nightingale burst into melody at night after a stone is thrown into the thicket not far from where the female bird is keeping their eggs warm. The spontaneous medley is quite evidently given in anger toward an imagined interloper of their own kind.

ANOTHER common poetic error concerns that which we view only from a distance, without familiar insight into exactly what is continually and tragically taking place everywhere in woods and fields, over and within the earth and its waters. It is not surprising that the lover of entirely beautiful things sees only quiet and peace, but upon closer observation this idea is tragically dispelled. There is not a spot a yard square, in grove and meadow, in forest and thicket, on hill or plain, that is not almost continuously beset by death-dealing forces. There is never a leaf or blade too isolated to be the arena of a tragedy.

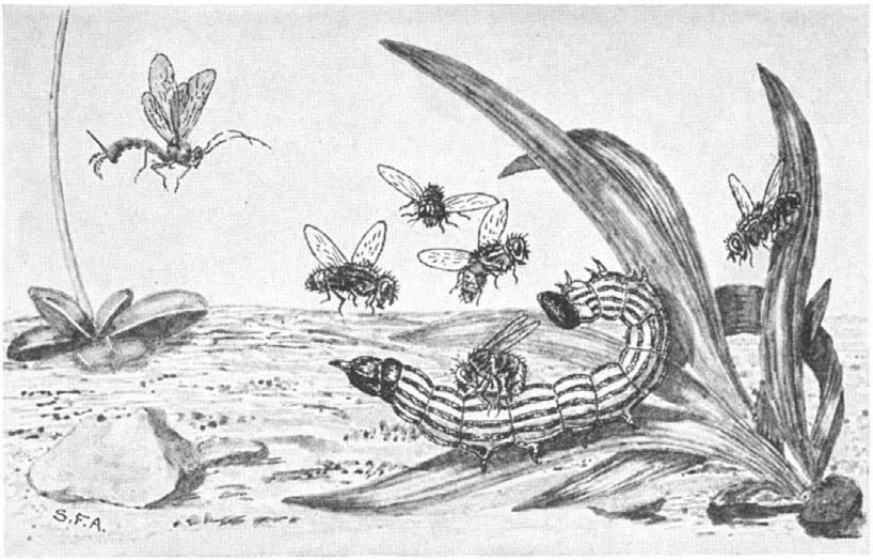
Calamitous occurrences which constantly take place in nature, with the most direful results, go far toward upsetting the pleasure to be derived from nature study. To the humanely constituted investigator, the horrible ends

which overtake animals seem to cry for some alleviating element of sympathy from nature. This often leads to an emotional denial of her heartlessness, and a wish-fulfilling substitution of gentle influences. But science cannot dodge facts, even to favor its inner feelings.

Paramount among these tragedies is the destruction of young quadrupeds and birds, the killing of mother creatures and the consequent starving of the young. Nature advances her interests in the formation of species by purposes not in the least allied to pity or peacefulness; there have been no such developments within animal understanding (other than mother love) except as between mates and the members of individual flocks and herds. Thus, crows will endeavor to rescue a brother of the wintertime congregation that has been injured by a falcon, owl, or gunner. Bobwhites, with a remarkable show of valor, will turn suddenly upon an enemy such as a cat, weasel, fox, hawk, or snake that has seized one of their number and, by swift, combined effort of beating wings into befuddled eyes, will sometimes liberate the unfortunate member of the covey. Wild goats and certain species of larger deer, such as the wapiti, caribou, sambur, and some of the powerful African forms, savagely attack *en masse* when one of their number is threatened by an enemy other than the larger carnivora. Whatever apparent sentiment of sympathy is shown by male creatures for the females is, however, protective and ingratiating; at other than breeding periods it may be quite wanting or even turned to violent bullying.

IN regard to animal happiness, it is very true that many creatures show a disposition to play, and therefore exhibit something akin to enjoyment—especially the young when well fed and protected. Of this the cubs of the larger carnivora are extreme examples, and even among adult species which live in constant fear of enemies, as do all the smaller forms which are commonly preyed upon, there is a tendency to caper and ignore conditional vicissitudes, but never is there a prolonged forgetfulness of danger. Those animals which are well holed up and thus free from attack, and the larger carnivora and ungulates that have no enemies in the sense commonly understood, may often know relative degrees of comfort, but there are not to be forgotten those pests that constantly annoy them: fleas, lice, mites that are kept active by the body heat of their hosts in winter, the tremendously numerous winged pests of warm weather, together with the not unfrequent effects of disease from internal parasites, thus making life rather a constant irritation.

I once watched two bears in file pass down a rock ledge perhaps an eighth of a mile long and devoid of vegetation, and in that distance they stopped to scratch themselves more than a dozen times. This was high in the mountains of Mexico where the temperature was anything but encouraging to insect life. I have seen a gray fox do much the same in midwinter. All animals, from mice to moose, are subjected to pests; it is impossible to imagine that anything approaching comparative comfort can be experienced under such circumstances.



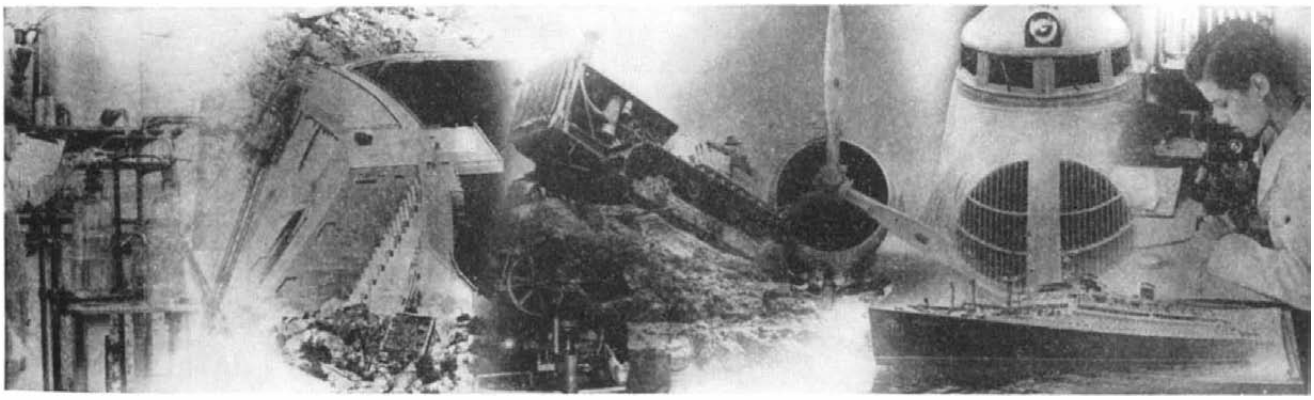
A walnut web-worm caterpillar (Datana) followed by parasitic tachina flies and an ichneumon wasp seeking to lay their eggs in the well-fed living host's body

The smaller quadrupeds, especially the rodents and the birds, know that the chief cause of discomfort is the dodging of enemies. Not that these creatures are beset by worry, as would be cogitating humans if constantly menaced, but the fact that they are conscious of danger becomes evident by their being always on the lookout. Observe a rabbit, or a terrestrial species of bird, while feeding. Double the effort is put into being aware of the possible approach of foes that is expended in getting food. But the mortality of the helpless young—and this also applies to many larger creatures that are preyed upon—is an astonishing percentage when investigated. Consider the number of nests in and around the average farm acres and note the numbers of helpless young destroyed in one way or another, mostly by carnivores, wild and domestic—the latter often exceeding in numbers the wild species that existed before the advent of man and his pets, thus often interfering with the balance of nature. Irresponsible man, too, often upsets the balance of nature.

It is the lower forms of life, so-called, including the vast number of insects and their relatives, that furnish the most complete argument against the idea of nature as a gentle mother. It is this vast group, commonly the victims of birds, moles, shrews, mice, snakes, toads, frogs, and lizards (also constantly at war with each other) that present to the nature student the most horrible examples of torture and death-dealing by slow maceration, dislocations, poisons, starvation, and what not.

Of all animals the hunted creatures greatly outnumber, both as species and individuals, those that seek their prey. Were this otherwise, the killers would find it far more difficult to obtain food. It is the very exceeding proliferation of the hunted creatures that maintains the balance between them and their natural foes. The carnivora do not obtain food as easily as is commonly supposed; there are a good many hungry stomachs among them at all seasons. The vegetable eaters obtain their food far more easily than the flesh eaters, though the latter vary their diet with succulent roots, twigs, seeds, nuts, and grasses in winter, and at all times most of the rodents, such as mice, wood rats, squirrels, and marmots, feed on insects in the grub and larval condition and eat defunct animal matter wherever they can get it. In winter those creatures that hibernate possess a very great advantage, in that they are out of reach.

PARASITISM is the most gruesome and horrible aspect of the struggle for existence, and one of the most effective agencies of limiting the individuals of many forms of life. I have in one season collected over 40 cocoons of moths, large and small, and every specimen hatched parasites alone. At another time nearly 30 cocoons brought forth only two perfect moths. Out of more than a baker's dozen of tomato worms, but three were free from the tiny apenteles larvae that crowded the interior of the worms' bodies. Such very common instances among hundreds of species are the extreme examples of the struggle for existence, for in such types there is no possible defense.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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

D. H. KILLEFFER
Chemical Engineer

"Plug-in" Instruments to Aid Industrial Use

INDUSTRIAL plants will particularly benefit by the newly developed plug-in instrument in which a self-supporting socket can be mounted directly in the wiring conduit with a 35 percent saving over a conventional installation, according to Westinghouse engineers. Industries powered by individual drive, such as the machine and textile industries, will find this development of benefit since it makes practical the low cost use of instruments to act as guides for "production speed *vs.* machine life."

Plug-in meter and socket

With four years' development behind it, the present universal socket will give any desired load conditions by merely plugging in an ammeter, voltmeter, watthour meter, etc., one after another in the same socket. Standard "troughs" (all-metal boxes), with several sockets, will be used when more than one instrument is to be read at the same time, and can be mounted much like a motor starter. Quick and easy mounting has been worked out for ordinary wiring, such as rigid conduit, open wiring, or cable.

Cancer Situation Far From Alarming

AN optimistic view of the cancer situation is taken by Dr. Louis I. Dublin, third vice-president and statistician of the Metropolitan Life Insurance Company. In a report to the *American Journal of Cancer*, quoted by *Science Service*, Dr. Dublin says:

"The cancer situation in the United States is far from alarming although much can be done to improve it. Encouraging are increases in research, education, and facilities for diagnosis and treatment. In three years, the American College of Surgeons registered almost 25,000 persons cured of cancer. Large numbers of physicians are being especially trained to diagnose and treat cancer more effectively. There are already about 200 cancer centers throughout the country which meet the standards of equipment and personnel established by the American College of Surgeons."

The increase in the cancer death rate during the quarter century from 1911 to 1935 is largely spurious, in Dr. Dublin's opinion. Previous to this period, just as many persons probably died of cancer but it was not recognized. The rise in the cancer death rate is almost entirely limited to men over 55 years of age, and especially white men. Cancer in men in four fifths of the cases occurs in inaccessible sites and could not have been recognized and diagnosed with methods used 25 years ago. This accounts for the rise in the male death rate from cancer which makes up most of the increase in the general death rate.

TIRES

THE average motorist's tire bill during 1937 will be less than 8 percent of the car owner's expenditures for tires 30 years ago, or about 15 dollars.

Alcohol Blends *Do* Produce Carbon Monoxide

ONE of the claims put forward for blending ethyl alcohol with gasoline for motor fuel use has been that the blend produces less carbon monoxide in the exhaust of the engine than straight gasoline does. This question has been carefully investigated under a wide range of conditions at Yale University and the results recently reported show that the proportion of carbon monoxide in the engine exhaust is entirely a matter of carbureter adjustment and is quite independent of the fuel used. The elimination of carbon monoxide from the exhaust of an engine requires that more air be provided than is needed for complete combustion, whether the fuel is gasoline or a blend. This amount of air is excessive and when so adjusted, the performance and efficiency of the engine is impaired. When adjusted for best performance, the output of carbon monoxide is practically identical whatever fuel may be burned. Experiments made in this investigation included gasoline and blends containing 10 and 20 percent of alcohol respectively.—*D. H. K.*

Safe, Silent, Personal Electric Fan

A PERSONAL breezemaker with rubber blades so soft they can't injure even a baby's fingers has been developed by the Samson United Corporation. And this Safeflex All-Purpose model can be used "where" and "how" no other fans have been used before. This "little acrobat" actually pins up on walls—stands anywhere—clamps any place—and you can stick your fingers into it if you want to.

The clamp-on feature is taken care of by a steel clamp concealed in the mar-proof base of the fan, while a special pin is provided to utilize the fan in a pin-up position.

This small electric fan for personal use has safety rubber blades

Furthermore, the ball and socket joint permits adjustment for every position.

Being portable, it means that a person can now carry his own private breeze with him. Besides, it is light enough to be picked up by a tot, yet laboratory tests and commercial applications show that its air displacement matches any eight-inch desk fan. Although the blades are constructed of flexible, moulded rubber, the shape and pitch keep them rigid. Added to its feature of safety, this all-purpose fan is actually silent.

DIAMONDS

NUMEROUS industrial diamond chips, mounted in the rim of a cutting wheel by a special Belgian process, enable the wheel to cut through such hard rocks as chert and jasper as a knife cuts through butter. The wheel revolves at 4000 revolutions a minute and is used in the diamond mines on the Rand in South Africa.

At Last—A Kinkless 'Phone Cord

FOR many years, telephone users have sensed the need for a hand-set cord that "knows its place and keeps it"—one that can be relied on to extend to full length when occasion requires, and yet will not curl around an ink-stand or drag papers to the floor as it trails across the desk.

Many and weird are the contraptions that inventors have devised to overcome these faults of the common cord. With most of them, unfortunately, the remedy has been worse than the disease. They have either had wire springs that sooner or later cut into the braid, or mechanisms that give more trouble than they save, or the cords have been so made that they work with reasonable satisfaction for a time, but soon deteriorate to a point where they are about useless.

In the accompanying illustrations, we show a new telephone cord which has none of these defects. This is the Extensicord—the Automatic Electric extensible cord.

Its construction is unique, but quite simple. The several insulated conductors, instead of being laid parallel and covered with a common braid, as with the conventional cord, are braided to each other around a braid-covered elastic strand as a central core. The cord is assembled on a specially designed braiding machine. When it leaves the machine the ends of the conductors are secured together, leaving the cord to assume a compact, contracted form—less than half of its fully extended length.

Kinkless 'phone cord in use, and, *at left*, in its normal shortened form

When the telephone is not in use, the cord has no chance to stray from the telephone to get entangled with papers or desk paraphernalia. When the user reaches for the hand unit, the cord stretches easily in a smooth, straight line while the user assumes a comfortable talking position. When the hand unit is replaced, the cord contracts instantly and smoothly to its normal shortened form.

Factory-Built, Even to the Doorbell!

BUILT complete, decorated, and ready to move into, a full-size, five-room, electrically-welded, steel house, with garage incorporated, was mounted on a semi-trailer and rolled out of the R. G. Le Tourneau grading machinery plant at Peoria, Illinois, recently.

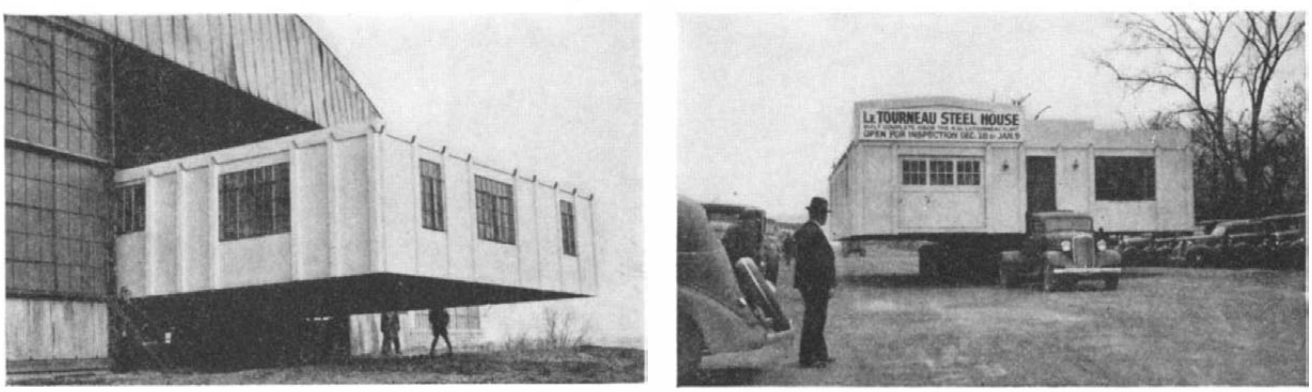
There was coal in the two-ton hopper, the furnace was going and the house was comfortably warm. The 16-wheel trailer, towed out of the factory by a Caterpillar tractor and along the roadway by a 1½-ton truck, had no trouble with its 41-ton load.

On a space leveled off in the front factory yard, just as a homesite would be leveled, the 32 by 44-foot house was gently set down by a tractor crane which took hold of the three steel rings on the roof, lifting it while the trailer rolled out from under. Within a few hours, water, sewer, and electric connections were made, drapes were up, floors carpeted, each room appropriately furnished, and the house was ready for occupancy.

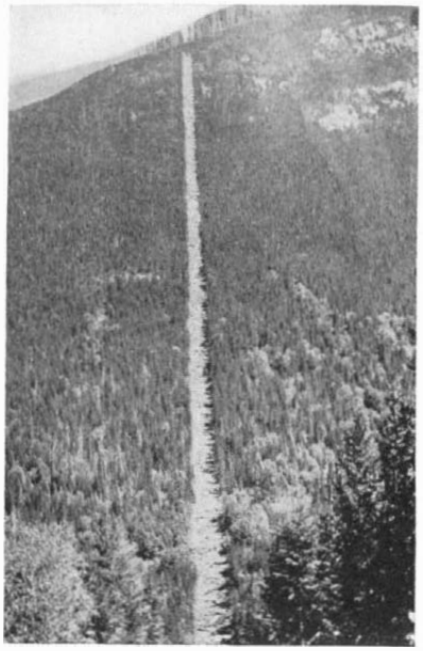
This house is the first of a number of similar cottages for employes that are to be built complete inside the factory. When the next five houses—on which construction has started—are finished, the six dwellings are to be launched on the Illinois River, which flows past the factory, and towed on their own bottoms across to a Le Tourneau colony site.

These are believed to be the first all-steel houses ever built, as well as the first houses to be completed, ready for occupancy, inside a factory. The first house has asbestos board ceilings and living room walls, and wooden doors, but the dwellings now under construction and all future houses are to be entirely steel except for plumbing fixtures and rock wool insulation between the wall sheathings and between ceiling and roof.

