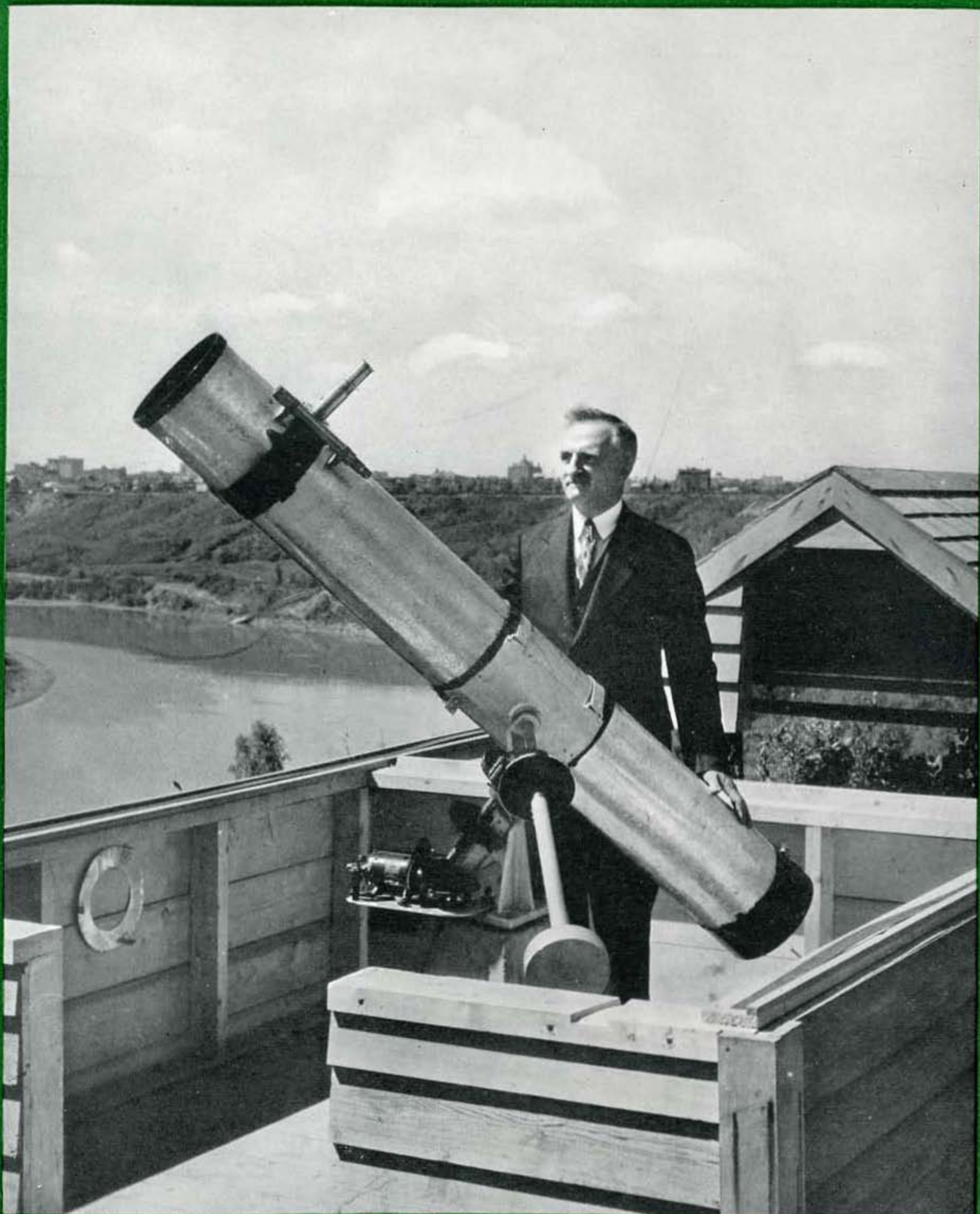
SCIENTIFIC AMERICAN



An Amateur Astronomer's Home-Made Telescope (See page 169)

VOLUME 153
•
NUMBER 4

NATURE FAKING

By S. F. Aaron

OCTOBER 1935
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SCIENTIFIC AMERICAN, now in its 90th year of uninterrupted publication, fills an essential need and performs a public service. No other publication performs a similar function, and its distinctive contribution to American life cannot be duplicated.

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

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

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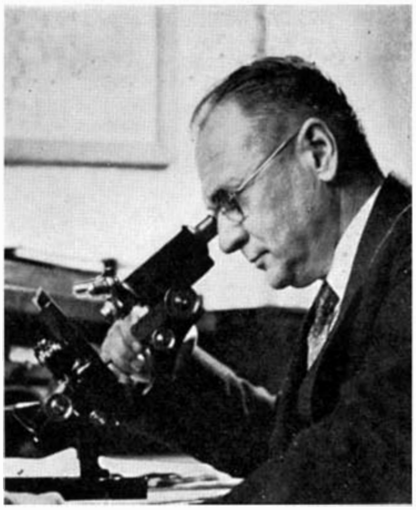
The Editorial Staff of SCIENTIFIC AMERICAN has always had the co-operation of distinguished leaders in all fields of Science. They serve as contributing editors.

It is our privilege to announce that beginning with the September issue, the readers of SCIENTIFIC AMERICAN have the benefit of the counsel of **VLADIMIR K. ZWORYKIN**, Director, Electronics Research Laboratory, RCA Manufacturing Co., Victor Division, Camden, New Jersey, as a contributing editor.



ZWORYKIN, VLADIMIR, K.: Born 1889 in Russia. Received E. E. degree, Petrograd Institute of Technology in 1912, where he studied physics under Professor Boris Rosing, and where he also started his first experiments in television. In 1912 he entered the laboratory of the Collège de France in Paris, to do X-ray research under Professor P. Langevin. During the World War served in Russian Army as an officer in the Radio Corps. In January, 1919, came to the U. S. A., and from 1920 to 1929 was a member of the Research Laboratory of the Westinghouse Electric and Manufacturing Company. Received Ph. D. degree, University of Pittsburgh, 1926. In 1929 was transferred to the RCA Victor Research Laboratory in Camden, working on television, electron optics, photoelectric cells, and allied problems. Was made director of the Electronic Research Laboratory of the RCA Manufacturing Company in 1934. In the same year he received the Morris Liebmann Memorial Award for his contributions to the development of television.