Production methods, which are being



An electrically welded home, ready for occupancy, leaving the factory—and being transported by trailer



We publish this picture not because it is just a pretty picture. It isn't even unique. It does, however, serve to symbolize the friendly relations between Canada and the United States, for this is a part of America's northern border. Europeans may take note that this 20-foot clearing tract is merely a marker and not in any sense of the word a path for military sentinels or transportation

perfected on the five houses now building, will permit completing future houses with the economy, precision, and speed employed in manufacturing scrapers and other equipment. It is estimated that with present available space and facilities one house can be finished every three weeks.

Although this steel house, proposed and outlined by R. G. Le Tourneau and designed by Architect Ephraim Field, is a mobile house, it is certainly not in the class of any so-called portable house or any prefabricated house. The purpose in planning it was to provide Le Tourneau employes with a complete, convenient, and attractive house of about average size that could rent or sell at a moderate price. It is designed to utilize every foot of space and thereby afford with a modest ground area a five-room house with rooms of generous size.

The built-in garage or utility room, with overhead door, also houses the heating and cooling plant and the laundry. It is quite livable enough to be used as a party room winter or summer.

When they are on the market in a variety of styles and sizes with models changing as architectural fashions shift and advance, the builders suggest that an owner should be able to trade in his house from time to time for a newer or larger model to accommodate increasing family and income.

Cabooses

TRAIN crews on the Chicago, Milwaukee, St. Paul and Pacific Railroad have been taken down off their high seats in the cabooses on that road. The cupola, long a familiar sight on the last car of freight trains on all railroads, has been removed and trainmen have been given instead projecting cabs at the sides of the caboose from

TRANSPORTATION SECTION

which they may view the train ahead. This change is partly due to the fact that higher box cars have lately so obscured the view of trainmen that brakemen had to crane their necks to watch the train ahead to see that the long line of swaying cars functions properly.

The Milwaukee road is rebuilding in its shops in Milwaukee its fleet of 900 cabooses and besides making the change above noted are modernizing them in other respects.

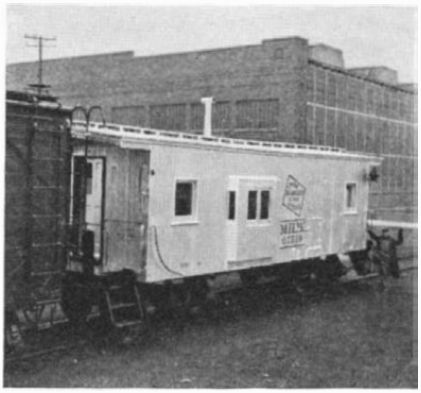
Trainmen seated in a remodeled caboose more easily inspect a train for dragging brake beams or truck parts. Also they readily detect hot journals since the odor arising from burning oil-soaked waste, used for lubricating journals, usually hangs close to the ground. There is an added safety feature since trainmen no longer are required to climb in and out of a cupola.

Removal of the cupola has permitted removal of partitions inside the car, making a roomier, more airy and more readily heated caboose.

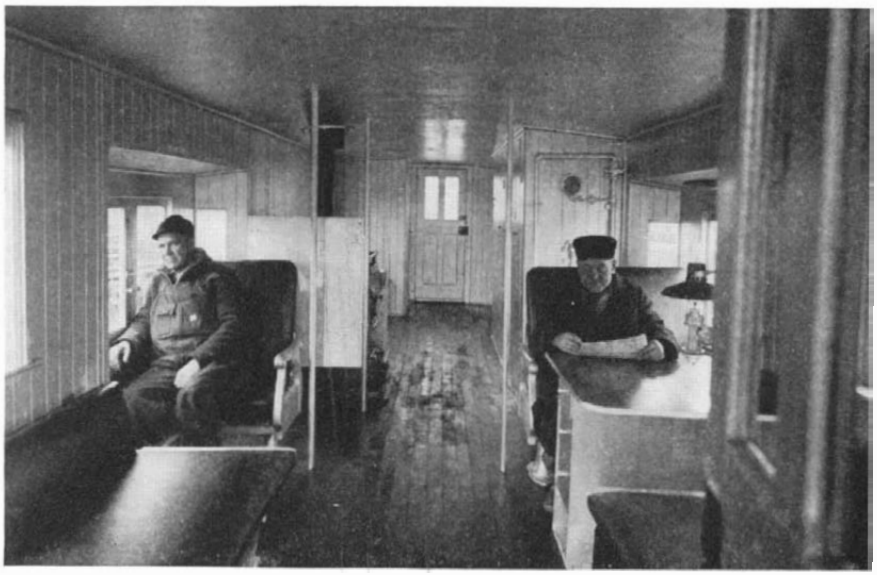
Side seats six feet long, upholstered in leather, are built in and used by trainmen to make into beds during the time they are at terminals away from their home stations. Standard type coach seats are provided in the side bays, permitting trainmen to assume a comfortable position while watching the operation of the train.

Toilet facilities are provided, as well as washstand with water supply. There is a built-in refrigerator for storage of food and also a tool locker.

The exterior is finished with aluminum paint; the running gear, platforms, handles and ladders are finished in black.



Above: **The new caboose, *sans* cupola and with "bay windows." *Below:* Interior of the caboose, showing the comfortable position of the trainman watching his long line of freight cars**



ALUMINUM ROADS

OFFERING the advantages of corrosion-resistance, prevention of softening of the road in hot weather, and high visibility at night, aluminum roads have been developed in Germany. To construct these, powdered aluminum is mixed with the usual surface material of tar or asphalt.

Correction—Union Pacific Trains

FROM Professor Edward C. Schmidt, Railway Engineering Department, University of Illinois, the Editor has just received the following letter. We gladly publish it in order to keep the record straight.

"I am sorry to find that in the article entitled 'More Efficient Locomotives' which I prepared for your April issue, I have on page 225 twice referred to the first of the Union Pacific Railroad high-speed trains as being provided with Diesel engines. This is not correct. The motive power for the first Union Pacific train was obtained from a 12-cylinder V-type distillate-burning engine rated at 600 horsepower. All subsequent high-speed trains on the Union Pacific were provided with Diesel engines."

No More Oil Cans

LOCOMOTIVE engineers and oil cans have been inseparable since steam railroading began. But the tradition has been broken by the new Mallets of the Norfolk & Western, says *American Machinist.* All

bearings that take oil are supplied by a pump from a central reservoir on the side of the locomotive. Oil supply to each bearing is metered by the usual control of the opening at the bearing. The engineer still has the oil can but no place to use it.

U. S. CARS

A NEW all-time high for motor vehicle registration was made in 1936. Registrations in the United States in 1936 totaled 28,221,291, of which 24,197,685 were passenger vehicles and 4,023,606 trucks and tractor-trucks.

Erosion Control Measures on Highway

EROSION control measures developed for farm lands will be used to protect sections of state and federal-aid highways this year under plans now being worked out between 19 state highway departments, the Bureau of Public Roads, and the Soil Conservation Service, the United States Department of Agriculture announced recently.

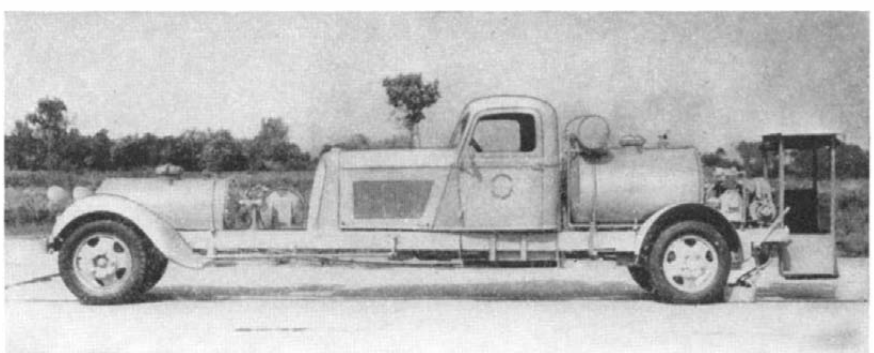
A recent survey in Wisconsin showed erosion responsible for much of the cost of highway maintenance in certain parts of that state. Uncontrolled soil erosion also increases maintenance costs on federal-aid roads, according to officials of the Bureau of Public Roads.

Under the proposed program, state and federal officials will select short stretches of right-of-way along highways within the boundaries of Soil Conservation Service areas. The Service will furnish technical supervision, labor, and necessary planting materials. The state will supply construction material and equipment, and agree to maintain the work for five years.

Actual operations to protect highway cuts and fills, highway ditches, and drainage structures, have been started in some of the 19 states, says H. H. Bennett, Chief of the Soil Conservation Service. Vegetative control measures will be used wherever possible, although some construction work will be done where gullies are menacing adjacent farm lands.

To Mark the Nation's Highways

WITH a wheelbase of 24 feet but measuring only a yard between each pair of tires, fore and aft, is the newest type of highway marking truck shown in our illustration. By use of a triangular sight mounted on the front end, and aided by the excessive length of the vehicle, the driver can lay down a painted stripe in the exact center of the roadway without any preliminary marking. The driver, amidships, looks through the triangle that takes in a section of the entire road ahead of the truck. A vertical line on the sight tells him the center. Actual painting is done in the rear by an operator seated in the small cab, who is equipped with a two-way electric signal to the driver. Up to three lines can be marked at once and from 40 to 50 miles covered in a day at a cost of about 15 dollars a mile.—*Science Service.*



This odd-looking vehicle was designed for marking highway lanes

Motor Trucks and New Fuels

IN her attempt to attain self-sufficiency, Germany is turning to several domestic products for power for her larger motor vehicles. At the recent 1937 International Automobile Exposition in Berlin many of the exhibitions of carbureter motors bore this legend—"This car can be run on illuminating gas, or gasoline, or wood gas."

Benzine is being rapidly abandoned in favor of domestic products. The powerful and efficient Diesel motor is, of course, by far the most used in the building of trucks and buses, and it is here that Diesel oil has frequently been replaced by some form of domestic fuel.

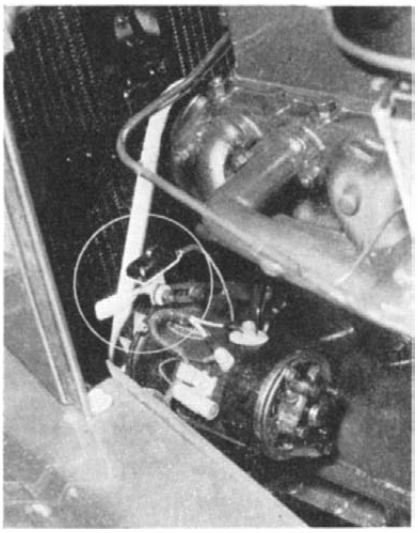
The electric motor vehicle which for many years has been in the background has again made its appearance. In addition to small electrically propelled delivery carts and wagons, there are also four- and five-ton trucks and tractors run with electric motors.

Many buses in Berlin are being operated on ordinary illuminating gas, large compression tanks being installed on the buses to carry a supply of fuel. Since, however, they can carry no great quantity, two gas-tank cars (portable filling stations) have been put into service to follow up the buses and replenish their supply. It is said that city gas is now saving Germany something like 750,000 liters of benzine daily which otherwise would have to be imported.

The use of gas derived from wood as fuel is making much headway. Already something like 2000 buses in Germany are being driven on this form of fuel.

Horn for High Speed Driving

LOUD automobile horns in city streets have become so annoying that many cities have carried on anti-noise campaigns for months in the attempt to silence them. In this day of high speed, however, a horn of penetrating tone is necessary on the open highway and when that same horn must be used during low-speed driving in the city the result is only what might be expected.



***In circle:* Air-operated switch that cuts-in a high-speed driving horn**

This problem has been attacked and solved most ingeniously by the Delco-Remy Division of General Motors Corporation. They have developed a horn of great penetrating power for high-speed driving only. It is expected that the car owner will use a separate horn of low pitch for ordinary city driving but when he hits the open road, the Klaxon Penetone will automatically cut in. Therein lies the trick.

The Klaxon Penetone is connected to an air switch which is mounted beneath the hood at any convenient location near the front of the engine. On this air switch is a cupped air vane, the cupped side of which faces forward just behind the fan. As the speed of the car increases, the increased flow of air swings this cupped vane to cut-in automatically the Penetone so that its stronger signal may be heard for long distances on the open highway.

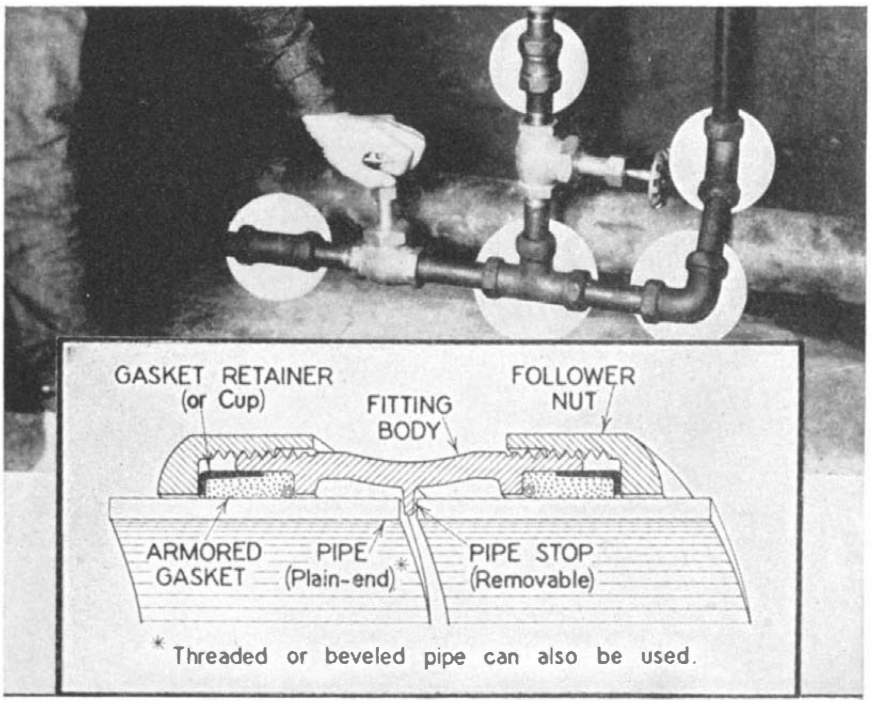
Locomotives Run Backwards

THE conventional locomotive is likely to get stuck in snow under a snowshed and almost suffocate both the engineer and the fire. So, reports *Power*, Baldwin is building big Mallet-type locomotives to run backwards. The cab is where it ought to be, but the smokebox and the stack are connected to the tender. Control levers are put in a stand in front of the operator, and what should be the back of the cab is glassed shut. The bell comes down off the smokebox and goes under the cab with the headlight.

Women Drivers

SCIENCE has come to the defense of the woman driver. If she is not so efficient as are the men, it is not because of her sex or innate abilities but merely because she lacks driving experience.

This is shown by tests, reported by *Science Service*, of more than 2000 persons on vision, reaction time, and other essential abilities for the automobile driver, made by Dr. A. R. Lauer, associate professor of psychology at Iowa State College.



Threadless pipe couplings, and, *in drawing*, how they are used

Only in strength of grip was there any difference between the sexes. Among the younger persons tested, the men were somewhat better than the women in judging distance. Women were somewhat inferior in tests of performance of skills resembling auto driving, due to the lack of experience of those tested.

The best drivers are those 22 years old, Dr. Lauer reported to the American Association for the Advancement of Science. This is true of both men and women. In complex mechanical skills, boys and girls are about equal up to the age of 15. After that, the boys are superior, but this difference disappears again in later age.

Keenness of vision drops off rather sharply for both sexes after the age of 40 to 45, and after 55 the loss is still greater. Ability to stand glare begins to lessen at the age of 20, and the drop is much sharper after 40.

In making these tests, Dr. Lauer transported his driving clinic about like a circus, making two-day stands in each town and inviting the general public to come and be measured.

"It was very strongly emphasized that the studies were experimental and that no definite statement could be made regarding a single driver—no more than a doctor could guarantee a certain life span by a physical examination," Dr. Lauer said. "One can tell that the individual has certain characteristics which need treatment, or which should pre-dispose the person to live to a ripe old age, but he cannot be assured that the person will live such length of time."

(End of Transportation Section)

Light-Weight Concrete Aggregate

OVER 30,000,000 pounds of dead-weight were saved in building the San Francisco-Oakland Bay Bridge by the use of a new light-weight concrete. The lightness of this concrete was made possible by the use of a new aggregate called Gravelite.

The upper deck of this bridge is a continuous slab (except for occasional expansion joints) of reinforced Gravelite concrete six inches thick, 60 feet wide, and extending the entire length of both the western and eastern bay crossings of the bridge, a distance of 4¾ miles. This slab of light-weight concrete contains 28,000 cubic yards, and weighs 15,000 tons less than the same slab would weigh if made of ordinary concrete.

Gravelite weighs only half as much as the ordinary sand and gravel it replaces. It is made by burning particles of clay and shale in such a manner as to cause them to expand into a light material of unusual strength.

In manufacturing Gravelite, the clay is mined and ground, mixed with enough water to make it plastic, and then forced through hardened steel dies under high pressure, these dies having holes of sizes corresponding to the sizes desired in the finished aggregate. As the pencils of clay are forced through these holes, they are cut off by rapidly rotating wires, producing small cylinders of clay. These cylinders are then introduced into a rotating kiln, where they are subjected to a high temperature, which causes them to expand to more than twice their original size. This expansion of the particles of Gravelite imparts lightness to the concrete, and heat-insulating properties that are said to be four times greater than for ordinary concrete. The high crack-resistance of the concrete results from the fact that the particles of Gravelite are more resilient than sand or rock.

After being burned, the Gravelite is stored in large piles, and, before being shipped, it is separated as to size, so that the user will receive accurately-sized particles in accordance with his requirements.

Pipe Threading Eliminated by Standard Fittings

"TIME OUT" for cutting pipe to exact lengths, threading, grooving, flaring, or screwing up joints in cramped quarters, is not necessary with the standard line of Dresser Style 65 Fittings just announced by the S. R. Dresser Manufacturing Company. Nothing but an ordinary wrench is needed to complete a joint in a few moments.