Dr. Zworykin is the author of a number of papers on photocells, sound recording, facsimile, television, and electron optics, and co-author of the book, "Photocells and Their Applications," which have attracted international attention.

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

CONTENTS · OCTOBER · 1935

COVER

PERHAPS, because of its grandeur, astronomy has become the most popular branch of science among the public. Many amateur astronomers own excellent astronomical telescopes, and of these a large number have been home-made from published instructions. Our cover photograph shows a typical telescope of this kind —a Newtonian reflector made by Cyril G. Wates, a telephone engineer of Edmonton, Alberta, Canada. Its aperture is nine inches and it magnifies over 100 diameters. Perched 200 feet above the Saskatchewan River, Mr. Wates' observatory commands a wide and romantic view of the nearby earth and the skies. He believes it to be the most northern home-made telescope on the continent. For further data, see page 214.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, October, 1935. Vol. No. 153, No. 4, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Copyrighted 1935 by Munn & Company, Inc. Great Britain rights reserved. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

ACROSS THE EDITOR'S DESK

THERE has been a close and sympathetic bond between the Navy and SCIENTIFIC AMERICAN for so many decades that a tradition has grown up linking the two in a common, patriotic purpose. As the American "Journal of the Peaceful Arts," SCIENTIFIC AMERICAN has always considered the Navy not as an instrument of war but one which, by commanding the respect of other nations, keeps the United States out of other people's wars and leaves us free to pursue our chosen path to progress and prosperity.

Our Navy tradition, the breaking down of the Naval Limitations Treaties, the enlargement of fleets by world powers, the Treaty-limited naval building program of the United States, the rumored building program of Great Britain—these things together with the fact that SCIENTIFIC AMERICAN and the United States Naval Academy at Annapolis both celebrate their 90th Anniversaries this year, make it fitting that we should publish our November issue as a Navy Number, the release date to be October 18th, just nine days prior to Navy Day, October 27th.

Through the co-operation of the Navy Department of the United States and of other naval authorities, we will present in our Navy Number a variety of special features, all of which have an important bearing on both national defense and national prosperity. Editorially we shall discuss the necessity for a Navy strong enough to carry out the peaceful policies of the United States. Another feature will deal with naval problems in the Pacific, this latter discussion giving reasons for, and the extent of, our interest in the Pacific, and offering a solution to this disturbing problem.

Secretary of the Navy Claude A. Swanson, Assistant Secretary of the Navy Henry L. Roosevelt, and Chief of Naval Operations, Admiral William H. Standley have co-operated in producing this issue. This triumvirate feels strongly on the subject of national defense and particularly as it pertains to sea power. They have, therefore, given us original statements stressing the importance of the work which we hope to promote in some slight measure with our November issue.

What might be considered the two major features of the Navy Number will be "Fifteen Years of Naval Development," by Captain Jonas H. Ingram, U.S.N., and "A Forecast of World Navies," by Dr. Oscar Parkes, for 16 years editor of the world-famed publication "Jane's Fighting Ships." Post-war problems and naval limitations' treaties have laid the onus of national defense more heavily upon the shoulders of technical men and they have made great strides in developing a finer and more efficient Navy. Therefore Captain Ingram's article is extremely important, covering as it does this period of momentous development. Looking to the future, Dr. Parkes gives us an idea of what we may expect in the design and fighting ability of ships that will be built by the naval powers. Dr. Parkes makes some original suggestions which should provoke much thought and discussion among naval architects and constructors.

Our November issue

will be a

NAVY NUMBER

It will also contain a generous amount of other scientific material.

Captain Ingram also writes of Annapolis, giving the traditions and spirit of this fine old institution with its background of 90 years of service to the country as a trainer of superior naval officers and a maker of men who rank high in civilian life. Another article will concern itself with the healthy influence the Navy exerts on progress in industry. The Navy made possible the famous Whirlwind airplane engine, was the first user of aluminum foil insulation, perfected a Diesel which was the forerunner of the American Diesel engine industry, and demands perfection in such a host of other things that industry has gained tremendous rewards in developing the technique to fill satisfactorily the Navy's needs. Still another article, discussing lucidly the uses of aircraft in the Navy, disposes of the old myth that aircraft have spelled the doom of surface vessels. In this, as in Captain Ingram's first article, the statement is made that the battleship is still the backbone of the fleet. Radio, of course, has become of great importance in the field of communications, so another major article by a naval authority will cover this subject.

We now come to a feature that is tremendously important. This is a dramatized map of the United States, done attractively in wash and suitable for framing, showing the contribution which each of the 48 states makes toward the construction of a typical naval vessel. Often the statement is made that there are certain states which do not even realize that the country is surrounded by water and can see no need for the expenditure necessary to maintain a navy. This map, with its appended notes, will show that practically every state supplies thousands of dollars' worth of material or equipment for ships that are built, thus aiding state industries. The significant facts brought out by this feature will, we feel sure, prove most interesting to all, as they are not generally realized.

Needless to say, the November issue will also contain a generous amount of other scientific material. The entire number will be presented in attractive fashion and we hope that all readers will consider their copies worthy of preservation for future reference in connection with naval questions.