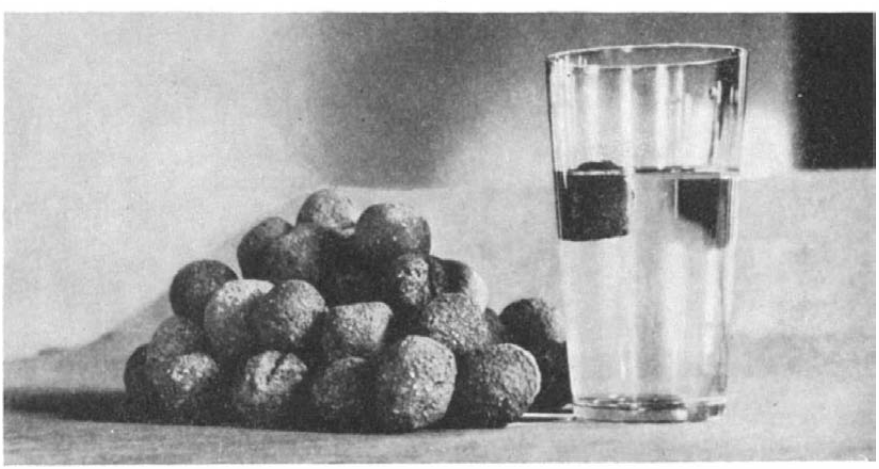
After inserting the plain-end pipe into the fitting, which comes completely assembled, it is only necessary to tighten two threaded octagonal follower nuts with a few quick turns of the wrench. As this is done, resilient "armored" gaskets at each end of the fitting are compressed tightly around the pipe, forming a positive seal. The resulting joint is claimed to be not only permanently tight but to absorb normal vibration, expansion and contraction movement, and permit deflections of the pipe in the joint. If the pipe is already threaded, it can also be joined in the same way.

The complete line of fittings includes standard and extra-long couplings, ells (both 45 degrees and 90 degrees), and tees, all supplied in standard steel pipe sizes from ½-inch to two-inch inside diameter, inclusive, black or galvanized.

These fittings are recommended by the manufacturer for joint-making and repair work on both inside and outside piping, for oil, gas, water, air, or other industrial lines.

Tear Gas as Fumigant

CHLORPICRIN, an effective tear gas used in the World War, is finding increasing use as a disinfectant and fumigant. Methods of application have been developed which make the residue of the material easily removable. Chlorpicrin has been found to kill the clothes louse and its eggs in a half hour when applied to clothing in a galvanized iron container which is slightly



Light-weight concrete aggregate floats in water

The Editors Choose

A Few Outstanding Books That are Informative and Stimulating

1. NEW WAYS IN PHOTOGRAPHY—*By Jacob Deschin.*
The whole range of amateur photographs including such things as trick photography, photomurals, retouching, infra-red, and a number of other divisions that will not be found elsewhere discussed in as clear and concise a manner.—**$2.90** postpaid.

2. SHIPS OF THE WORLD'S BATTLEFLEETS—*Edited by Pay-Lieut. Comdr. E. C. Talbot-Booth, R.N.R.*
Essential facts regarding the principal ships in the navies of the important powers, with details of construction, silhouette drawings, and a large number of photographs.—**$1.65** postpaid.

3. UNSOLVED PROBLEMS OF SCIENCE—*By A. W. Haslett, Cambridge Univ., England.*
Covers those unsolved problems of science which are fully as intriguing as the things science has definitely settled—cosmology, geology, meteorology, anthropology, biology, physics, and mathematics.—**$2.15** postpaid.

4. THE BALANCED DIET—*By Logan Clendening, M.D.*
The widely known author of many medical features and books gives us here an ideal, popular book on diet—ideal because it is not too technical and not too superficial. A good book for most people.—**$1.65** postpaid.

5. FOOD, FITNESS AND FIGURE—*By Jacob Buchstein, M.D.*
A popular treatise on foods, their content and effect in our diet, also on beverages, food fads, vegetarianism, fasting, and weight control. Detailed 14-day diets—**$2.15** postpaid.

6. WHY BE TIRED?—*By Daniel Josselyn.*
Short and to the point, this book should be a tremendous help to all "office athletes"—those sedentary workers who work as strenuously as laborers but do not realize it except that they are usually "dog-tired."—**$1.10** postpaid.

7. FOR STUTTERERS—*By Smiley Blanton, M.D., and Margaret Gray Blanton.*
Said to be the first book to point a way to the recovery of normal speech through the application of well-tried principles of medical psychology and psychoanalysis. What the individual, the parents, and the teacher can do.—**$2.15** postpaid.

8. 1500 NEEDED INVENTIONS—*By Raymond Francis Yates.*
A revised edition of a book published three years ago, expanded to include many additional subjects. Crammed with short, pithy paragraphs describing various desirable inventions in a number of different fields.—**$2.65** postpaid.

9. FUN WITH ELECTRICITY—*By A. Frederick Collins.*
Electric phenomena with directions to perform the experiments that exhibit them. Simply written, this book has proved a source of enjoyment and mental stimulation to mechanically inclined individuals. —**$2.15** postpaid.

10. HOW TO MAKE A GHOST WALK—*By Joseph Dunninger.*
How the so-called psychic mediums perform some of their stunts. Delightfully humorous, it tells how to develop "psychic forces", how to tip tables, produce "spirit" messages on slates, how to read sealed messages, etc.—**$1.15** postpaid.

11. ON YOUR GUARD!—*By Carl Warren, B.S., M.S.J.*
Neither hard-boiled nor cynical, this book on the social diseases is one that both you and your boy should read. It is a practical, definitive discussion of the diseases and how to guard against them.—**$1.15** postpaid.

12. THE ART OF CONVERSATION—*By Milton Wright.*
Inarticulate people will be tremendously helped by the reading of this book by a man who is a brilliant conversationalist. It will help remove that inferiority complex.—**$2.65** postpaid.

13. THE NEW MAGICIAN'S MANUAL—*By Walter B. Gibson.*
Contains over 100 complete and easily followed instructions for tricks of parlor magic. A bound-in envelope contains all the actual apparatus needed for these tricks.—**$3.25** postpaid.

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warmed, using 4 cc. per cubic foot at 80 degrees, Fahrenheit, or higher. A subsequent five minute airing period allows the clothing to be worn at once.

Other uses for chlorpicrin are based on its high toxicity, remarkable penetration, and definite germicidal and fungicidal properties. Its tear-producing qualities are valuable to prevent poisoning of workmen, since even in non-dangerous concentrations it produces floods of tears. It does not affect textiles, furs or colors, and it has no explosion hazards.—*D. H. K.*

BOOTS

BECAUSE boots are being made by a rubber factory in Liverpool, England, for sheep does not mean that the sheep are sissies. According to *Business Week*, they are supposed to protect the animals against "foot rot."

Athletes No More "Red-Blooded" Than Average Men

THE idea that strong men and athletes are more "red-blooded" than the average man may provide good reading in a dime novel but as far as scientific confirmation goes—well, there just isn't any. Nor is there any evidence to support the popular conception that a champion athlete has bigger lungs than the average man. With ordinary-sized lungs, however, he can handle half again as much oxygen as the average man.

Research by Dr. David B. Dill of Harvard's Fatigue Laboratory, reported to the American Association of Physical Anthropologists, shows that hemoglobin, the red coloring matter of blood used for transporting oxygen, is just as concentrated in the arteries of the average man as it is in those of the superman.

Dr. Dill also exploded the myth that man must "alkalize" or stay on the alkaline side. "If we are to believe current advertising slogans," he said, "a considerable fraction of our population is in need of additional alkali. Sodium bicarbonate or more expensive substitutes will open the door to strength and health, we are told. So far as our observations go, well-nourished boys and men seldom need more acid or alkali than is found in their foods. The regulatory function of the lungs and of the kidneys maintains an extraordinary nicety of balance. The capacity appears to be fully developed in the adolescent."—*Science Service.*

Research on Marble

DESPITE the commonly asserted backwardness of the building industry toward research and development, the industry does move forward. Less spectacularly perhaps than others, material manufacturers' researches occur in unsuspected places. The makers of synthetic products would seem to enjoy special advantages here since their product or method of manufacture may be improved in endless ways. But some of man's oldest construction materials, such as lumber and stone, are not made. As handicapped members of an assertedly backward group, producers of such materials should be in an especially difficult research

position. It is therefore refreshing to take note of research concerning one of man's oldest building materials—stone.

The Vermont Marble Company, long skilled in the art of extracting, cutting, and polishing one of nature's more beautiful stones, has accepted the challenge to research concerning the product itself.

Noteworthy is the amount of fundamental research carried on by the company in petrology and the micro-structure of stone. It has been learned that interlocking crystals favor durability, that the size and orientation of the crystals also play a significant rôle. Weathering characteristics are improved when stone cutting is guided by the knowledge of such details. The effect of different fabrication processes is being studied. When and how surface flow occurs in polishing, and the width and distribution of the extremely narrow spaces between the crystals are topics of investigation.

Such research has led to three relatively new products. Newest of these is "Markwa"—marble in tile sizes and form. This development is made possible by the use of new equipment to reduce the cost of thin cutting. The beauty and natural delicacy of these tile seem to promise stern competition to the present tile field.

More intimately concerned with fundamental research is "Lumar," the new translucent marble. This product is an attempt to provide not only a translucent marble but one with high diffusion while still retaining the life and sparkle associated with marble. Here the crystal orientation, composition, size, and spacing are of first importance. The fact that each minute calcite grain has optical properties dependent on direction enormously complicates the problem. As would be expected, most marbles do not conform to the rigid requirements and severe stock selection before cutting is necessary.

Black marbles have not been common in this country and the demand has been met by importation. Through an undisclosed process of interfusion, the Vermont technologists have developed a jet black marble, known commercially as "Jetmar."

These are examples of the way many building material manufacturers are quietly pushing their research. Unfortunately there is still little evidence that those who assemble these materials into buildings have any similar interest in fundamentals. Thus we must still cope with leaky flashings of high-grade metal and poor masonry walls of apparently good mortar and stone. It is the duty of the maker of the stone and mortar to produce a good wall but only other types of wall will force him to do so.

More information may be secured from Mellon Institute, Pittsburgh, Pennsylvania, where the Vermont Marble Company is sustaining broad basic research, resulting so far in the new products described above.

Lightning Hazards in Golf

THE golfer caught in a thunderstorm with its accompanying lightning is no more in danger than are farmers and other persons who make their living in rural communities. Although death by lightning is one of the rarer forms of accident death, the city dwellers of the nation are, as a rule, safer than their agricultural brethren in this respect. For the nation as a whole,

lightning kills less than 400 people a year, based on figures for a 10-year average. The chances of being killed by lightning are only a few parts in a million at the worst. On the Pacific coast they are as low as two in ten million.

Habits in part account for a slightly increased hazard from lightning in the open and the golfer suffers from the common tendency to get out of the rain when a thunderstorm comes. His first impulse is to seek protection from the rain under the nearest large tree. And if the tree is isolated, as it may very well be on a golf course, he is standing under a favored spot for a lightning stroke. If the tree is in a fairly dense woods the chances of it being hit are much less.

If the golf course is fairly level and the golfer is caught in the open without protection he himself forms an isolated target for a possible lightning stroke. If he continues to play in the rain and persists in swinging his steel-shafted golf clubs over his head, he is adding still another small factor to his chances of being struck.

Without protection from a nearby wood or club-house, the golfer in the open would do well to stay in the small depressions on the course and off the higher knolls.

—Science Service

Germicides from Petroleum

IN refining petroleum to make transformer oil, certain complex nitrogen compounds have been recovered. Ordinarily these are left in the tarry oil which is discarded. Recent investigations at the University of Texas show that some of these compounds are efficient germicides. It is possible that within the near future this large waste of petroleum refining may become valuable as a source of pharmaceutically useful materials.—*D. H. K.*

Centuries of Intermarriage

INTERMARRIAGE for several generations is popularly supposed to weaken the stock and produce a race of people physically and mentally degenerate. Evidence to the contrary appears in a report to the American Medical Association of a study of conditions in the small fishing village of Usuki on the coast of western Japan. The inhabitants of this village have strictly kept the custom of intermarriage for hundreds of years.

According to tradition, the village was settled in 1605 by the descendants of a noble family forced to flee in a civil war. The biologic effect of intermarriage has been studied in the village since 1933 by Dr. Takeshi Ikemi. His findings are summarized in the following report:

"There are 135 families having 1786 members in all (904 males and 882 females). They have never mingled with other villagers or townsmen except in business transactions; consequently their habits and customs are quite different from other Japanese.

"Although the children are not regular attendants at school, an investigation of the school records shows that they generally do well at school. Thus intermarriage never affected their intellectual faculties.

"Crime is rare. The sanitary knowledge of the people is meager; they have epidemic diseases, such as dysentery and cholera, but there is never any serious hereditary disease. Leprosy, syphilis, and elephantiasis at present are not seen among them. Neither color blindness nor insanity occurs. The constitution of the people is strong and they are good wrestlers in spite of their taking very simple food. In the physical examination for conscription, these villagers have always ranked first, in that prefecture, with respect to health and constitution.

"Divorce is rare. The birth rate, in comparison with that of the two neighboring villages, shows that intermarriage does not affect the birth rate. Still births are uncommon.

"There are now 27 couples who married cousins."

Information about the offsprings of these couples shows that "when the excellent are married, no bad results are to be found."

—Science Service

SKINS

ONCE 25 cents would purchase a muskrat skin in prime condition, but now they bring two dollars each. Muskrats support a business of 2,000,000 dollars a year in the state of Maryland alone.

Luminous Paint

A NEW luminous paint of Swedish invention, claimed to have a brightness similar to a neon light, will soon be put on the market here. Considerably cheaper to manufacture, the "Swedish Radium Light," as it will be known, is a luminous radioactive paint, which will find wide use for instrument boards, signs, life-saving cabinets, as well as for marking emergency exits. The Swedish Admiralty and the Swedish State Railways are seriously considering its adoption.—*Holger Lundbergh.*

Archeologists and Pot-Collectors, Amateur and Professional

ON previous occasions, this magazine has taken a stand against circumstances which at present permit anyone to excavate for archeological finds and keep the finds. In France and elsewhere in Europe, such finds are rightly regarded as the property of the state—which in this instance means the property of science since the state there acts on behalf of science. We reprint a letter written by Ernst Harms and published in *The New York Times* bearing on this subject, but in doing so we point out that it is not amateur archeologists, as such, which we regard as "out of order," since trained amateurs can do and have done good work in archeology, but amateur and particularly professional "collectors" of irreplaceable archeological artifacts which are detached from their surroundings, sold as mere curios, and thus are lost to science. Mr. Harms' letter:

"I read in *The Times* report of the archeological meeting in Washington that 'Herbert F. Spinden called the mound-building area of the Mississippi Valley the "oldest and richest archeological area in the United States." However, its archeological value,' he noted, 'was being reduced by amateur "pot-hunters," who destroyed valuable cul-

tural deposits in the pursuit of specimens for private collections.'

"The federal government and the individual states have in exemplary fashion taken care of valuable locations through founding parks and special territories. Meanwhile, archeological sites of equal value and far greater irreplaceability are left to the evils of arbitrariness and destruction. Some time ago, for instance, I learned how much damage was being done to the remains in Mimbres Valley, New Mexico. This spot is still of greater archeological value than the mound-buildings, because it is the birthplace of a unique prehistoric group of international importance.

"Laws have been passed in almost all European countries prohibiting amateur or commercial excavation and even providing for the disposition of finds and sites independent of the land owners involved. In several countries the laws go so far as to appropriate all archeological discoveries as state property. Buying and selling are forbidden unless the cultural departments give special permission.

"It is an urgent public need that the United States pass federal and state regulations to protect the archeological documents of America's past."

RAISINS

PURCHASING power of the masses in China is so low that one American company found that it would have to package as few as five raisins in an envelope to capture the lowest unit of Chinese copper currency.

New Cellulose Plastics

A NEW cellulose acetate, triacetyl cellulose, has been shown to have extraordinarily valuable properties as a plastic. Most important of these is the impermeability of a thin film of this material to water. The compound is prepared by the action of acetic anhydride on cellulose and when finished is stabilized by including about 0.02 percent of combined sulfuric acid. Films, foils, and rayon can be prepared without the addition of softening agents and have excellent properties for use in the electrical industries.—*D. H. K.*

Cleaning Sprayed Cherries

ALTHOUGH cherries ordinarily hold less spray residue than other fruits, it is sometimes necessary to clean them before marketing in order to meet the stringent requirements of the law regarding arsenic and lead. The delicacy of cherries requires that the washing process be very carefully conducted to prevent damage in the form of split skins if the fruit is handled wet.

A procedure recommended by the New Jersey Agricultural Experiment Station consists in dipping the cherries already crated in baskets into a solution of 1 percent hydrochloric acid for 30 to 60 seconds and following this acid wash by two rinses in water. The hydrochloric acid solution is prepared by adding three gallons of 20° Beaume acid to 97 gallons of water. This

(*Please turn to page* 52)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

HERE is interesting news. Aluminizing brought one step nearer reach of the average amateur and at least within practical reach of groups. The compact data presented below were prepared by Prof. Henry L. Yeagley of the Department of Physics at the Pennsylvania State College, State College, Pa. For two years he has been teaching mirror making as a part of a college course in descriptive astronomy, is also an amateur telescope maker in his own right, and therefore rightfully belongs to our gang. Figure 1 shows the equipment he has developed, after two years of experimenting with the aim of cheapening the process for the amateur. A small sample mirror he sends us looks fine, yet he says he aluminized it from some pieces from a ten-cent aluminum pan, after merely washing it in Ivory soap and rinsing in distilled water. His description follows:

Figure 2 is a combination photograph drawing of the parts and assembly of an ideal evaporation chamber. The top and bottom consist of 1″ glass plates *I*, strong enough for vacuum chambers up to 14″ in diameter. The ¼″ cylindrical wall *K*

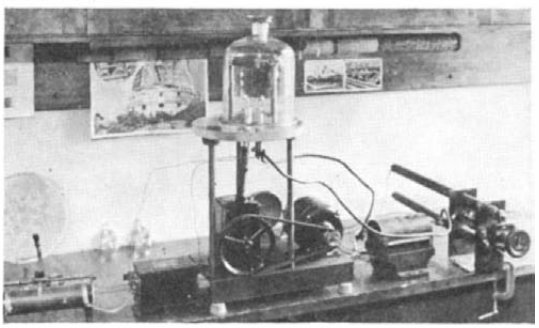


Figure 1: **The complete set-up**

may be of ordinary glass, Pyrex, or metal, such as brass or aluminum. In case metal is used, a concentric cylinder *J* is desirable, to receive the stray aluminum (easily removed with a copper sulfate hydrochloric acid solution). A large bottle with bottom removed, as suggested by John Strong in ATMA, serves adequately for either an inner or outer cylinder. If the outer cylinder is of this type it should be completely covered with a wire screen to prevent injury in case of an implosion.

Holes in the glass base are cut with Carbo and a rotating pipe. The use of these holes for sealing in the electrodes and exhaust port obviates the need for tricky glass-blown seals.