Editor and Publisher

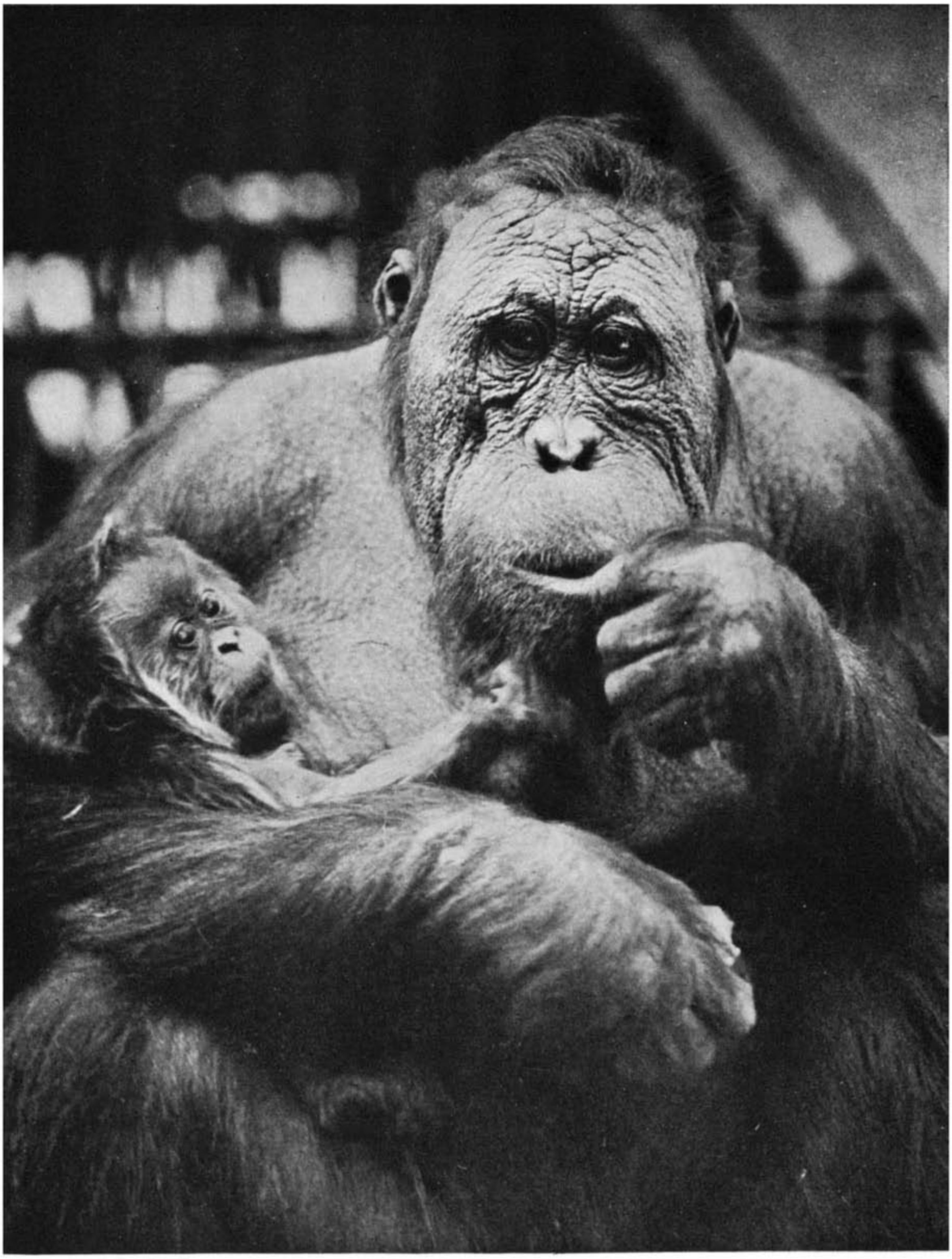


Photo by Newton H. Hartman

ORDER X—PRIMATES
SUBORDER III—ANTHROPOIDEA
SECTION B—CATARRHINI
FAMILY II—SIMIIDAE and
FAMILY IV—HOMINIDAE

HER old man has been fed and has gone off to the club, the dishes are done, and Mrs. Jones now finds time to sit out on the front steps with the baby in her arm and pick her teeth while she enjoys the autumn sunset and relaxes a bit after a hard day over the cook stove. She is thinking vaguely about nothing in particular. Reader, you are not asked to believe that this orang is our poor relative, but the scientific evidence points that way. And we have seen humans whose looks we liked less. This is "Guarina," at the gardens of the Zoological Society of Philadelphia, and she is from Sumatra.

Intensive breeding of wheat insures better flour for bread, pastry, and other bakery products

Agricultural Research Aids Industry

Co-operation Brings Results . . . Better Crops Are Produced . . . New Industries Born . . . Old Ones Benefited . . . Ultimate Consumer Reaps a Harvest

By JAMES T. JARDINE
Chief, Office of Experiment Stations, U. S. Department of Agriculture

MANY of the facts and principles upon which the relationship between modern agriculture and the nation's industries is based have been accumulated during the past half century as a result of the combined research efforts of the state agricultural experiment stations and the United States Department of Agriculture. Prominent among related industries are those engaged in the manufacture of a wide variety of chemical and biological products and by-products such as are used not only in improving farming practices but also in providing many of the essentials as well as comforts and conveniences of the every-day life of the average citizen.

The interests of processors and distributors of food and clothing materials of plant and animal origin are served by the experiment stations in a more or less obvious and direct manner. As a class they are probably the biggest industries benefited by agricultural research and their business aggregates a value somewhere near 14 billion dollars annually. Manufacturers of fertilizers, sprays, and many other chemical commodities, and the producers of mechanical and electrical equipment also have long standing relationships with the stations.

The production of field, fruit, and vegetable crops and their preparation and processing for human and animal consumption, as foods or otherwise, have almost unlimited industrial implications and relationships. The more evident problems of production are subjects of extensive study by the experiment stations, owing to their economic importance. Around each of these have been built commercial industries which manufacture many commodities and types of equipment necessary in the production of crops.

Farmers have found that the most convenient and uniformly profitable procedure, supplementing the proper selection and adaptation of natural soil resources to crop production, is the rational and intelligent use of fertilizers. Bringing to light the specific food requirements of growing crop plants and the development of fertilizer manufacture and use on a sound basis have been among the major activities of the experiment stations and the Department of Agriculture for a long period of years. This work has provided a foundation of

Experimental development of machinery for cultivation and weed control removes much of the guesswork from machinery manufacture and retail selling

principles governing the practical use of commercial fertilizers by farmers which reached a high point of more than eight million tons in 1930. The use of high grade and concentrated fertilizers has greatly increased with gains in efficiency and savings in cost of transportation and handling, and more efficient means of applying fertilizers have also resulted. Both agriculture and the fertilizer industry have profited by this intensive research.

EXPERIMENT station research also has revealed that growing deficiencies of some more or less rare elements in otherwise normal soil may cause crop failures. Recent instances were the discovery of the essential character of zinc, both in preventing and reducing the severity of bronzing of tung oil trees and of little leaf, rosette, chlorosis, and similar physiological disorders of walnuts, citrus fruits, grapes, apples, pecans, and peaches, and the development of effective zinc sulfate treatments. Similarly, the essential character of manganese, copper, boron, and other elements has been established in the nutrition of important crop plants. Such researches have resulted in saving crops of considerable total value and have increased the business of the chemical industries.