The operations entering into the making of the electrode parts *A*, *B*, *C*, and *D*, are ordinary metal turning, drilling and threading. The lead-in and low voltage connection *A* is turned and threaded to fit into the lower drilled and tapped portion *B*. The L-shaped members *C*, *C*, are bent from ¼″ brass rods and held in place in the drilled holes in the upper part of *B* by set screws. The horizontal portions have 1/16″ holes and are slit lengthwise by a hacksaw. Rings *D*, *D*, with set screws, serve to clamp the filament wires in these jaws.

The exhaust port *F*, preferably of brass, is also made on a lathe. The opening should be at least as large as that entering the Hyvac rotary pump, and the sides of the hole as smooth as possible, to facilitate the passage of air molecules. The metal walls should be at least 1/16″ thick at every point and it is a good idea to cover the outside parts entirely with vacuum wax.

All joints, including metal-to-glass, metal-to-rubber, and glass-to-glass, are joined with vacuum wax, as indicated by cross-section at *L*. The method of applying the wax is shown in Figure 3: an electric soldering iron is held so that the vacuum wax may be melted and guided into place by it. Care should be taken not to flow the wax between surfaces, as in metallic soldering, since this prevents easy separation of the parts later. It is desirable to build up a good backing of wax around the electrodes and exhaust port joints, since they become slightly warm during the high voltage cleanup. This prevents an undesirable flow of the wax into the joint. If leaks are present after evacuation is started, the remedy is always the same; *i. e.*, simply warm the wax joints with the soldering iron until the leak ceases to exist. The writer has always succeeded in quickly healing leaks (which seldom occur) in making some 200 evaporations with this technic.

To open any of the seals the wax is easily scraped away with a wood chisel and penknife. To free the main cylinder entirely, after atmospheric pressure has been restored inside, force more air in through the release valve opening, either with the lungs or a small air pump, and then force a sharp wooden wedge under the cylinder-base plate joint. A slow, steady push is more desirable than strong-arm methods, for obvious reasons. The removed wax may be used over and over again.

The filament is of new, overlapping, adjustable type. The older type helical and sine wave filaments are costly and require hot winding and bending of the tungsten wire. The single V type will largely eliminate these features but often permits the molten aluminum bead to travel up one side and freeze. This effect is due to occasional greater heating on one side of the molten ball, which causes a relatively lower surface tension on that side, permitting it to be pulled up the opposite side in spite of weight.

The filament shown at *E* is somewhat similar to the electrode arrangement in a carbon arc light. Two straight pieces of tungsten wire are clamped in the holders *C*, *D*, so that they overlap 3/16″ at the mid point between the electrodes. Three inches of .04″ aluminum wire are carefully wound on this overlapping portion. When the current is established in the filament, the overlapping portion becomes welded immediately. Because of the greater cross-sectional area, less heat is formed here, resulting in a "cold spot" which causes the molten aluminum to hug this position tenaciously. If the aluminum is all boiled off of the filament after a run, the overlapping tips of tungsten should be sanded on the contacting sides and again sprung together. This is to insure low resistance and keep the local temperature low enough to maintain the aluminum ball in position.

Successive evaporations gradually amalgamate and weaken the tungsten wherever the molten aluminum is in direct contact

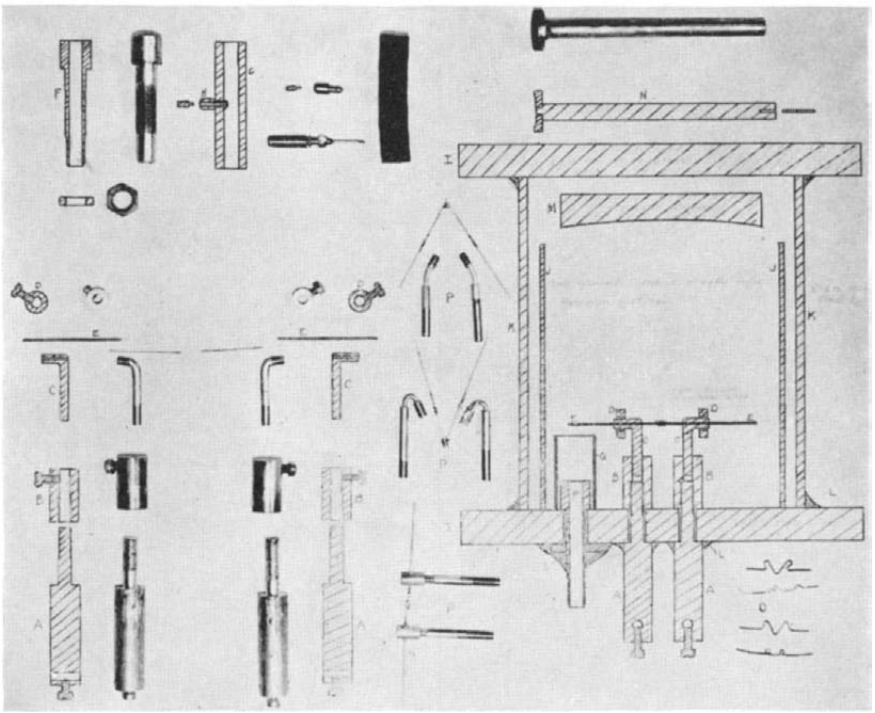


Figure 2: **Cross-section of the evaporation chamber, with parts**

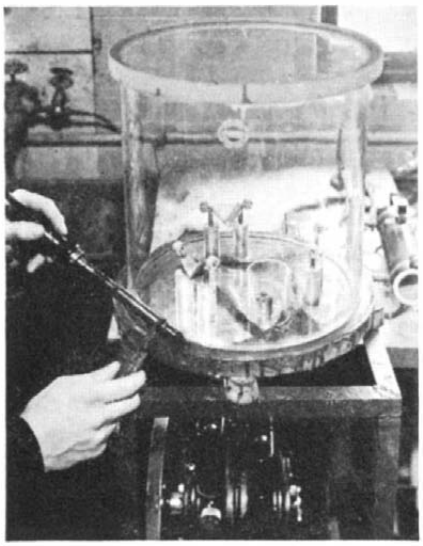


Figure 3: Applying wax

with it. After about 15 runs the filament will break during one of the cooling periods. The break always occurs on one side of the doubled portion, which is removed by breaking off the opposite side with tweezers. The remaining portions of wire are then released and moved toward the middle, to form a new filament. By this means a hundred or more runs may be made with two 3″ pieces of tungsten. With the older types of filament a considerably greater portion of wire must be discarded when they become weakened by amalgamation. (*O* and *P*, Figure 2, may be ignored, being another type once used.)

The release valve *H* began life in the form of a hypodermic needle which was inserted through the rubber connecting tube *G* after each run. The same hole could be used and resealed with wax an indefinite number of times. Although this was an entirely satisfactory method, the valve *H* was evolved to take its place. The small plug, indicated in the illustration, is easily removed, reinserted and sealed as often as necessary. Either the hypodermic needle or brass valve will eliminate the need for costly and troublesome glass stopcocks.

The inverted position is best for aluminum coating small mirrors.

When mounted in the inverted position the mirror may be freed from lint and dust particles with very little danger of further contamination of this type. This insures freedom from "pin holes," provided also that the pre-cleaning by washing has been thorough. This position also eliminates the chance of molten aluminum falling on the mirror and melting a hole in its surface—an extremely remote but possible occurrence. The depth of coat is easily and accurately controlled by observing through the top edge of the disk, when the film becomes opaque.

The surfaces to be coated may be cleaned satisfactorily by scrubbing with Ivory soap and hot water for ten minutes. A soft cotton cloth makes a good wad for this purpose. Subsequent rinsing with distilled water, and firm rubbing with cotton or cotton cloth, assure a surface conditioned to take an extremely adherent coat of aluminum.

A Cenco Hyvac rotary oil pump, connected to the vacuum chamber by a short piece of large diameter rubber pressure tubing, will produce the required low pres-

sure if leaks are absent. About 3″ of ¼″ walled, ⅜″ inside diameter pressure tubing is desirable. The oil in the pump should be renewed after about 15 runs. No. 30 Quaker State Oil is excellent for this work.

The necessary low pressure is indicated when 5000 volts across the exhaust port filament space ceases to produce a visible discharge when viewed in the dark. This latter is true when the distance involved is about 2″ to 5″ or more. The necessary voltage for the above purpose is obtainable with a neon sign transformer.

The heating current for the filament is best obtained by means of a 110-10-volt heavy current transformer. Both of the transformers mentioned require the use of suitable rheostats in the primary sides to vary the impressed voltages.

Sources and costs of materials (costs when purchased, but subject to inflation):

Hyvac Pump. Central Scientific Co., Chicago (price includes motor and base. Pump alone is $50.00 and requires ⅙ H.P. motor), $90.00.

110-5000 volt transformer, No. 721,161-2, Jefferson Electric Co., Chicago (a neon sign transformer is suitable), $6.50.

110-10 volt transformer with secondary current rating of 40 amperes (though lower ratings could be used, since it is all over in so short a time), $6.50.

Rheostat for primary of high volt. trans., Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago (No. 67680-2, 0-1570 ohms, .3 amps.), $6.00.

Carbon rheostat for primary of 10-v. transformer, Chicago Apparatus Co. (No. 67700 carbon compression rheo.), $12.00.

10″ x 10″ x 1″ glass base plate, Pittsburgh Plate Glass Co., Pittsburgh, Pa., (order with unfinished edges), $2.00.

Two pieces tungsten wire 3″ long and .04″ diameter, approx. (.03″ to .06″), General Electric Co., Schenectady, N. Y., .50.

Brass stock: 2′ of ¾″; 1′ of ¼″; 4′ of ½″ and ½′ of 1″ brass rod (estimated), $1.50.

Piece rubber pressure tubing, Chicago Apparatus Co. (1 foot of No. 78880 D, 5/16″ inside diameter, ¼″ walls), 30 cents.

Bell jar, Chicago Apparatus Co. (No. 75640D 8½″ inside diam., 15″ high), $5.50.

Vacuum wax (vacuum sealing compound 94216), Central Scientific Co., 79 Amherst St., Cambridge A Station, Boston, Mass., per can, .70.

Total: $131.50.

Note: This list is only to suggest possible sources of the materials. Most amateur groups will be able to gather all the necessary equipment for a fraction of the amounts listed.

Next month, Prof. Yeagley will give the actual, step-by-step instructions for aluminizing.

HERE are the data on designing Barlow lenses, by Jack Haviland, author of the chapter on O. G. design, in ATMA.

"In designing a Barlow the formula on page 227, ATMA, becomes:

$$f_f = -F \times \frac{V_f - V_c}{V_f}$$

"Since the V figure for crown is larger than that for flint, the numerator of this fraction will be negative which, when multiplied by –F will give a positive result. Thus the flint turns out to be a positive lens.

"Still keeping track of signs and substituting in the formula at the bottom of 226 we get

$$f_c = -F \times \frac{V_c - V_f}{V_c}$$

"$V_c - V_f$ is positive for reasons stated above, so that when this is multiplied by –F the result is negative.

"This is the reverse of what happens in designing a positive objective. The Barlow lens is also used 'backward,' with the flint facing the incident light. Of course it is probably possible to design the lens the other way with the flint negative and the crown positive. The Germans make telescope objectives with the flint leading and positive. Either would have to be reconsidered from the standpoint of spherical aberration, however. But, since we already have empirical data that give suitable corrections for spherical aberration, let's not go into that, just for the fun of turning a lens around.

"Regarding spherical aberration: for incident light, parallel or converging, a convex surface facing the light is best. For diverging light a concave surface is indicated. The general idea back of this is that the above prescriptions lead toward making the deviation a minimum; that is, the bending of the ray at incidence and emergence is more nearly the same at both surfaces.

"A Barlow designed as above will have a slightly convex surface on one side and a concave on the other. Since the flint is the one with the convex surface it is faced to the light to get the best correction for spherical aberration. This is the only reason the flint leads. It is also the reason why the crown leads in a telescope objective.

"Barlows add color, especially with short focus—*f*/8 or less—reflectors. With a long focus reflector or refractor they are not needed to get power with reasonable (⅜″ or longer) eyepieces. So what?"

Figure 4: **R. W. Porter**

Thinking moods of two veterans are shown in Figures 4 and 5. Philip E. Myers of San Diego caught Porter, while R. W. Munn of Pittsfield took the picture of Everest thinking how much work it will be to grind the 20″ Pyrex disk before him.

IN a letter, J. D. Beardsley, of the Washington Instrument Co., present address 1718 I ("eye") St., Washington, D. C., who

is the author of the notes on metal mirrors, ATMA, page 67, says:

"One little point about lead laps. Lead is rather gummy, as you know, and small abraded particles of it will roll up into small balls and lift the mirror off the tool. An ordinary 50-50 solder lap is much better

Figure 5: A. W. Everest

and it would seem that a 90-10 mixture would be better. This incidentally is the composition of Chase 'sweat' solder, a rather expensive item for a large lap, but a thin film can be attached to cast iron if it is first copper plated and then tinned.

"You can suggest to the boys to try chrome green (Cr_2O_3), which has been washed, for polishing metal mirrors. That is the stuff the commercial boys use for buffing; they say that rouge dirties stainless steel. I have used the stuff on crystal quartz and it cuts much faster than rouge. It costs more than rouge but if time is worth anything it is a money saver.

"Dr. Canfield tells me that substituting nickel for copper in speculum metal gives a very elegant substance free from the reddish tinge of the copper alloys."

OLD settlings from local eyeglass opticians' shops contain rouge that has already been worked down and, after proper washing, will not scratch. Often the owners are glad to be rid of it. This tip recently reached us from Dr. S. H. Sheib of Richmond, a contributor to ATMA, just before his unfortunate death from pneumonia, late in April. We should not have said, "will not scratch," but "should not scratch."

IN ATMA, Clark tells how to make an optician's spindle, and now a dealer's descriptive literature on a factory-built vertical spindle reaches us. Price, only $245! Most TN's will make Clark's kind, instead!

IT seems that we have erroneously "promoted" Dr. Gaviola, author of the chapter in ATMA beginning on page 76, to be director of the great observatory at La Plata, Argentina, giving him that title in the by-line at the head of that chapter. Modestly he now "resigns," saying there is a director already, and asks readers to cross off the word "Director" after his name.

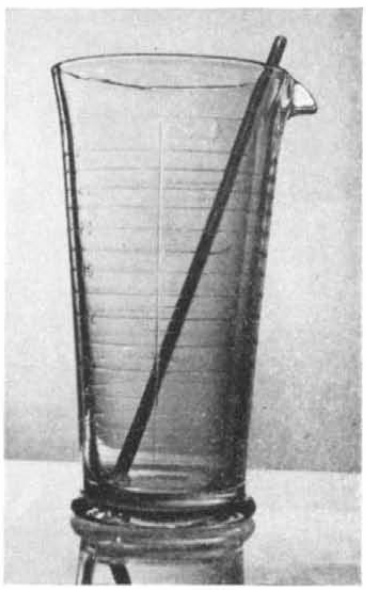
TWELFTH annual powwow of amateurs will be held at *Stellafane*, Saturday, August 14. Porter is expected. So are you.

CAMERA ANGLES

Conducted by JACOB DESCHIN

Photographing Glass

PROBABLY the chief reason for the failure of many amateurs in their attempts to photograph glass subjects lies in improper lighting. Once the problem involved is thoroughly understood, this subject should offer no further difficulty. The problem is simply this: Glass, like water or a mirror, is a strong reflector of light. Throw a light upon it from the front and the pic-



"Graduate"

ture is lost. To illustrate: we once had occasion to photograph a radio set with glass covered dials, and were obliged, unfortunately, to work with flash bulbs. Had regular lamps been used, we would have spotted trouble immediately, but as it was we simply blazed away with the flash bulb reflector attached to the camera, in the manner of the synchronized flash "gun." When the negative was developed, we found that one of the dials was completely obliterated. In place of the dial the negative showed a dense black ring which was represented in the print by blank white paper. The next time we were called upon to use flash bulbs in a similar case—not a radio set this time but a pretty lady looking through a glass case containing a pair of chemist's scales—we knew better and, removing the "gun" from the camera, slanted the reflector at an angle so that the light swept across the face of the glass at an angle instead of hitting it head on.

This is one phase of glass photography. Here is another. As if to counteract its tendency to throw back glaring splotches of light when attempts are made to illuminate it from the front, glass has the great, perhaps unique advantage that because it is transparent it is often possible to light it for photographic purposes entirely by transmitted light, in the same manner as one views a transparency. For the best results, however, this light ordinarily should not be sent directly from the source but by way of a reflecting background. That is, the light should be trained on the background, which should, of course, be of a bright enough tone to reflect light through the glass subject being photographed. All three photographs illustrating this discussion were made in this manner. It is a method which ought to prove very successful in the photography of laboratory apparatus, glass vases, glass bottles, and similar subjects.

Although the general lighting scheme was based on the same basic maneuver of transmitted light, the procedure in each case was a little different. In "Still Life" the only light used was that reflected from the gray felt background. Of course, in the case of a glass bottle partly filled with a dark liquid, it may sometimes be found necessary to provide illumination from the front to get

"Brilliance"

shadow detail in the dark portion of the subject. When lighting from in front of the subject is required, the illuminant should be thoroughly diffused. A polarization filter will practically eliminate all glare and reflection. This filter is used in the regular filter mount and placed over the lens. In "Graduate" the subject was placed on a sheet of plain glass which was elevated a distance of about six inches from the table. A white blotter was placed on the table under the glass. A light was directed at the

"Still Life"

background, as in "Still Life" and another light (a spotlight, to narrow the circumference of the beam) illuminated the blotter. Thus, reflected light was sent through the glass from two directions. In "Brilliance" the light was sent directly through the glasses, resulting in a series of shadow patterns and soft highlights.

Negative Viewer

DESIGNED to facilitate the selection of miniature negatives or motion-picture frames to determine their suitability for enlargement, the recently introduced Bee Bee Film Negative Viewer is said to do the job to perfection. The instrument has a lens at one end of a tube and a groove at the far end for the insertion of the negative. The lens gives a magnification of four times, the focusing tube is of polished nickeled metal and the slides are of black enamel. While intended primarily for use with 35-mm negatives, additional grooved slides are available to take 16-mm and 8-mm motion-picture frames.

"Draftsmanship"

A FEW characteristic tools of the trade, an angle view, and the light at a slant to throw long shadows, and we have a picture symbolic of the draftsman's work. Most trades and professions lend themselves to similar treatment. The accessories chosen for arranging the set-up should have significance, the lighting planned for a dramatic effect, and the general composition so disposed that the essence and spirit of the trade or profession symbolized is apparent.

Filter Wallet

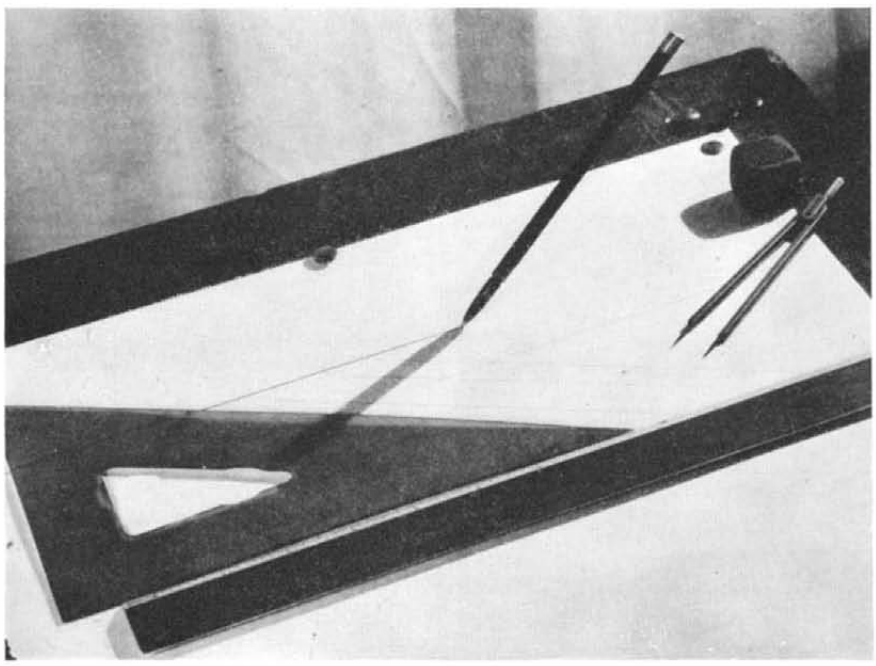
A FILTER wallet that accommodates as many as five filters and a holder, and when folded fits snugly into the vest pocket, is now available. The wallet is made of imitation leather and consists of four pockets, each one holding an unmounted glass filter in any of the various tints and in sizes 25, 31, and 39 mm. There is also a larger pocket which takes the holder. The whole outfit folds up quickly and safely and is held together with a snap.

M. I. T. Goes Pictorial

PROVING that their interest in photography is not exclusively technical, the students and faculty members at the Massachusetts Institute of Technology recently held a photographic exhibition in which they displayed a preference in off-hours for the pictorial rather than the technical in photography. The show was held under the auspices of the Faculty Club and included work done, in the main, with miniature cameras, though users of simple box cameras also won recognition. The response to the exhibit, following two similar ones held last year, was so great that it has been decided to hold an annual spring competition, during which prizes will be awarded for outstanding prints in various classifications.

Super Plenachrome

INCREASED speed in an orthochromatic film is offered by Agfa Ansco Corporation in its newest addition to a famous line of roll films made for amateur use—Super Plenachrome. In addition to greater speed, the makers say, the new orthochromatic film possesses higher color sensitivity, improved brilliance, and extreme latitude. The new



"Draftsmanship"

film is protected against unsharpness due to halation and is provided with a special surface coating to prevent scratches in handling.

"Star Performer"

NOT all "performance" photographs are taken in the theater. The pet-shop window or the zoo also offer unusual opportunities in this field, with the added advantage

"Star Performer"

that the lighting is that of the sun, at least in many instances. When the picture "Star Performer" was taken, we were not the only ones blazing away. There were at least a dozen others in the vicinity all doing the same thing; most of them using miniature cameras, by the way. And no wonder, for the sea lion is a wonderful entertainer.

Fellowship for Weston

PHOTOGRAPHY in recent years has spread its influence into so many fields that one might almost call it the universal occupation of mankind, whether vocationally or avocationally. A little while ago we learned, not altogether in surprise though with considerable pleasure, that Edward Weston, of the Pacific Coast, who is probably as famous for his sand dunes, halved cabbages, and other studies in sharp texture as Steichen is in his field, has been awarded a Guggenheim Fellowship to make a series of photographic studies of the West. There's something to look forward to. Whatever other qualities they will contain, we can be sure that they will be technically perfect, that a large view camera will be used, that all the pictures will be contact—as befits a member of the F:64 Club, that group of exponents of "pure photography"—and that everything in the picture will be sharp, clear, and clean-cut, both as to definition and contrast.

Flexible Tripod

EXTREME versatility was the aim of the designer in perfecting a small tripod now available called the Flex-a-Pod. Besides its use in table-top photography, its special construction makes it useful also in making shots from the floor, in macrophotography, in copying and in amateur movies, for tilt-

ing, in the creation of animated cartoons, and in general photographic work. A tilting and panoramic device is also provided. The Flex-a-Pod may be lowered to a height of only 1½ inches or raised to 7½ inches by using one extension rod, or 12 inches with two. The tilting and panoramic attachment may be removed and fitted on one's regular tripod.

Single Lens Stereo-Photography

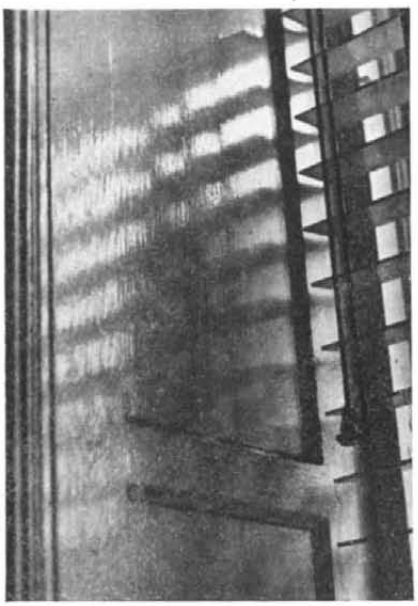
WE are all familiar with the trick of getting a stereo-photograph by shifting the camera for the second exposure about 2½ to 3 inches after making the first exposure, but ordinarily it is done either on a tripod or some other support, in which the distance is accurately measured. However, we recently learned of one man who uses no tripod at all, but a trained sense of the correct distance to shift while holding the camera in his hands. After making the first exposure, he extends the right leg to the right, and moves his head—while holding the camera (a Contax) to his eye—approximately the distance called for in stereo work.

Champion Salon Exhibitor

DEVER TIMMONS, A.R.P.S., of Coshocton, Ohio, whose "Fevrier," a chlorobromide, you may have had the pleasure of seeing at one of the photographic exhibitions, is reputed to be the world's most active exhibitor. The authority for this is "Who's Who in Pictorial Photography," published annually in the "American Annual of Photography," and the fact on which it is based is that during the year ending July 1, 1936, Mr. Timmons had a total of 364 prints on exhibition in 67 American and foreign competitive salons. No, Mr. Timmons is not a professional photographer but an enthusiastic amateur whose livelihood comes not from pictures but from the manufacture of chemicals.

"Afternoon Shadows"

THE glossy paint on the window casing and the ribbons of alternating light and shadow constitute the attractions that in-



"Afternoon Shadows"

duced the photographer of "Afternoon Shadows" to aim his lens. He used a reflex camera (which was ideal for the angle and the composition of the subject) and gave an exposure of one second at F:5.6 on medium speed panchromatic film.

Hamlet's Ghost and the "Candid"

THE fame—or notoriety—of the American candid camera "fiend" has crossed the ocean to England with the recent departure from these shores of John Gielgud, who made a considerable impression in his rôle of Hamlet in a New York City theater. In talking to his countrymen about New York recently, he told his London listeners that while he thought New York "a grand place to work" there was "one new habit" which he loathed.

"The latest fashion," he said, "is to take a miniature camera to the theater and spend all your time taking snapshots of the performance. It got on my nerves. There were never fewer than four of these camera fiends in stalls.

"All the time I was trying to create the atmosphere of ghost scenes at the beginning of the play I would keep hearing the click, click, click of cameras."

A sad state of affairs, indeed, but we are sure that by this time Mr. Gielgud must have discovered the "habit" of theater snapshooting is as prevalent in England as it is in America and that, moreover, where the "candid" camera is concerned the whole world is kin.

Double Exposure

WE admit it. It was a mistake. But what's the difference? Don't you think it's good, just the same? Here's the alibi: We were trying out a new 35-mm miniature camera with a semi-automatic film-changing device and forgot to change the film. We had made a shot while walking in the park and the next time we used the camera it was to photograph a ballet dancer. "Mirage" was the result.

Enlarging Exposure Meter

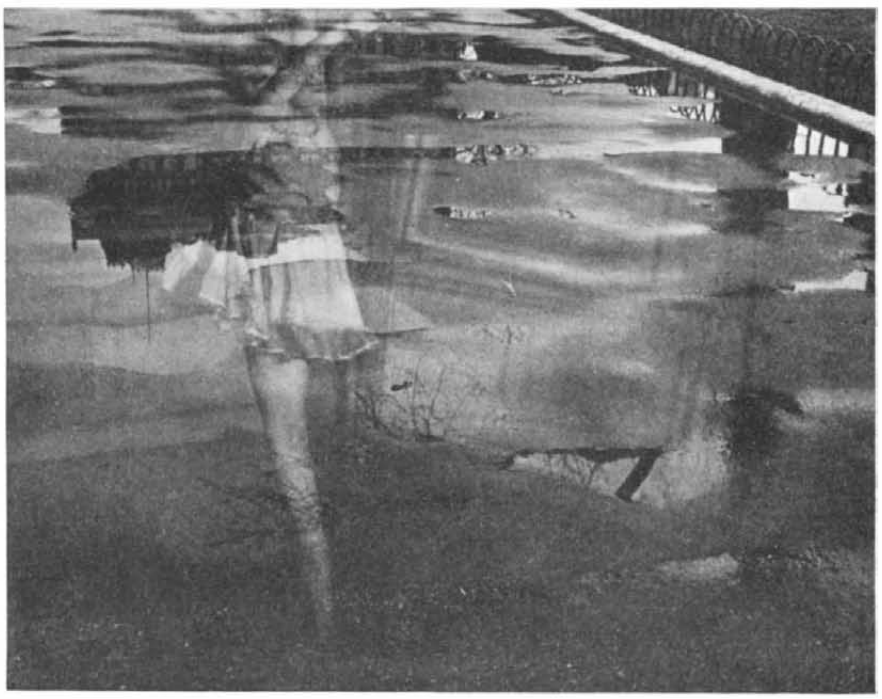
CONVENIENCE and accuracy in determining proper exposure on different contrasts of enlarging papers for negatives of varying densities is assured by a new exposure meter for this purpose called the Lios Grandoscope. Pipe-shaped in appearance, the device is furnished with an eyepiece at the end of a focusing tube which slides into a longer tube, the latter fitting into the "pipe" shaped end which contains the translucent glass screen by which the exposure is read. The field of the Grandoscope contains a series of numbers and the last visible number seen is the key to the required exposure.

Prices Coming Down

REPORTS from two reliable sources, relayed to this department, indicate that as the result of negotiations in Germany by American importers of cameras and accessories, some favorable concessions in connection with the exchange value of the German mark have been made, thus enabling importers to bring the prices of imported cameras considerably lower. The reduction is said to be as high as 15 percent in some cases. We may, therefore, look to a general downward revision of camera prices all along the line. This will be welcome news to many who have felt that the prices of some of the higher-priced outfits ran too high, and should furnish an additional stimulus to the already thoroughly stimulated activity of supplying camera hobbyists with tools to work with.

Legislating Miniature Cameras

THE way of the candid picture hunter is hard. When he was few in number, and timid to boot, nobody gave him much thought. He could shoot in theaters, in restaurants, in the subways, and he could do it in such a way that no one was the wiser. But now he is great in number, he is everywhere, and he fools no one any



"Mirage"

longer. Also, he sometimes turns out pictures that are much too candid to suit the subjects themselves. So his wings are being considerably clipped on all sides. Two such clippings are reported by *Leica Photography*, one being a campaign by movie stars and prominent people in Hollywood to bar miniature cameras from the resorts and amusement places they frequent because of the often unflattering results of the pictures produced and published, and the other a move in the State of Missouri to enact a statute requiring the licensing of miniature cameras.

While disapproving of these moves as being practically "a ban on the freedom of speech," *Leica Photography* adds, however, that "the resentment of famous movie stars or other prominent people is justified in some cases, for publication of certain candid pictures would be injurious to them."

"Our friends," the magazine continues, "will even take offense at our actions if we continually thrust cameras unexpectedly into their faces and later 'proudly' present them with pictures which, to phrase it mildly, are unflattering. On many occasions it may be wise for candid photographers to use discretion in displaying or publishing some of their candid pictures."

Picture Market

IF you are interested in making some money with your camera, a new market has recently opened that will consider your products if you will take the trouble to offer them. It is The Salon Photographique, 1619 Broadway, New York City, and Miss Gladys Hutchins is the one to write to. Miss Hutchins announces she has started this Salon to act "as the authorized representative of photographers in every classification of still photography" and that her "compensation will be on a commission basis."

Paper-Wrinkling Distortions

A NEW method of creating caricature effects under the enlarger was recently described in *The New York World-Telegram* by Mario Scacheri, staff photographer. After discussing the more familiar method of tilting the easel vertically and horizontally, Mr. Scacheri describes paper-wrinkling or buckling:

"Find an old print that you do not value," he writes, "and work with the plain white, reverse side. Tack the upper corners to a board. Then turn on the light in the enlarger and push some bulges into the paper. Experiment until these bulges come where they do the most good. They can be straight across, or slanting, but they should lengthen the nose, give a pinhead effect to the cranium, or paint the lily in some other interesting way. The higher the bulge the greater the distortion, and also the greater difficulty in printing.

"When you have the right effect, substitute a sheet of bromide paper for the blank. Turn on the red light of the enlarger, buckle up the paper as desired, and hold the bulges in place with thumb tacks along the edges. You have already got your focus, at full opening, while monkeying with the blank paper. Close the lens down to F:11, and give twice as much time as you would if you had closed it to F:8."

THE SCIENTIFIC AMERICAN DIGEST

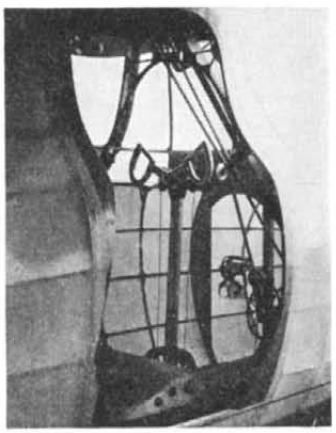
(*Continued from page* 41)

solution is kept in wooden tubs used for the treatment and is too dilute to harm or discolor the crate or baskets containing the cherries.

The legal requirements are that the maximum amount of arsenic on fruit shall be less than 0.010 grains of arsenic trioxide per pound of fruit, not more than 0.018 grains of lead per pound, and less than 0.010 grains of fluorine per pound. Cherries ordinarily fall below these limits but the washing process suggested above brings them well within legal requirements without injury.—*D. H. K.*

True Human Flight

THE Italian Government has offered a prize of 5000 dollars to the man who first succeeds in making a flight with the unaided power of his muscles over a two-kilometer closed course and who reaches an altitude of 15 feet during the flight. The Germans have also offered a prize, written some excellent rules, published some scientific memoirs, and made accurate preliminary tests of a purely laboratory character. An American citizen, Enea Bossi, a member of the Budd Manufacturing Company, has gone ahead in more direct fashion and built a glider, propelled by two chain driven airscrews. With this man-powered glider a flight of ⅝ of a mile has been achieved in Milan, Italy.



Above: **Interior of the foot-propelled aircraft, showing pedals and controls.** ***Below:*** **A view of the glider on one of its trial flights held in Milan, Italy**

Mr. Bossi holds the second pilot's license issued in Italy, and has had vast experience in the construction of aircraft of various types, particularly those using stainless steel. Accordingly, while he regards this latest venture purely as a hobby, he has developed this novel machine in the most approved engineering style.

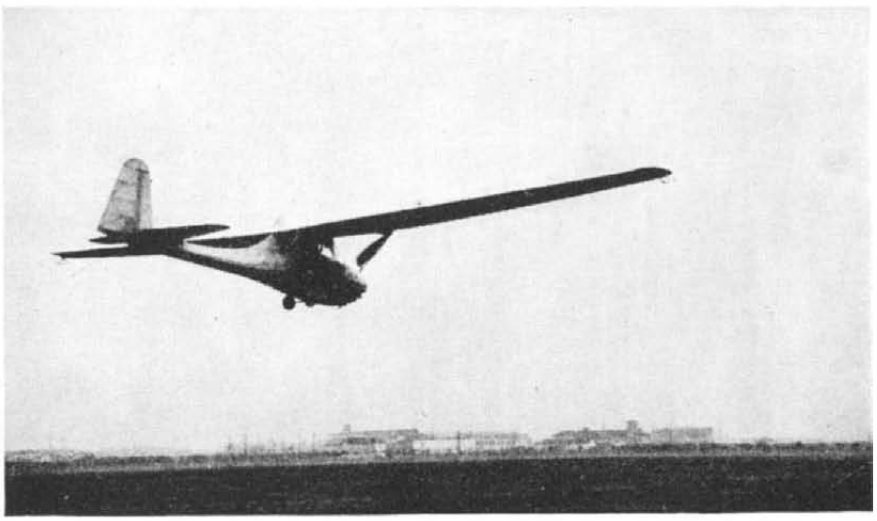
First he towed a light primary glider behind a bicycle, and made seven consecutive tests for a distance of about 1400 feet each. Some help was given to the cyclist and to the glider at the start; the glider took off and flew several times for distances of between 150 and 300 feet. This gave Mr. Bossi the assurance that with a better streamlined glider, with a little more wing area, flight could have been continuously maintained.

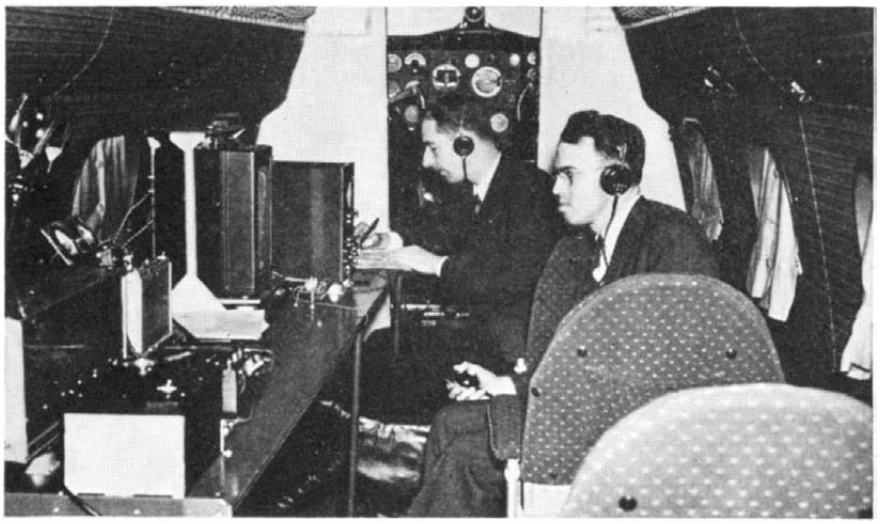
His next test consisted of removing the chain from a bicycle and equipping it with a propeller 6½ feet in diameter, rotated by means of gear and chains through the usual pedaling system. With this propeller Mr. Bossi obtained the truly remarkable speed (on the ground, of course) of 25½ miles an hour, for a distance of one kilometer.