Research at the experiment stations with insecticides, particularly the oils and oil emulsions and arsenicals, has led to their every-day use for the protection of plants and animals against insect pests, and has resulted in the commercial manufacture and marketing of products valued at several million dollars annually. For example, experiment station research resulting in the extensive use of crude oil emulsion and miscible oils for control of scale insects, red spider, leaf roller, and other similar pests, also has resulted in corresponding chemical industries of considerable magnitude.

Not only do weeds decrease materially the profits from crops by increasing costs of production and reducing yields but they bring about a decrease in land values. The national toll from weeds approximates 400,000,000 dollars annually. Practically every experiment station in the United States, as well as the Department of Agriculture, has studied problems of weed control which are of interest to the machinery and chemical industries.

Mechanical methods and equipment of commercial importance for the control of weeds in crops have been developed. More recently progress has been made in the development of chemical control methods, including especially the successful use of arsenic compounds for the sterilization of soils against weed growth in walks, driveways, roadsides, fence lines, parking spaces, railroad rights-of-way, drainage and irrigation ditch banks, and in other similar areas. Other studies have developed the effectiveness of sodium chlorate and acid arsenicals for the control of certain of the more important weeds on cultivated soils, resulting in their wide use in agricultural areas. Also mechanical equipment has been perfected for applying various chemicals, such as sulfuric acid, for effective control of weed growth.

The fruit-growing industry of the United States produces crops valued at hundreds of millions of dollars annually. In order to protect this vast industry against partial or total loss due to late frosts, orchard heaters, developed in their present state of efficiency largely as a result of experiment station research, are used to heat the air surrounding the trees on cold nights. The majority of these heaters burn low-grade fuel oil. In California alone there are 3,300,000 such orchard heaters, of which about 3,000,000 burn low-grade fuel oil. It requires 2500 railway tank carloads of oil to fill these heaters once, and as much as 15,000,000 gallons of fuel oil frequently are burned in one night in protecting the citrus crop of that one state against frost damage. The manufacturers and oil companies utilize the information secured by the stations to produce more efficient and economical heaters and fuels which will not create a smoke nuisance. Such heaters are now used widely where valuable fruit crops are produced.

THE adaptation of electricity to agricultural practices and processes began to assume a position of considerable industrial importance more than 10 years ago. As many as 28 of the state experiment stations, co-operating with utilities and equipment manufacturers, have engaged in research on the utilization of electricity in agriculture during the past 10 years, not only for the conventional household uses but for many production operations. This has entailed especially the adaptation of electric equipment to farm requirements. The result has been a marked increase in the use of electrical energy for stationary farm production operations, including feed grinding, poultry incubating and brooding, irrigation pumping, wood sawing, hay hoisting, dairy equipment and product sterilization, milking, cream separation, grain threshing, greenhouse and hotbed heating, crop processing, and for many other purposes. Research has resulted to date in some 227 practical applications of electricity to agriculture and 2,250,000 rural customers, of which a third are farmers. The annual consumption of electricity on more than 713,000 farms now averages nearly 1,635,000,000 kilowatt hours.

Forty-six of the experiment stations, in co-operation with the Department of Agriculture, have conducted nation-wide studies of farm housing and its requirements to develop designs of farm homes and buildings which are adapted specifically to local conditions and climates and combine convenience, comfort, economy, maximum serviceability, and durability. Farmers, building contractors, and commercial dealers in building materials have been quick to take advantage of these services of the stations and have co-operated to the fullest extent. The industrial significance of this work is indicated by the fact that in 1930 farm buildings of the United States represented an investment of approximately 13,000,000,000 dollars, of which 7,000,000,000 dollars were for dwellings and 6,000,000,000 dollars were for production structures.

The relation which livestock production bears to the great meat-processing and meat-packing industries is well known. The livestock products industry is immense, being valued at more than three and a quarter billion dollars in 1931. Packed meats alone were valued at 2,180,000,000 dollars during that year. Back of the development of the livestock industry stands the experiment station system with its comprehensive program of research for economical production of and quality in meats, milk and milk products, hides, wool, and other products and by-products.

Animal disease prevention and control is no small part of the experiment station research program in the unceasing efforts to protect the public and insure quality in livestock products. In that connection a sizable commercial industry has been built up for the production of serums, vaccines, and chemical treatments for diseases and parasites.

Crop products are used universally for food, clothing, or some other purpose. Aside from direct uses as food are many uses which involve the commercial industries as necessary processors.

Bread and other bakery products are probably the most important crop food products from the standpoint of the total population. The baking business is valued annually in billions of dollars and employs hundreds of thousands of people in flour mills, bakeries, and wholesale and retail stores.

THE national milling and baking industries are based upon years of research, much of which has been conducted by the experiment stations in co-operation with the Department of Agriculture, not only in the selection, breeding, grading, storage, and improvement of wheat, rye, corn, and other grains, but also to some extent in the physics and chemistry of milling the grain into flour, the manufacture of dough of the proper characteristics, and baking doughs into the different commercial products such as bread, crackers, doughnuts, pastry, pretzels, and other foods. A majority of the stations have served these industries in the production of grains specifically adapted for the different baking purposes. Others have made contributions to the technique of milling and baking through researches in cereal chemistry.