In a third test, Mr. Bossi was towed on a bicycle behind an automobile, with a spring scale in the rubber cord towing line. This indicated that at 21.8 miles an hour, a pull of 16 pounds and a horsepower of .92 were necessary.

This preliminary scientific work taught Mr. Bossi a great deal. He deduced that the average man could deliver enough power to the airscrew to pull a glider through the air at about 20 miles an hour and that the gyroscopic effect of the large propeller was very troublesome, so that two airscrews rotating in opposite directions should be used. In general he established sufficient data for his final design. The propeller was designed with particular care, with the blade systematically varied from hub to tip. The maximum pull of the airscrew at rest was 19.8 pounds—during a continuous man-effort of 10 minutes the pull was 13.2 pounds. It was found that the most efficient pedaling speed was 60 revolutions per minute, allowing the screws to turn up 170 r.p.m.

The interior of the streamlined cabin of the glider, with the pedaling and chain and gear arrangements, is shown in one of our photographs. Another photograph in-





Above: **Equipment in the flying radio laboratory.** *Below:* **Two of the four types of experimental aerials**

dicates the general appearance of the bicycle glider in flight.

Mr. Bossi has kindly given us the following main dimensions of his design: Wing spread, 51 feet; length, 20.2 feet; height, 6.6 feet; total wing surface, 215 square feet; airfoil, N.A.C.A. 0012; propeller diameter, 6.4 feet; number of propellers, 2; number of revolutions in flight at maximum short effort, 200; number of revolutions at normal effort in flight, 170; weight empty, 198 pounds; weight of pilot, 172 pounds; total weight, 370 pounds.

It is rather hard to gain speed from a dead start before the airscrews have bitten into the air, so to speak, and in all probability a landing wheel will be provided in the future to be connected at will with the pedaling system. Another possible development is to allow the airscrew under favorable conditions to wind up a shock cord, thus storing energy for subsequent use.

At present, of course, the craft is only a scientific curiosity. But we must remember one thing. A skilled glider pilot can, using thermal currents, stay up almost indefinitely and fly cross-country for a distance of, say, 150 miles. Imagine such a pilot being able to keep going with his pedals when the thermal currents or other up-gusts give out temporarily. Obviously he will then be able to keep going much more readily and also determine his direction much better than when he has to rely on his skill and favorable air currents alone.

What an absolutely fascinating sport is just in the offing!—*A. K.*

Radio Laboratories in Flight

THE great airlines are making constant experiments with aircraft radio, and are converting their ships into veritable laboratories. Thus in one of our photographs two radio technicians of United Air Lines are shown at work in a passenger cabin in which upholstered chairs have been replaced by a test stand with delicate recording devices. The flying laboratory is equipped with a number of special measuring instruments to record electrical charges of clouds through which the plane will fly on test flights. A new type of de-icing equipment will eliminate possible ice static. Four special anti-static antennas have been developed by United and will be subjected to rigorous investigation. They include the tear-drop shaped device mounted on top of the fuselage (as shown in another photograph); the ring type projecting from the nose of the fuselage; a rotatable ring under the belly of the ship; and a fourth type installed inside the fuselage. The thin shafts projecting downward from the nose and from the side are "lightning rods," designed to discharge static collected by the metal skin of the transport. Nothing is so important from a safety point of view as these experiments in aircraft radio.—*A. K.*

A Wealth of Aviation Literature

NO member of the public who seeks accurate but interesting information on modern aviation need complain to-day. It is a pleasure to see the authentic, fascinating, beautifully illustrated books that have recently come off the press. We have three books particularly in mind, each excellent in its kind.

"Once to Every Pilot," by Captain Frank Hawks, is written by a famous aviator, who has himself experienced many adventures, knows flying from every possible angle, and is a "pal" of everyone of note in the brilliant and friendly band of adven-

turous pilots. In Captain Hawks' entrancing book we meet them all, and at the most hazardous instants of their lives. Eddie Allen, the test pilot, "lands on a cloud" and brings a new ship to earth after the most trying maneuvers. Jimmie Mattern, flying 'round the world, is lost flying the Atlantic, gobbled up in Siberia—apparently—and it is many weeks before the world finds him. Casey Jones relates how he almost lost Gene Tunney when flying to the famous Dempsey-Tunney fight. Rickenbacker, Jimmy Doolittle, George Vaughn, and many others . . . we meet them all within the covers of one beautiful volume. It is all very well to say that flying should now be a matter of cold efficiency; these stories still thrill us.

"Your Wings," by Assen Jordanoff, combines perfect illustrations by Frank Carlson, and tabloid simplicity with real accuracy in imparting the elements of flying, the art of aerobatics, the fundamental principles of navigation, the elements of meteorology, and so on. Here is an absolutely painless yet reliable method of grasping the fundamentals of flying.

Last but not least is "The Wonder Book of the Air," by C. B. Allen, Aviation Editor of *The New York Herald Tribune*, and Lauren D. Lyman of *The New York Times*. These men have seen everything, known everybody in aviation. They have produced an admirable popular semi-historical, semi-informative book on aviation. Early History, Flights Round the World, Why an Airplane Flies, In the Pilot's Cabin, Flying Phraseology, and Sky Slang, are the names of representative chapters. A splendid treat for any boy keen on aviation from the age of 12 to 72.—*A. K.*

FOOD

LIGHT lunches served on commercial airplanes might seem to be a small item. However, the food bill of 11 commercial airlines that serve meals on planes was close to half a million dollars in 1936.

AMERICAN AND BRITISH AIRCRAFT ANNUALS

AS it so happened, we received on the same day the Aircraft Year Book for 1937 of the Aeronautical Chamber of Commerce of America, and the Air Annual of the British Empire for 1937. For any one who wishes to obtain a comprehensive view of the marvelous strides being made by aviation, nothing better than either of these two publications can be found. Even the man professionally interested in aircraft development and constantly following technical publications in this field will find much to instruct and even to amaze him. For the layman they may be as thrilling as a best seller.

An adequate review of these books is almost impossible with the space at our disposal. The British Annual will probably have more reward for one seeking novelty, since the advances of less familiar foreign practice are recorded. Thus in the United States the Goodrich Overshoes, which move out under pressure and force ice from the wings, have become so familiar that we can scarcely conceive of any other device that would do the job. But the British have quite another method. Their plan is to force ethylene glycol slowly through leather strips extending along the leading edges of the wings. This depresses the freezing point of the super-cooled moisture striking the surface and prevents solidification.

Another point of difference lies in the policies adopted in the procurement of new designs. In the United States, constructors who wish to obtain contracts for military aircraft must build prototypes entirely at their own risk and expense, and take their chances in a competition. Under stress of the re-armament program, the British Air Ministry now has adopted the policy of ordering aircraft "off the drawing board." In the past the policy has been to go through the sequence of mock-up, experimental prototype, a development contract, and finally the production contract, a process which took anything up to four years. "Off the drawing board," the development of a new service type may take only a little over a year. Not only would the adoption of a similar policy in the United States be infinitely fairer to constructors, but it would help us to keep ahead of foreign developments in fighting planes. Such a happy result might more than compensate for the possible waste in ordering a ship or two that might prove to be failures.

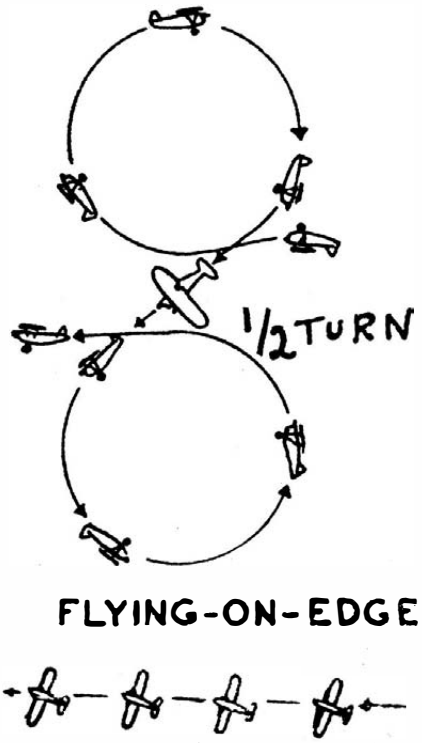
There is another tendency in Air Ministry work which we might well reflect upon. Our policy is to check everything, particularly stress calculations, in the various bureaus—Navy Bureau of Aeronautics, Matériel Division of the Army Air Corps, Air Commerce Bureau of the Department of Commerce. The aircraft designer and constructor is, of course, a child in knowledge and skill compared with the officials! The British are adopting a far more reasonable attitude. While the Air Ministry still reserves the right to check the strength and safety of aircraft, the manufacturer assumes a far greater burden of responsibility. This is precisely as it should be. The less an industry is kept in swaddling clothes, the more rapid will be its progress. We do not remember that government bureaus helped the American automobile to its present wonderful stage of development!—*A. K.*

AEROBATIC COMPETITION

TO revive and intensify public interest in air racing, the St. Louis Air Race Association recently held, among other events, an "Aerobatic Competition" under the sanction of the National Aeronautic Association. Such contests have often been held in Europe, but are new to the United States. The rules of the competition take a little understanding. There was an elimination and a final contest, each of ten minutes' duration.

For each maneuver there was allotted a coefficient of difficulty, from 1 to 10; and a proficiency rating from 0 to 5. Thus an outside loop had a coefficient of difficulty of 4, and if the judges gave a perfect rating, the contestant would have scored 20. The judges' ratings were averaged for each stunt executed. The judges included such authorities as Jimmy Doolittle and Al Williams, and since the stunts were executed at less than 1500 feet above the ground, there was no difficulty in scoring.

We did not know that there were 84 different stunts in existence, but there are. A spin is so easy that it only has a coefficient



Two daring aerobatic maneuvers described in the accompanying note

of difficulty of 1. A loop is such child's play that it only rates a coefficient of difficulty of 1. The same low or slightly higher ratings apply to a variety of stunts which once upon a time were considered marvels of the flying art. What then do these airmen now consider difficult? The double loop shown in the sketch *does* rate 10. The pilot enters into an outside loop in an inverted position, performs an outside loop, then rolls his machine over and makes another outside loop lower down, and finally comes out in horizontal flight. If asked to perform this maneuver, we would give it a coefficient of difficulty not of 10, but of ten thousand! "Flying on edge" rates just 4; another name for this is "vertically banked flying." There were also Immelman turns, flick half rolls, inverted spins; vertical 8's of inverted position, and so on.

What is the effect on the public of such stunting done comparatively near the ground? They get a thrill while the performance lasts. Afterwards their feeling of safety in the air is apparently increased. Inquiring Reporter Swanee Taylor, at one of the air races, investigated this very point. A colored man told him: "Why, after seeing them stunts, a trolley car would be no safer to me than an airplane."—*A. K.*

No More Landing Gears?

WE have had occasion to report in these columns the "belly" landings made by Beechcraft planes, with retracted landing gear. [February, 1937, page 108. *Ed.*] Such landings were either a matter of sheer necessity or in the nature of a stunt. Now rumors reach us, from well informed sources, that somewhere in the Middle West, "belly" landings, on ships without any landing gear, are being made successfully, time and time again. The fuselages of the airplanes used in these experiments are themselves provided with shock-absorbing elements on their undersides. On the field where the experiments are being carried on, a movable track is shifted around by a powerful tractor. The movable track is designed somewhat on the principle of the escalator, and planes are shot off the track as if catapulted. On alighting, they move against the motion of the track and are brought to rest in a very short distance.

If these experiments demonstrate full practicability, we may see the landing gear disappear completely. After all, the engineers go to great pains to design retractable gears, with additional complexity and weight, and these gears are used for only a small fraction of the flying time. What a step forward it would be in performance or at least in greater payload if they could be dispensed with completely.—*A. K.*

Elastic Umbrella

A NEW umbrella with a replaceable cover offers new convenience to travelers and shoppers. A telescopic frame in which both the ribs and the handle telescope is covered by an elastic cover made from latex. This cover is highly elastic and can be attached to the frame readily by hooks fastened to a fabric tape around its edge. The tape not only serves as a means for attaching the cover to the frame, but at the same time holds the opened ribs in position. The umbrella folds into small compass and, by an ingenious arrangement of telescoping the ribs, opens to full size with no more effort on the part of the user than that required to open an ordinary fabric umbrella. —*D. H. K.*

Not Necessary to Stop Reading to Rest Eyes

READ when, where, and how you like, but insist on sufficient illumination, use glasses if glasses are necessary, and have a periodic eye examination every two or three years. This is the fundamental principle for the care of the eyes, declares Dr. Theodore L. Terry, instructor in ophthalmology at the Harvard Medical School.

Do not try to save your vision by avoiding reading, sewing, or the movies, he advised, because eyes do not wear out. It is disease, he declared, that destroys vision.—*Science Service.*

Comfort for Alligators

HUNDREDS of miles of electric soil-heating cable have been buried in the ground for such ordinary agricultural purposes as supplying heat for hot beds, cold frames, propagating benches, germinators, and other horticultural applications. Now, in the Brookfield Zoo at Chicago, 600 feet of the cable is being used to warm the feet of alligators and turtles.

Zoo Director Edward Bean noticed that the reptiles were sluggish during the cold weather, even though the thermometers indicated comfortable room temperatures. The 'gators and turtles moved so slowly they hardly seemed alive; they did not care to eat; they avoided the sand in the reptile house. Director Bean found that the sand was too cold for comfort, so far as the reptiles were concerned. He then installed 600 feet of General Electric soil-heating cable, and thereupon the inhabitants of the reptile house resumed normal activities.

The flexible, lead-sheathed cable has had

numerous unexpected applications. Aquaria and lily ponds containing delicate tropical fish or rare plants that cannot withstand chilled water have been protected with lengths of the cable. Floors in buildings are being kept warm and dry with it. Other installations of such cable are supplying low heat to liquid products in pipe lines. Industrial applications have included immersion heating for miscellaneous storage, treating, and manufacturing processes in such varied places as glass, chemical, and soap factories. Poultry brooders are being kept warm with the cable, thermostatically controlled; downspouts and gutters of homes and other buildings are kept from being ice-clogged.

TITANIUM MAKES PAPER OPAQUE

BECAUSE its index of refraction is much higher than that of the vehicle of printing ink, titanium oxide added in small amounts to paper makes even thin papers opaque and prevents printed matter from showing through from the other side. In this respect titanium pigments are superior to others used in sizing and finishing paper stock. The opacity of a 16-pound rag-content paper is increased from 74 percent to 86 percent by the addition of 3.8 percent titanium oxide. This difference is especially important in making papers for modern books of 1000 pages or more to be bound in a single volume, since without this added opacity reading is extremely difficult.—*D. H. K.*

TESTING MACHINE DEFEATS COINERS

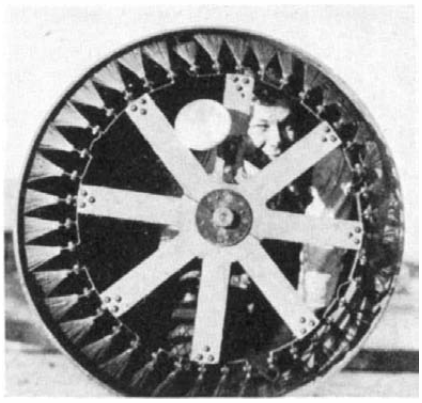
COUNTERFEITERS' Enemy No. 1, the invention of a Sydney, Australia, engineer, R. J. Lyttle, is now at work for the first time. It has been installed at the Commonwealth Bank, where it is handling 1000 coins every 3½ minutes, counting them, bagging them, and decisively and unfailingly rejecting "duds."

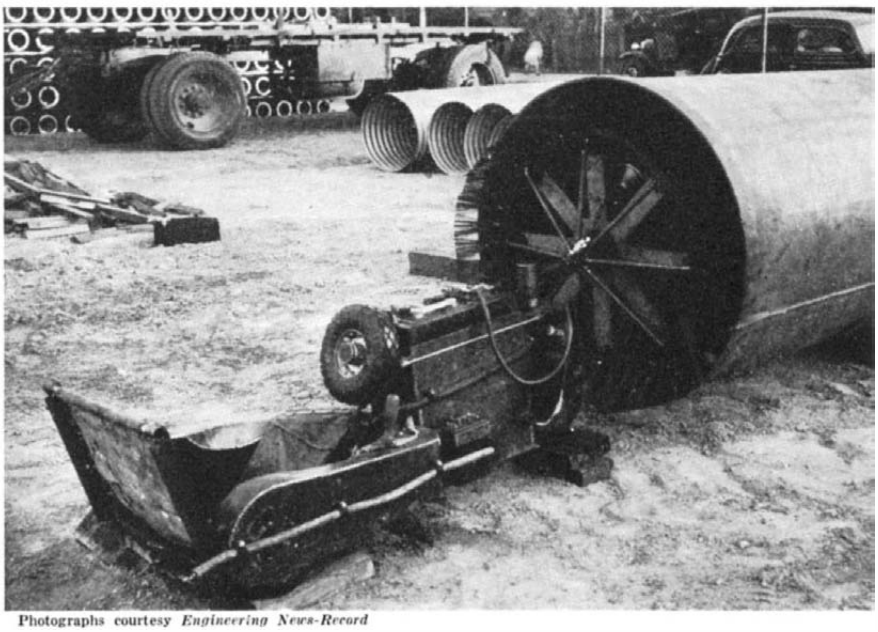
Lyttle has received inquiries from banks all over the world about his machine which electrically analyses every coin it handles and compares it with a master coin. So accurately does it work that it even rejects shillings which were made in China some time ago and circulated in Australia and which had the unusual fault of containing 4 percent too much silver.—*Australian Press Bureau.*

MOTOR CAR INSIDE A WATER MAIN

A NEW water pipe 15½ miles long recently built by the Los Angeles Bureau of Water Works & Supply was an incentive to devise a better means of inspecting the interior of water mains. This particular main is 36 inches in diameter which would offer no serious problem as a limiting dimension in the design of a motor-propelled vehicle suitable for carrying an inspector and equipment. Requirements were made more difficult, however, by valves 20 inches in diameter and the necessity for taking the vehicle into or out of the pipe through 11- by 18-inch elliptical manholes. In addition to conveying inspectors through the line, a major function of the equipment is to test the enamel with which the inside of the pipe is coated and to treat the "holidays" or small defects in this coating such as are found by the usual high-voltage brush test.