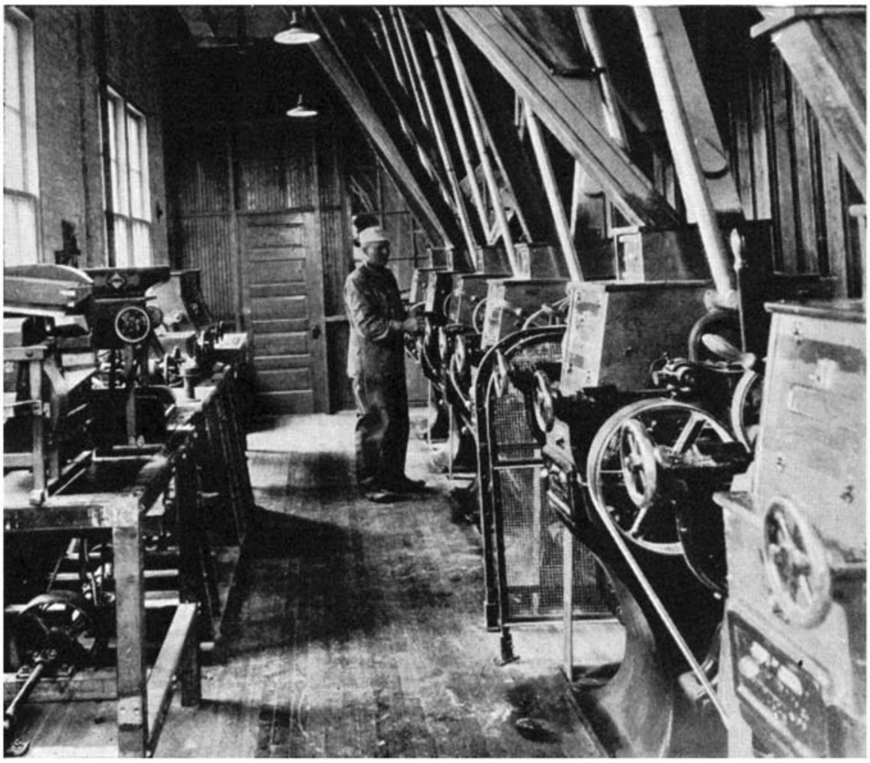
Orange juice and grapefruit are used largely as sources of the necessary vitamins in the diet. Largely by virtue of research, the average citizen is able to secure fruit of high quality, uniform grade, and protected against spoilage in transit. The relationships of this work with commercial enterprises include especially those with the packing, canning, container manufacturing, transportation, refrigeration, processing, and chemical by-product industries.

Among the textile crops, cotton is of outstanding importance. In 1931 the value of cotton goods textile materials produced in the United States was over 800,000,000 dollars. Experiment stations in the South have studied spinners' requirements and the characteristics of the crops in different localities and supplemented this by variety trials, breeding, and physical tests. By virtue of this research a large proportion of the cotton crop in several states has been improved in staple lengths, uniformity, and physical standards required by the textile mills to provide the materials essential in the wide variety of cotton manufacturing processes and products employing cotton.

THE canning and quick freezing of fruits and vegetables have developed into sizable commercial industries. Here again the experiment stations have taken an active part in breeding fruits and vegetables especially adapted for these purposes and in contributing to the technique of the process by safeguarding the quality of the product from the standpoint of the consumer. A northern station has co-operated with one of the leading commercial freezing companies in testing strawberries, raspberries, cherries, peas, and corn on the cob for freezing purposes.

The research at certain western experiment stations in co-operation with the Department of Agriculture on storage, precooling, and handling of fruits and vegetables designed for distant markets has been of great value to the railroads and other commercial transportation and marketing agencies. The significance of these researches can be appreciated when it is considered that in 1932, for example, 84,683 carloads of apples, 81,320 carloads of oranges, 46,215 carloads of grapes, and 46,681 carloads of lettuce were transported by the railroads, to say nothing of large shipments of other popular fruits and vegetables, all perishable.

It has been possible here to draw attention to only a few of the more obvious relationships which exist between the work of the agricultural experiment stations and the nation's industries. Many other examples and illustrations might have been cited. These numerous relationships have done much to eliminate or reduce many of the hazards of agricultural production and to increase the efficiency and lower the cost of production and marketing to the mutual benefit of agriculture, industry, and consumers. Superior crop and animal products and by-products have evolved which influence the comfort and welfare of every citizen. And lastly, the productive capacity of the farmer and of the industrial worker has been increased many fold.



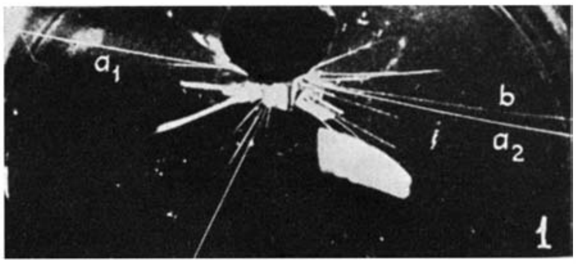
Wheat produced by intensive breeding experiments is put through an experimental mill in order to determine the milling qualities of the various types

Building Blocks of the Atom

Artificial Disintegration Leads to Knowledge of How Atoms Are Made . . . A Round-up of Terms

In 1917, Robert A. Millikan published a book called *The Electron*, which contained most of what was then known about the atom. The book, now revised, emerges this year as almost an entirely new creation. Its present title suggests the lengthy strides science has taken toward an understanding of the microcosm during the last 18 years. The book is called "Electrons (+ and —), Protons, Photons, Neutrons, and Cosmic Rays." Had the author wished to be even more inclusive, he might have added *alpha* particles, deuterons, and neutrinos to the list.

The development of experiments to break down or build up the nucleus of an atom by bombarding it with high-speed particles is probably responsible for these tremendous advances in our knowledge of what the atom is made of and how it is put together. The three remarkable photographs on this page, from Dr. Millikan's book, show the element lithium actually in the process of disintegration, under fire of tiny projectiles. The lithium target is at the center, and the thin white lines are tracks of particles knocked from the atomic nuclei.



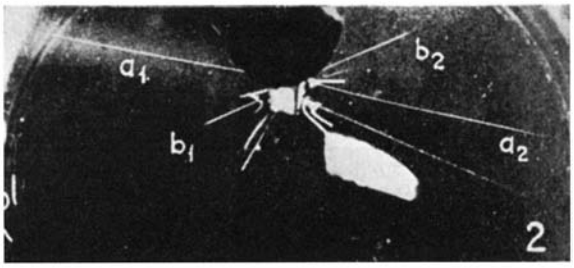
The lithium target at the top is under fire of a stream of heavy hydrogen cores, and is shown actually in the process of breaking up. The lines a_1 and a_2 are alpha particle tracks

With science progressing so swiftly, it is well sometimes to pull up and take inventory. Up to date there are some eight chief terms which scientists use in connection with the atom.

Electron. The negative electrons revolve in orbits about the nucleus of the atom, neutralizing its positive charge. They are identical with the *beta* particles which escape from radioactive substances. The most modern theory holds that electrons are not particles but wave trains. Since they have the properties of both, someone has suggested "wavicles" as an appropriate name.

Positron. The positron is a positively charged electron. It occurs far less often in nature than its companion, a fact which is not yet adequately explained. It does not exist within a normal atom, but when cosmic rays or *gamma* rays penetrate the nucleus, a positron and an electron may be created together, probably representing a transformation of radiant energy into mass.

Proton. Protons are the cores of hydrogen atoms, and are a primary building block in all nuclei. They are almost 2000 times as massive as the positron, but they bear the same charge as the positron.



Each lithium atom squarely hit by one of the hydrogen bullets disintegrates into two alpha particles. a_1 and a_2 mark the tracks of such a pair. b_1 and b_2 are caused probably by rapid protons

Neutron. The neutron is a particle with approximately the same mass as a proton, but without any electrical charge. It is likewise a primary constituent of atomic nuclei.

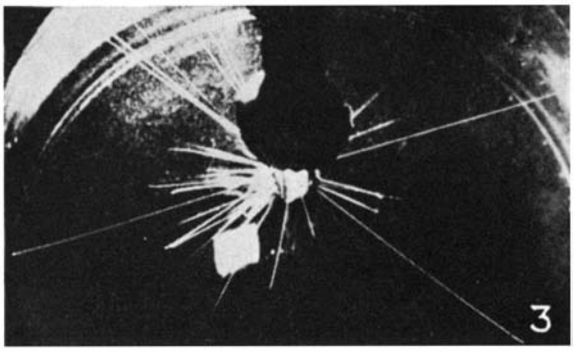
How the four particles thus far mentioned are related to each other is still uncertain. It seems probable that a neutron is made up of a proton plus an electron. It is also possible, however, that a proton consists of a neutron and a positron. Before the discovery of the neutron in 1932, it was assumed that the nucleus must contain some free electrons to balance part of the positive charge; now it is generally conceded that if electrons are present at all, they exist within the neutron.

Alpha particles. These are the cores of helium atoms, made up of two protons and two neutrons. The protons and neutrons within the nuclei of complex atoms tend to group themselves in these compact, stable units. When elements disintegrate, either radio-actively or under bombardment, *alpha particles* are frequently emitted, as shown in the accompanying photographs.

Neutrino. No scientists can say definitely that this infinitesimal, chargeless particle really exists, for it has never actually been identified. If the law of conservation of energy holds, however, one must assume that it does. In radioactive disintegration, similar atoms emit *beta* particles of different energies, yet still remain similar.

Deuteron. This is the nucleus of the famous heavy hydrogen atom, the isotope which weighs twice as much as ordinary hydrogen, but behaves exactly the same in other respects.

Photon. According to the quantum theory, the photon is a unit of radiant energy. Although photons are not direct constituents of atoms, they are radiated whenever there is a loss of energy within the nucleus or the extra-nuclear structure.—*Jean Harrington*



Simultaneous emission of many pairs of alpha particles. The shorter tracks are chiefly due to protons. The faster a particle moves, the longer track it makes

OUR POINT OF VIEW

Uniform Traffic Laws

PROBABLY the greatest bugbear which the motorist has to face today is the wide diversity of traffic laws which he finds in different states and even in different communities of the same state. Here he is allowed to turn right on red. There he is not. Here he turns to the left of a traffic post, there it is required that he go to the right. Here he parks parallel to the curb. There he must head in at an angle, and in a third place he must back in at an angle. Speed laws show as wide variety. This bridge can be crossed only at a speed of less than eight miles an hour. On this highway it is required that he maintain at least a 35 mile an hour speed or else receive a summons for obstructing traffic!

These brief statements show the great need which exists for some uniform method for regulating the flow of traffic. True enough, uniform laws would reduce to some extent the revenue acquired by a certain few grasping politicians in the smaller communities who feel that motorists passing through are their legitimate prey and who therefore enact trick traffic laws which are designed for no other purpose than to trap the unwary and thereby add to the exchequer of the community. But this is a small-time way of looking at the matter. The automobile has made possible a vast expansion of our nation. It provides a means of transportation which has made it possible for the average man to travel widely and to learn more about his own country than would be possible in any other way. On the other hand, of course, the automobile has shown itself to be a dangerous weapon when in the hands of irresponsible drivers, and particularly so when these same drivers are faced by ever-changing and never-uniform traffic regulations.

If when a motorist approaches a crossing he knows that his actions will be governed by the same laws as pertained at the last crossing; if he knows that he is not going to be summoned for a traffic violation by a small-town police officer who is over-zealous in his duties; and if he knows definitely that the law is on his side rather than against him, many of the psychological dangers of motoring will be eliminated.

Here is a case where the oft-discussed states' rights must be disregarded. Small communities can no longer be a law unto themselves when the good of the greatest number is to be considered. There must be developed a uniform set of laws which will apply in all localities throughout the country. Such a set of regulations can best be arrived at by a study of the situation as a whole and by collaboration between state and federal authorities. SCIENTIFIC AMERICAN lends its voice in demanding that such co-operation be secured and that all possible speed be made in securing for the motoring public the safety of uniform traffic regulations.

Forgotten Inventors?

THERE is no need to argue the question that the inventor is the very backbone of our present-day civilization. Without a constant supply of inventions, our present rate of progress would be impossible. It seems, however, that the Patent Office, established for the purpose of assisting the inventor to protect his property, is overlooking the fact that in many cases the question of financing the securing of a patent is a very serious one. In these times of financial stress, it appears that the United States Government has forgotten that there are many workmen and mechanics out of jobs who have turned their idle hours to perfecting inventions but unless these men can obtain proper protection in the form of a patent, their inventions are frequently of little value to them. No doubt there are many inventors who would seek patent protection but who cannot afford to pay the fees now required by the Patent Office —30 dollars on filing his application, whether he gets a patent or not, and 30 dollars more, should the application be allowed, in order to have his patent issued.