These several requirements have been met by a vehicle which is used even on grades up to 8 or 10 percent, sometimes pulling two trailers with a total of three men. The conveyance has traveled 20 miles per hour on level ground and once the writer attained





Above: **The inspection motor car inside a 36-inch water main.** ***Below:*** **The car ready for an inspection trip**

Photographs courtesy *Engineering News-Record*

a speed of 15 miles per hour while backing inside the pipe line. It can be used for inspection and for conveying materials used in patching or placing enamel.

Essentially the motor car is composed of three parts: a battery box, a right- and a left-wheel unit. The battery box serves as a chassis to which the other units are attached. Two 150-ampere-hour, six-volt storage batteries are used, connected in series, and mounted one above the other. Braking is accomplished by means of a fiber shoe which may be pressed against the tire of the right wheel by a hand lever. On the left wheel unit a starter-generator, such as is used with automobile engines, is coupled to the single driving wheel by chain and sprocket. The motor can be reversed by shifting the brush ring. The starter button is operated by the right foot and a spring clip on the end of a flexible lead permits the motor to be operated at voltages ranging from six to 12 in two-volt stages.

Potential for the brushes is supplied by an induction coil (from a model T Ford) mounted on the side of the battery box. The brushes subject the enamel to a potential of about 10,000 volts. As the carriage moves forward at two or three miles per hour, the entire periphery of the pipe continuously is swept by this high potential. The enamel, with its normal thickness of 0.010 inch, withstands this voltage if there are no flaws. The slightest opening, however, causes a visible and audible spark as the brush passes. When exactly located, the spot is covered with enamel by the man in the trailer. —Howard Wait in *Engineering News-Record.*

Fertilizing Fish Ponds

BY adding fertilizer to fish ponds to promote the growth of vegetation upon which the fish feed, the Czechoslovakian government has been able to increase the yield of fish. Approximately a ton of mixed fertilizer and lime is used per ton of fish produced. Both chemical fertilizers and barnyard manures are finding markets for this purpose.—*D. H. K.*

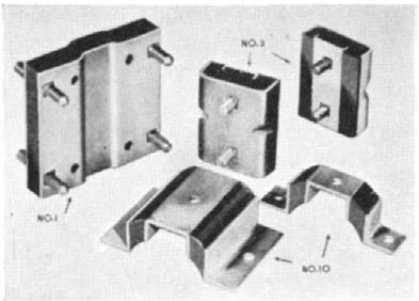
Mechanical Monsters Tamed By Rubber

TAMING of machinery that frazzles the nerves of employees and threatens to crack the buildings in which it is located, is the latest victory of engineers, whose perfection of rubber suspensions for heavy factory units is opening an era of freedom from vibration and noise.

According to J. D. Tew, president of The B. F. Goodrich Company, whose engineers developed vibro-insulators—shown on this page—as a means of easing nervous strain and fatigue of employees working in buildings containing heavy machines in the Goodrich plant, rubber mountings are now being adapted to solve similar problems in nearly every industrial establishment.

"Fatigue studies showed a great reduction in nervous strain on employees tending the units after vibro-insulators were installed on seven machines weighing a total of 238 tons," declared Mr. Tew. "The range of this latest improvement will soon be extended when four machines weighing a total of 100 tons are equipped with rubber mountings.

"After their development of rubber com-



Standard types of rubber mountings designed to be used to reduce the destructive vibration of heavy machinery

positions for mountings for automobile engines and small motors to banish vibration," Mr. Tew said, "our engineers decided to try suspending in rubber one of the heavy factory machines. An 80-ton rubber masticator in the company's Akron plant was mounted in rubber and transmitted vibration was virtually eliminated, ending the threat that the pounding of the machine would open a crack in the building in which it was located."

Artificial Radioactive Material

THE possibility of applying artificial radioactive elements to biologic research and radiation therapy has aroused much interest. Some investigators have prophesied that artificial radioactive elements may eventually replace radium and radon for certain types of therapy.

M. and Mme. Joliot, son-in-law and daughter of the late famous Mme. Curie, were awarded the Nobel Prize (1934) for their discovery of artificial radioactivity. They bombarded boron with alpha rays, making a substance called radio-nitrogen, which gave off radiation resembling the radiation from radium. The life of the product, which is about 14 minutes, is insignificant compared with the life of radium. Other investigators in many parts of the world have followed this line of research. For the bombarding medium some have used the neutron, the electrically uncharged elementary particle possessing nearly the same mass as the hydrogen atom, and others have used the deuteron, the charged atom of heavy hydrogen. To date, more than 40 elements have been made artificially radioactive, and the half-life of this radioactivity varies from a few seconds to about 14 days.

In the radiation laboratory in the Department of Physics, University of California, a device called the cyclotron has been invented, which creates exceedingly high velocities of deuterons. The high velocity of these deuterons is generated between the poles of a huge electro-magnet. Essentially, its operation consists of deuterons being continuously accelerated 'round and 'round in a spiral. This gives them their high speed energy, which otherwise would be unobtainable. The deuterons reach a wall of one electrode and pass out of it through a slit; then they pass through a thin vacuum-tight metal window. Materials such as common salt are placed at this point. It is possible to bombard the sodium in the salt and make a product known as radio-sodium. The half-life of radio-sodium is 15½ hours. The chief advantages of these products would seem to lie in the homogeneity of their

radiations, the suitability of their half-lives for therapeutic uses, and the non-toxicity of their decay products. Several other research laboratories have acquired cyclotrons, and more are obtaining them now.

The life of the radioactive substance is short and therefore would probably not be as detrimental to the human being as radium when it is taken internally. More experimental work is required. At present it will be retarded because of the unavailability of machines to produce artificial radioactive materials. Other instruments have been developed for this purpose, but the cyclotron seems to present the greatest possibilities. Its bulk of several tons and its great expense necessarily restrict research activity except in localities where the cyclotron is already available.—*Journal of the American Medical Association.*

Warning On Use of Nose Drops by Laymen

THE mother who puts drops in her child's nose or sprays it to relieve a cold may inadvertently give him pneumonia or other serious lung trouble. So may the lay person who uses a certain type of nose spray or drops for his own cold.

This danger was pointed out by Dr. Paul R. Cannon of the University of Chicago before the Federation of American Societies for Experimental Biology. He and Dr. Theodore Walsh found in animal studies that the oil of these sprays and drops may get into the lungs, frequently causing edema, or watery swelling, and pneumonia.

The particular kind of nose sprays which Dr. Cannon warned against are those in which the medicinal substances are dissolved in light oils. Mineral oils are used in many of the preparations because they keep better than plant oils. Plant oils, however, are safer because if they do get into the lungs the tissues can dispose of them. If these sprays and drops are used expertly, as by a physician, there is probably little danger. It is their indiscriminate use by the untrained person that may cause serious trouble.—*Science Service.*

Portable Vibrograph

OUR highly mechanized age has raised the serious problem of what to do about vibration. Faster traffic speeds, the design and construction of new machinery and vehicles, building and mining operations, and many other activities make the study of vibration important to safety, comfort and economy.

Among a number of models of vibrographs manufactured by the Cambridge Instrument Company for recording the characteristics of vibration, the instrument illustrated is particularly interesting because of its portability and its novel method of writing its records in permanent form on a strip of celluloid. This portable vibrograph is designed for making spot tests of high-period vibrations and can be applied to a vibrating surface in any plane.

A small projection at the base of the instrument is pressed against the surface at the point where it is desired to measure the vibration. The vibration is transmitted through a series of levers to a fine stylus moving over a strip of celluloid film wrapped around a drum, the levers giving a mechanical magnification seven to one. A celluloid strip 35 millimeters wide and 16 centimeters long is moved past the stylus by means of a clockwork mechanism, the speed of which can be varied from 3 to 20 millimeters per second by means of a switch. The stylus actually deforms the celluloid plastically and does not *scratch* it.

Means are provided to raise the stylus out of contact with the film to protect its point when the instrument is not in use. An independent time record is traced on the inner surface of the strip by a second stylus enclosed within the drum, and controlled from a separate contact-breaking clock arranged to make and break the electric circuit at regular intervals of 1/10th of a second. Four-way connecting leads pass through the removable handle to connect the apparatus to a battery. A push-button switch on the handle starts and stops the clockwork driving the film and the time-marking mechanism.

The records obtained with the instrument are of micro size, and are projected and enlarged for examination and photographic reproduction. The record line is very clearly defined and will bear considerable magnification. Records can be removed from the instrument and examined immediately after they are made without chemical treatment or any lighting precautions, and are not destroyed by water, oil, or dirt.

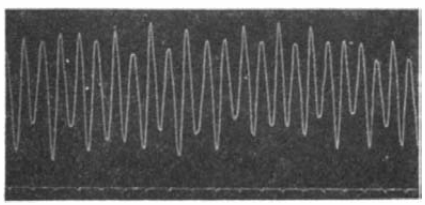
Non-Skinning Paints

THE tendency of paints to form skins on the exposed surface is counteracted by a new synthetic addition-compound recently put on the market. This material has no adverse effect on the paint when applied, but prevents the formation of a slimy skin in the can.—*D. H. K.*

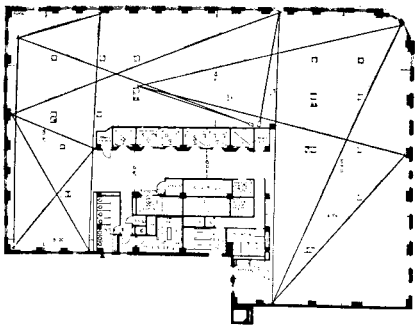
Invisible Electric Snare for Burglars

HOW an intricate net of invisible electric rays can be used effectively to snare burglars and kidnappers, and bring down the law upon them without their being aware of it, was demonstrated to a technical group in New York by engineers of the Signaphone Corporation.

Developed with the aid of General Electric engineers, the protectional device relies



Above: **The portable vibrograph, and,** ***below,*** **a record of vibration made by a stylus on moving celluloid**



Invisible reflected light beams protect these offices from burglary. See complete explanation in text below

principally on the photo-tube to foil marauders. The protective network was made up of the beam from a standard automobile headlight bulb, from which all visible rays of the light spectrum had been filtered. By a multiple system of mirrors, this single invisible beam was reflected back and forth across a room, around corners, and at different levels and angles until the guarded area was completely protected against movement of a body in any direction.

The system is extremely flexible in that the energy released by interfering with any beam can be used for various purposes, such as sounding an outside bell or siren. The type of installation demonstrated was unique and presaged more modern and effective methods. It automatically cleared a telephone line, dialed police headquarters, and transmitted a spoken message summoning aid. After this message had been repeated for a minute and a half, the device "hung up" and then called the telephone company, repeating its message for the same period as a check upon the first call. Having done this, it once more cleared the line and automatically placed the telephone back in service.

It could just as easily have dialed the fire department, or summoned aid from other quarters. The invisible beams are sensitive to smoke as well as human intrusion. A small button is provided to check the apparatus so that operation can be assured before leaving the protected premises or retiring.

Proof of the Matter is in the Making

THE following note from *Science and Culture* (Calcutta) describes an experiment which is to be made by the noted Dutch-German physicist, Professor Paul Debye, most recent Nobel Chemistry Prize Winner. If this experiment succeeds it will provide a tangible answer to many who have refused to believe in the possibility of "heavy matter."

"Probably the reader knows that astronomers have discovered a system of bodies in the heavens which are known as white dwarfs, in which the density of matter may be 60,000 times, nay, even a million times, that of platinum which is the heaviest metal known on the earth. How does this thing take place? Matter must be existing inside these stars in a form which is not known to us on the earth. It is well known that the atom which we know on the earth consists of the nucleus with a positive charge surrounded by a shell of electrons. On subjecting matter to compression, the diminution of volume which takes place is opposed by the mutual repulsion of the electron shells and atomic nuclei. Further increase of pressure will then lead to the successive stripping of the electron shells, until in the end we have nothing but the stripped nuclei occupying an extremely small volume with free electrons lurking between them in an unknown form. This pressure ionization is supposed to exist in white dwarfs.

"This kind of effect is rendered probable by the existence of neutrons, the new elementary particle discovered by Chadwick in 1932. This neutron is of extremely small dimension and it has been found to be a constituent of all nuclei. Further, the neutrons and protons appear to have strong attraction for each other when very close. In white dwarfs, therefore, most of the matter probably consists of agglomeration of neutrons and protons.

"Debye proposes to produce this state by a novel experiment. He will make a cyclotron, an apparatus which has been invented by Lawrence of California and is found to give us a very copious supply of neutrons. These neutrons will be shot into a path which is maintained at absolute zero of temperature. Debye thinks that neutrons will then cling to each other and will form a sort of compact mass which, volume for volume, will be a million times heavier than ordinary matter and will thus be a piece of white-dwarf matter."

FIERY RIVER

"STARDUST" on the river Seine during the Paris 1937 International Exposition which started in May, will transform the water into a river of fire. A metallic dust is scattered over a thick layer of oil on the water, while shafts of varicolored lights are focused upon this glittering surface from a tower on the river bank. So far, we have been unable to learn just how the fishes are faring with this deadly diet.

Billion Elms Threatened by Disease

WITH the nation's elm trees counted for the first time, the American Forestry Association recently announced that unless immediate steps are taken by Congress to control the spread of the Dutch elm disease, destruction of a billion trees, with a monetary value of more than 750,000,000 dollars, is imminent. The saving of this tree resource, the extent and magnitude of which was heretofore unknown, the association stated, constitutes one of the most urgent conservation problems of the federal government and the nation.

Paraffined Fruit

COATINGS of paraffin wax are being applied to fruits and vegetables to preserve them from the garden to the kitchen. By properly selecting the grade of paraffin used, a coating can be applied to tropical fruits and to vegetables, including even the lowly turnip, which preserves their freshness over long periods of time. The paraffin is removed with the peel.—*D. H. K.*

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

HOUSE PLANTS, by Robert Van Tress, (Botany Leaflet 20) is a 36-page booklet that describes and illustrates nearly 30 different plants that can be raised successfully in pots and window boxes in the home. The author gives complete instructions as to the proper care and feeding of plants and concludes with a list of numerous plants, other than those illustrated, which may be grown in the home. *Field Museum of Natural History, Chicago, Illinois.—37 cents.*

HOW AN AMERICAN TECHNICAL LABORATORY SOLVES THE PROBLEM OF FAST DYES is a 12-page mimeographed booklet that shows how it is now possible to buy materials which will retain their color as long as the fabric holds together. The development of the dye industry in the United States has reached a point where the fastness of dyes and the technique of their application are such that there is no longer any excuse for the value of a fabric being reduced or ruined because of improper dyeing. *Write for Bulletin 737A to Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

DESCRIPTIONS OF AIRPORTS AND LANDING FIELDS IN THE UNITED STATES, AIRWAY BULLETIN No. 2, lists in concise form all such fields, giving such pertinent data as exact location, surface, runways available if any, how the field is marked, and what facilities are available to the flyer. Since this bulletin is available only in a limited quantity, it can be sent only to those who actually have need for it. *Department of Commerce, Bureau of Air Commerce, Washington, D. C.—Gratis.*

BROWN PYROMETER covers a complete line of millivoltmeter pyrometers — indicating, recording, and controlling. It also describes a new moisture-proof rotary switch, multiple key type switch, control relays, valve mechanisms, thermo-couples, and accessories. It is of particular interest to plant managers and executives. *Write for Bulletin 737B to Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

CONSOLIDATED ODOR ABSORBERS IN AIR CONDITIONING shows how one organization has attacked a problem peculiar to the developing science of air conditioning. Recirculated air in such systems is apt to become objectionable unless some method of odor absorption is used. The present booklet shows several types of such absorbing units and tells specifically of their applications. *Write for Bulletin 737C to Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

AIR TRANSPORT IN FOREIGN COMMERCE, by Colonel Edgar S. Gorrell, is a reprint of an address delivered before the National Foreign Trade Convention, and is a definite plea for more business for the airlines. It shows specifically the advantages that will accrue to the American business man who has control of any appreciable volume of foreign trade, if he makes use of the commercial air service that is now available to practically all parts of the world. *National Foreign Trade Council, 26 Beaver Street, New York City.—Gratis.*

FACT IS SOUNDER THAN FICTION is a small pamphlet which draws attention to the desirability of fact finding by actual laboratory work rather than by letting the consumer of manufactured goods find out for himself the desirable and undesirable features. This booklet is chiefly intended for those who have a genuine interest in research and testing. *Electrical Testing Laboratories, 80th Street and East End Avenue, New York City.—Gratis.*

HOW AND WHEN TO SPRAY AND DUST FRUIT TREES, VEGETABLES, PLANTS, ORNAMENTALS is a pamphlet that covers the subject in tabular form, telling what sprays and dust are most desirable and when they should be applied. The information will be of interest and value to owners of small gardens as well as to managers of the largest farms and orchards. *E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware.—Gratis.*

ALTERNATING CURRENTS IN RADIO RECEIVERS, by John F. Rider, is predicated upon the idea that a more detailed and elaborate presentation of certain basic A.C. phenomena is desirable, particularly as applied to modern radio receivers. This bound book of 94 pages will be of particular value to the radio technician. *John F. Rider, Publisher 1440 Broadway, New York City.—60 cents.*

GLORIFY YOUR PRODUCT is a 20-page booklet that shows how aggressive business firms are definitely increasing their sales through the medium of talking motion pictures. The booklet tells of some of the organizations that have made use of this advertising method and of the results which they have obtained. *Gratis to advertising and sales executives. Herman A. DeVry, Inc., 1111 Center Street, Chicago, Illinois.*

THE WILD TURKEY ON THE MISSOURI OZARK RANGE, by Harold L. Blakely, is a comprehensive report covering the life history, features limiting abundance, field management, and future conservation problems of this particular game bird. 32 pages including a bibliography. *United States Department of Agriculture, Bureau of Biological Survey, Washington, D. C.—Gratis.*

WHO SELECTS AMERICA'S MOVIES? is a discussion of the advantages and disadvantages of "block booking," a phase of motion picture distribution that has been subjected to vigorous argument pro and con for a good many years. *Motion Picture Producers and Distributors of America, Inc., 28 West 44 Street, New York City.—Gratis.*

CHEMICALS is a listing of acids and heavy chemicals, agricultural chemicals, electroplating chemicals, electroplating equipment, and zinc and alloys, arranged in alphabetical form and giving data of particular interest to purchasers. *E. I. du Pont de Nemours & Co., Inc., Grasselli Chemicals Department, Wilmington, Delaware.—Gratis.*

LEGAL HIGH-LIGHTS

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

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

Processed Product

THE sale of the product of a patented process does not infringe a patent for the process. The United States patent statute provides that any person "who has invented or discovered any new and useful art, machine, manufacture or composition of matter" may obtain a patent therefor. The word "art" as used in the patent statute has been interpreted as synonymous with "process" or "method" and means an act or a series of acts performed upon a given subject matter to transform or reduce it to a different state.