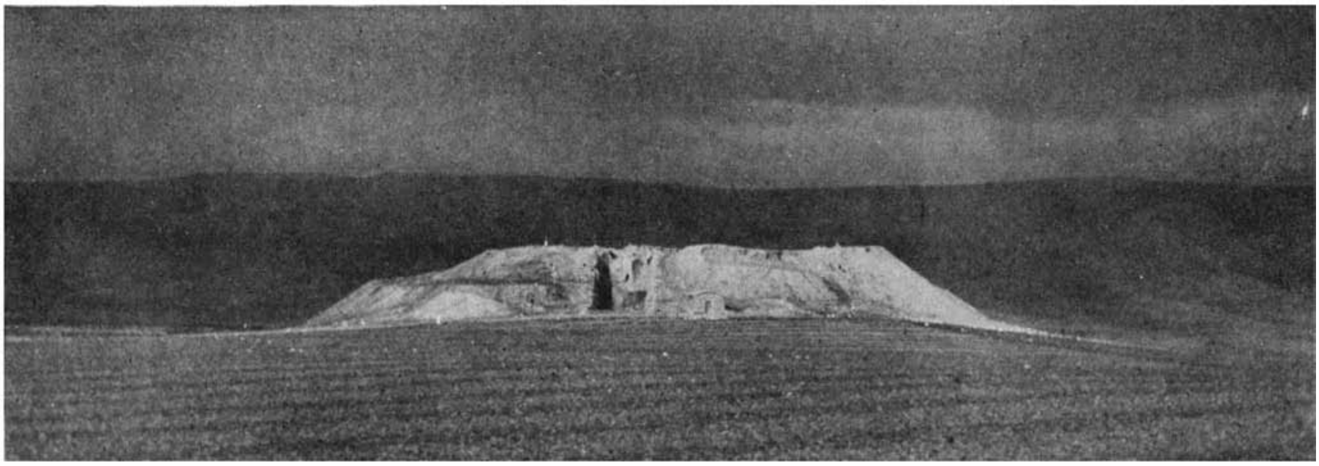
There was a time a few years ago when the filing fee was only 15 dollars and when the final or issue fee was only 20 dollars. At that rate, the Patent Office was not only self-sustaining but showed an excess of receipts over the cost of maintenance. Of course, the time required to make an examination of an application to determine the patentability of its subject matter has greatly increased, but the same may be said of all activities in all departments of government. It would seem to us to be a worthy action on the part of our existing administration to take into consideration the value of the work being done by inventors and to give them a break during hard times. A return to the former 15 and 20 dollar fees might make it possible for the Patent Office to be self-supporting: At any rate, this step would be of material assistance to those inventors who simply cannot afford to pay the fees now exacted. Who can tell what beneficial results might accrue from such a procedure?

Breaking into the Weather's Lair

BEHIND the trans-polar flights of the Russians lies more than a stunt. The flights were inspired by Professor Otto Schmidt, a scientist, head of the Arctic Institute of Leningrad. What Professor Schmidt and the Arctic Institute have had in mind is to fly clear across the polar regions and prospect out suitable sites for meteorological observatories. To Russia this is of especial importance because temperate zone weather comes from the Arctic and she is literally wrapped around the Arctic regions. At present there is a network of weather observatories covering, quite densely, most of the North Temperate Zone. The circumpolar region is a great gap in this world network and, since "highs" and "lows" of the temperate zone mainly originate closer to the pole, this gap happens to fall just where it is most embarrassing to weather forecasters.

To place a meteorological station serviced by airplanes at the exact Pole is a feat which, of course, makes appeal to the imagination but too much emphasis has been placed by newspaper writers on this aspect of the plan. The North Pole lies inconveniently in the midst of an ocean 1000 by 1500 by two miles in dimensions, on pack ice. What science wants is as dense a network wherever there are existing gaps as there now are elsewhere; no doubt the Pole would be one chosen site, however. The need has been well explained by the weather forecaster H. H. Clayton, in a scientific book entitled "Problems of Polar Research," edited by W. L. G. Joerg of the American Geographic Society, New York, a society of scientific geographers. Such stations, supplied with kites, sounding balloons, or airplanes of their own, could catch the storms of the temperate zone where they are whelped and, by reporting them by radio three times daily, they would permit forecasters to predict with less guesswork.

Whatever results the Russians ultimately obtain in this work will be equally helpful to us, since our weather, too, comes from the circumpolar regions. Therefore we should co-operate with them.



The great city mound of Tepe Gawra, in Irak. The mound represents 20 cities, one on top of another. In the Orient, the building materials—bricks of sun-dried clay—dissolve in the rain. It is easier to level off a half-ruined building, bring in more material and start on top of the last, than clear off and start anew. Hence the "pile" of city levels in stratified order

THE GREAT MOUND OF TEPE GAWRA

By JOTHAM JOHNSON
The University Museum, Philadelphia

IN the sixth millennium before Christ, a migrating horde swept from the east over India, Persia, and Mesopotamia. Many more waves of invasion were to break over the hills and valleys of these lands; it is not even likely that this was the first. But we still know so little about the early movements of man in Mesopotamia that we cannot say whether any race was there to receive this horde, for wherever their remains have been found they lie at the bottom of all other identifiable human remains.

Their most typical product was their earthenware vessels, for cooking and other household purposes, painted with distinctive geometric designs. This pottery has already been found in test pits and trial trenches at such sites at Tell Kukuteni in Baluchistan, at Susa and Tepe Hissar in Persia, at Tell Halaf and Nineveh in northern Mesopotamia, and at al-Ubaid near Ur in Babylonia; but with it has come to light nothing of the culture, no associated objects, only broken sherds of the vessels themselves.

In spite of the vast territory these peoples once controlled, literally nothing has been known about them—nothing about their racial type, their language, their arts and crafts, nothing except that they painted their pottery. For lack of any better description they may be called the "painted pottery peoples." Yet in the history of mankind no race now presents at once so potentially important a position together with so deep a mystery. It will call for the intense archeological endeavors of many scholars for the next generation.

The most sensible first step is the systematic one: to select some one city of this race and excavate it soberly and quietly. If written tablets are not found we must be content to watch for the muter testimonials of such sombre finds as potsherds and bone pins and obsidian razors and the battered stubs of mud walls. When by these means we have reconstructed the culture of this people, in some of its tangible aspects, at one city, we may turn to survey from a new and higher observation post the other unclassified primitive vestiges which tend to be associated with these remote peoples.