The question frequently arises whether the owner of a process patent can bring suit for patent infringement against one who sells a product which was made by a process infringing the process patent. It is well established, however, that the mere sale of the product of a patented process does not infringe the patent for the process. This question was recently passed upon by the Circuit Court of Appeals for the Second Circuit in a suit for infringement of a process patent. In that case the evidence showed that the defendant employed the alleged infringing process prior to the granting of the patent and that subsequent to the granting of the patent he did not employ the process but merely sold the products which had been made by the process prior to the granting of the patent. The court stated: "A mere sale of the product of the process does not constitute an infringement of a process patent."

There has been considerable agitation by inventors from time to time to amend the patent law so as to permit the owner of a process patent to proceed directly against the seller of the product of the process. It is contended by those favoring such an amendment that the owner of a process patent has no effective remedy unless he can proceed against the seller of the product. As yet such attempts to amend the law have not met with success and the only remedy open to the owner of a process patent is a suit against the user of the process.

Full of Holes

"GENUINE imported Swiss cheese" means cheese made in Switzerland and no other place—at least in New York State.

In a recent case in the New York Supreme Court the defendant offered for sale as "genuine imported extra fine quality Swiss cheese" a cheese which was manufactured in Denmark. The cheese was of the type known as Swiss cheese and it was imported from Europe into the United States. Nevertheless, the court found that the words "genuine imported Swiss cheese" had acquired a special meaning indicating cheese made in Switzerland, and granted an injunction against advertising cheese from other countries in this manner. In reaching this conclusion the court stated:

"Over a long period of time the words 'genuine imported Swiss cheese' have acquired a secondary meaning in the sense that they are associated in the minds of the public, with a special type and quality of cheese imported from Switzerland. While the defendants, in offering for sale 'genuine imported extra fine quality Swiss cheese' express a literal truth, they nevertheless convey to the public the impression that the cheese offered is imported from Switzerland."

Patentable Substitute

ORDINARILY the substitution of one material for another in a machine or article of manufacture does not amount to invention and can not be protected by patent.

The Court of Customs and Patent Appeals passed upon this question in a recent case involving an application for a patent on a high-speed rotary cutter made of steel of the high-carbon and high-chrome type. There was nothing new in the design of the cutter and the high-carbon high-chrome steel was also old. The inventor contended that the invention resided in making the cutter out of the particular material selected. The Patent Office tribunals refused to grant a patent and the Court of Customs and Patent Appeals sustained the Patent Office, stating: "As a general proposition of law, the mere substitution of materials is unpatentable." In reaching this conclusion the court found that high-carbon high-chrome steel had been used in other tools and that its properties were well known. The court found further that the inventor had merely selected the material for its well known properties and in so doing had merely exercised "the mechanical skill of one experienced in the art" rather than the skill of an inventor.

While the general proposition that the mere substitution of materials is unpatentable appears to be clear and understandable, its application to particular cases is sometimes confusing. Thus, in cases where a new and unexpected result is obtained by substituting one material for another, a patent will be granted. Also, where an inventor, by selecting a particular material, solves a problem of long standing in the art, which other inventors had tried unsuccessfully to solve, he is entitled to a patent which will protect the use of the particular material selected.

The difficulty of this problem is illustrated by a recent case decided by the Court of Appeals for the District of Columbia, in which the Commissioner of Patents was ordered by the Court to grant a patent covering a heating coil, for cracking hydrocarbon oils, made of an iron-chromium-nickel alloy. In that case the Court found that prior to the use of iron-chromium-nickel alloy for making the heating coils as taught by the inventor, the cracking coils were the source of considerable trouble due to their rapid deterioration and corrosion. It had been thought that the difficulty was occasioned by the acids in the hydro-carbon oils and unsuccessful attempts had been made to solve the problem by making the coils of acid-resisting material.

In the present case the inventor found that the corrosion was caused by sulphides in the hydro-carbon oils and he selected a material which resisted the corrosive action of the sulphides. By so doing, the Court found he solved a problem of long standing in the art and held that he was entitled to a patent.

It will be appreciated from the foregoing examples that while it may be stated, as a general proposition of law, that the substitution of materials is not patentable, there are many cases in which the selection of a particular material may amount to invention and be entitled to patent protection.

Honorable Discharge

FOR some time after the World War the Army and Navy disposed of large quantities of merchandise which were purchased and resold to the public by stores which included in their names the words "Army and Navy" in one form or another. In recent years the quantity of goods sold by the Army and Navy in this manner has greatly decreased, and many of the stores including the words "Army and Navy" in their names handle substantially no merchandise from the Army and Navy.

The Federal Trade Commission recently proceeded against such a store charging that the words "Army and Navy" in its name were misleading and that their use was injurious to its competitors and to the public. The Commission found that at one time approximately 90 percent of the merchandise offered for sale by the store was procured from the Army and Navy but that in recent years as little as 10 percent was procured from this source. The Commission then ordered the store to cease and desist from using in its name the words "Army and Navy" or either of them.

The order of the Commission was subsequently reviewed by the United States Court of Appeals for the District of Columbia when the Federal Trade Commission applied to that court for enforcement of its order, and the court sustained the order of the Commission, stating:

"The first of the two issues of law in the case is whether the conclusion of the Commission that the use of the words 'Army and Navy' in the Trading Company's name is an unfair method of competition, is justified. It is. The Supreme Court has ruled that false and misleading representations as to the origin of a commodity constitutes an unfair method of competition."

Books SELECTED BY THE EDITORS

CAREERS AFTER FORTY

By Walter B. Pitkin

TO mention that this is by the author of "Life Begins at Forty" is sufficient recommendation. In this book, Professor Pitkin has added inspiration to what before might have been defined as "wishful thinking." He shows how the economic setup has made such changes that many new opportunities in entirely new fields have opened for the person of more advanced age. This is as it should be. The problem of finding employment for those approaching and in middle age having been recognized as a very definite problem, it naturally follows that a solution must be found if national progress is to continue. Professor Pitkin's stimulating observations are worthwhile reading for every man and woman faced with this problem.—$1.90 postpaid.—*F. D. M.*

TEXTBOOK OF GEOLOGY

Part I, Physical Geology, *by Chester R. Longwell, Adolph Knopf, and Richard F. Flint, Professors of Geology at Yale.*

Part II, Historical Geology, *by Charles Schuchert and Carl O. Dunbar, Professors of Paleontology at Yale.*

THESE two volumes constitute a complete textbook of geology, one which occupies a "central" position as the standard detailed treatise, text and reference book of our present period. Unlike astronomy, in which textbooks become out of date in a year or two, geology is more fixed, and a substantial work such as this should be good for at least 10 or 20 years as a book to read and add to one's library as an authority and reference book. These volumes are so written that the outside person can start without prerequisites and expect to understand the whole content with little or no difficulty. The language is clear, straightforward.

Part I deals with fundamental geological phenomena: first comes a general view of the earth, then follow chapters on the breaking down of rocks, the effects of water, geology of lakes, glaciers, wind erosion, marine erosion and deposition, sedimentary rocks, volcanoes, crust deformation, earthquakes, metamorphism, earth's interior, origin of mountains, minerals, rocks, topographic maps. Total, 514 pages with 341 illustrations.

Part II, consisting of 551 pages and 332 excellent illustrations, covers in detail the whole drama of the history of the earth from its origin two billion years ago clear through to neolithic man. It gives a chapter to each of the geologic periods, its rock formations and changes, and its record of evolving life, and extra chapters to the principles of interpreting fossils, evolution, length of geologic time, and the geologic history of man.

The two volumes are purchasable separately, though Part II takes for granted the general working knowledge in Part I, without which the reader would often be perplexed, but Part I, alone, would cause no trouble.

Part I: $3.95 postpaid. Part II, $4.20 postpaid.—*A. G. I.*

THE MAGIC SHOW BOOK

By Alexander, the Magician

COINS and pencils, pieces of paper and handkerchiefs, matches, string, and drinking glasses can be made to do strange things in the hands of one who has studied this small book. In it, a noted magician has swept away the mystery around so many of the smaller tricks done with common objects and has explained them clearly and concisely for laymen. Of the more than 100 tricks included you may already know a few (this book is indicated for children from the ages of 10 to 14), but there are many new ones, both simple and difficult to perform.—$1.65 postpaid.—*F. D. M.*

TERMITE CITY

By A. E. Emerson, Prof. Zoology, University Chicago, and Eleanor Fish.

A JUVENILE but adult-readable description of the lives of termites, with emphasis on natural history. It says that termites eat members of their community who won't work, and this keeps their communities vigorous. That is a difference between termites and Americans today: here the won't-workers eat us.—$1.65 postpaid.—*A. G. I.*

THE DRAMA OF CHEMISTRY

By Sidney J. French

THOSE who were exposed to courses in chemistry in high school and college frequently find, only a few years later, that the background is so dim as to be almost non-existent; attempts to brush up their knowledge with the conventional textbook, frequently take them far beyond their depth. It is for just such people that the present book was written. It supplies the reader with the essential highlights of knowledge in compact and understandable form, thus making it possible to bring into more clear focus the aforementioned hazy background. A minimum of formulas is given—only those that are absolutely essential to clarification of the text. Particular attention is paid to the relationship between modern chemistry and everyday life.—$1.15 postpaid.—*A. P. P.*

THE WORLD OF SCIENCE

By F. Sherwood Taylor, Ph.D.

SURELY the author has embodied a whole "world of science" in this big book. In fact, since the famous "Outline of Science" was published, some years ago, no book so pregnant with facts is recalled. In 1045 text pages the whole realm of pure science, applied science, engineering, and industry seems to be thoroughly covered and covered accurately, everything being clearly described and explained. If this reviewer were to be transported to some desert isle and allowed but one book this would almost have to be that book, by the very logic of its great and wide content. A remarkable synthesis; the author deserves congratulation.—$4.00 postpaid.—*A. G. I.*

PROCEDURES AND METAPHYSICS

By Edward W. Strong

A STUDY of the philosophy and mathematical-physical science in the 16th and 17th Centuries, for students of the history of science.—$2.65 postpaid.—*A. G. I.*

VOCATIONAL GUIDANCE THROUGHOUT THE WORLD

By Franklin J. Keller and Morris S. Viteles

HIGH-SCHOOL students often write to the editors of this journal asking for advice as to what branch of engineering or science might be best for them to enter, not realizing that many things must be taken into consideration in answering such a question and that the answer itself would have to be of book length to be even partially satisfactory. These two authors have given, in something over 500 pages, about the best answer to such questions that could be put together for people generally, leaving

out the specific instances. Their work discusses, however, not exactly what is the best field to enter but how an education in any field might be obtained in the larger countries of the world. The young student would find this book difficult, so that it is best for the teacher to study and apply the psychological methods given therein for vocational guidance and analysis of the individual.—$4.20 postpaid.—*F. D. M.*

TOURING WITH TENT AND TRAILER

By Kimball and Decker

MOTOR camping, whether it be roughing it with an ordinary camp outfit or living in luxury in a modern trailer, requires a technique of its own if the vacationist is to get the most enjoyment and comfort from his travels. Thus we have the reason for the present book, based on practical experience, that will enable the reader to skip many of the rough spots and avoid the trials and tribulations that await the uninitiated. It details such things as what equipment to take and what to leave home, how and where to camp, what kind of equipment is most suitable, and so on. Thoroughly illustrated with photographs which alone will make the reader yearn for the open road.—$2.65 postpaid.—*A. P. P.*

TEXTBOOK ON SPHERICAL ASTRONOMY

By W. M. Smart, Astronomer in Cambridge University

THE second edition of a work published in 1931: errors have been corrected and three appendices added. The chapters are on spherical trig, celestial sphere, refraction, meridian circle, planetary motions, time, planetary phenomena and heliographic co-ordinates, aberration, parallax, precession and nutation, proper motions, astronomical photography (plate reduction), position at sea, binary orbits, occultations and eclipses. Appendices (new): method of dependences, stellar magnitudes, the coelostat. This book is all muscle (mathematics) and not fat (mere words).—$5.75 postpaid.—*A. G. I.*

ELEMENTS OF ELECTRICITY

By William Esty, Robert Andrews Millikan, Wynne L. McDougal, and other collaborators

BY securing the services of more than a dozen authorities in their separate fields, the publishers of this book have been able to present a comprehensive review of the field of electricity, its fundamental laws and their practical applications in the business and industrial world. The result is a perfectly simple book that carries straight forward from a discussion of electricity and magnetism through elementary circuits, Ohm's law, light and power circuits, signal systems, induced currents, transformer construction, and electrical equipment. The text is prepared particularly for the beginner, contains very little mathematics, yet gives the fundamentals of the subject in a form that is easily understandable.—$2.15 postpaid. —*A. P. P.*

A MARRIAGE MANUAL

By Hannah M. Stone, M. D., Medical Director, Birth Control, Clinical Research Bureau, and Abraham Stone, M. D., Associate Attending Urologist at the Sydenham Hospital, New York.

A PRACTICAL guide to sex and marriage. Of such books, there have been many. Why, then, another? Because we find that many medical authorities especially recommend this book as outstanding. The ground covered is: fitness for marriage, biology of marriage, mechanism of reproduction, prevention of conception, problems of reproduction, art of marriage, sexual disharmonies, and health in marriage. The method of exposition throughout is by question-and-answer, and the questions are those which have been most often asked the authors by their consultants.—$2.65 postpaid.—*A. G. I.*

THE FORD V8 CARS AND TRUCKS

By Victor W. Pagé

"PRACTICAL" is the best word we can think of to describe this entirely new book which, in a manner of speaking, tears the Ford V8 apart and shows you every tiny detail of it, how it may be adjusted and repaired. In addition to information on the car itself, there are chapters on trouble shooting with laboratory test sets and on Ford V8 radio troubles. A history of the Ford Motor Company is included in the back section.—$2.65 postpaid.—*F. D. M.*

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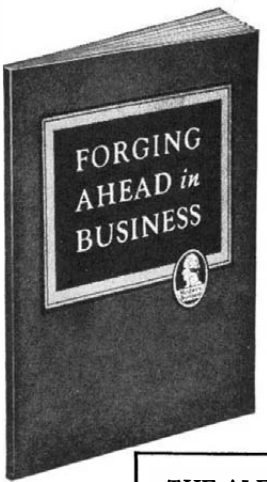

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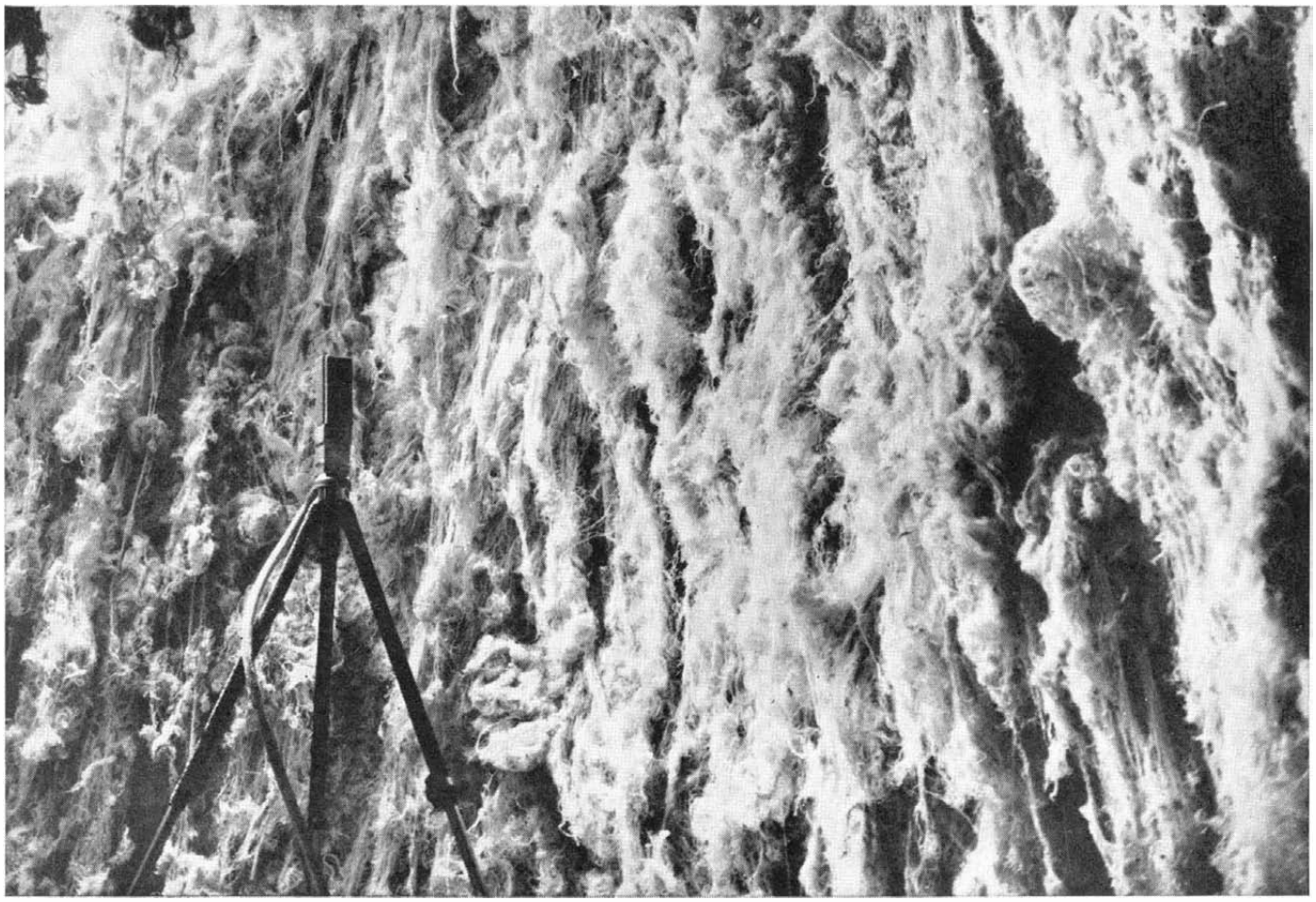

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