IN 1927 Dr. E. A. Speiser, exploring the mounds clustered in the upper Tigris valley, paid particular attention to the "great mound," Tepe Gawra. It had been observed by previous travelers but its significance had not been suspected. Later that year Dr. Speiser was able to run a successful and enlightening trial trench with funds supplied by the American School of Oriental Research in Baghdad. Of 20 cities neatly stratified on the tell, the lowest nine showed painted pottery as their typical find—a stimulus to further exploration.

Without this pottery the excavation of Tepe Gawra would have been reserved for a future generation. To the University Museum, however, the prospect and the privilege of realizing not one but nine cities of the painted pottery peoples was irresistible; and in the friendly rivalry between institutions competing for the honor of leading the journey back to man's origin, the approaching completion of our work at Ur suggested the choice of a still more ancient site. An alliance was struck with the American School in Baghdad, and with Dr. Speiser as field director, assisted by Mr. Bache, work was begun at Tepe Gawra, Level 1, in 1930; this in face of the depression and the expensive and potentially thankless task of clearing away the overlying debris of 11 later strata in order to clear the mound for the real work. Later, when Levels 6 and 8 yielded their extraordinary cultures, adding new chapters to history, and Level 9 gave up the burial chambers with rich finds of gold and electrum reported by the press of the entire world, the importance of Tepe Gawra's succeeding civilizations received due recognition.

None the less, Level 12 remained the real goal of the excavators for eight years. By exploring thoroughly the city of this level, and then earlier levels in turn right down to level 20 which may go back to 5500 B.C., the story of the architecture and of the arts and crafts of this ancient tribe, and, if luck favors, some account of their religious worship, will be unrolled.

Level 12 was partially uncovered during the 1934-5 season, and the first news of the architecture of the painted pottery peoples is here given. Press reports, stating that part of Level 13 was laid bare and giving a name to the town, are erroneous; but the statement that Level 12 goes back to about 4000

B.C. has the approval of Dr. Speiser and Mr. Bache. The city was 3000 years old 3000 years ago when Homer sang of Troy.

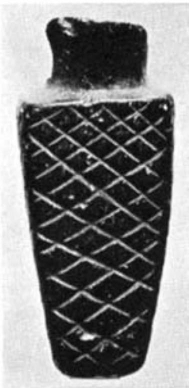
Over the area was a heavy layer of ashes and charred refuse; the city had been destroyed by fire. When this had been cleared away the forms of the building walls began to appear; they were of *libn*, mud brick, the typical material of Mesopotamia; yet Tepe Gawra is in sight of the Kurdish mountains. If the painted pottery peoples had originated in a mountain country with architecture in stone, we would have expected them to use the more familiar material; or else by the period of Level 12 they had lived so long in Mesopotamia as to adopt the customs demanded by the country. In any case, the architecture surpassed that of the three succeeding periods at Tepe Gawra. One large building was so extensive that it may have been the palace of a chief. Of the many rooms the largest measured about 37 by 17 feet; its walls were coated with fine white plaster to conceal their humble material; this is the earliest use of wall plaster yet recorded.

THE mastery of the secret of burning lime for mortar and stucco was one step forward. The walls of this same White Room contain another: they were carefully oriented to the cardinal points of the compass, showing that the architect was able to command the services of an able astronomer or, more likely, was himself a learned man with some knowledge of the stars.

It is unlikely that this building was a temple. The numerous vessels of pottery and stone found in it indicate that it was used as a dwelling by many people. In the corner of one room was a small oven. In this was a cooking pot, its lid still in place. It contained the bones of the meat which was being cooked for dinner when the unknown enemy charged the walls and ended a civilization. Many years later the deserted mound was smoothed off by the conquerors or their descendants, who built the next city, Level 11, disclosed by recent excavations.

6000 years ago some housewife left this pot of lamb stew in the oven and ran for her life, never to return

In spite of the progressive architecture, there are constant reminders that we are dealing with an older city than modern science has known. For instance, metals have been left far behind; gold was found in Level 9, but its possessors were not acquainted with the processes of smelting and refining and working metals, but obtained them from metal-working tribes in the mountains. In what mountains? When we find out we will have taken a tremendous new step backward into the history of man's past.



The slender little vase for eye shadow which women used a long time prior to A.D. 1935

Commerce in these products and in others such as the rare lapis lazuli was carried on by barter; nearly 3500 years passed before coin was minted.

The study of the religions of primitive races begins with the study of their burial customs. Respect for the departed had not progressed, at Tepe Gawra in 4000 B.C., to the point where surviving relatives built large underground burial vaults, such as those of Level 9 already mentioned, to receive the wooden coffins of their lamented dead; but several large jars, painted in monochrome like other typical specimens of Level 12, have been discovered to contain the bones of infants. The bodies were not cremated but simply placed in jars and interred. How adults were buried remains to be learned; perhaps they were carried to a cemetery in the plain below the mound.

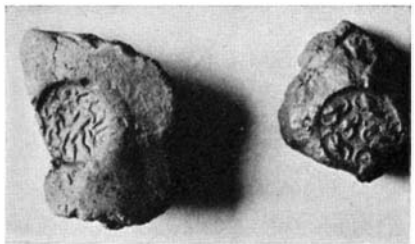
We do not know and we are likely never to know anything certain about the language of the painted pottery peoples. They were probably not acquainted with writing; it was a thousand years before the first groping pictographs were made at Ur, and the inhabitants of Level 12 of Tepe Gawra, at least, left no written documents. We shall never know even their name for the city.

IN the course of further research we must eventually discover the region of the earth's surface whence came the people who built the first primitive settlement known only as Tepe Gawra 20. Then we may be able to follow the wanderings and eventual fortunes of their relatives who migrated to other fields; and so we may come to know their racial and linguistic stocks. From other analogies it seems likely that they were associated with the Mongoloid or Circassian peoples; all conclusions along this line will contribute toward a solution of the still vexing problem of the origin of the Sumerians and their disputed relationship with the painted pottery peoples. Just so, do we hope some day to learn the identity of the strange invaders who wiped out Level 12 in turn and supplanted it with another culture.

Level 12 has produced none of the flat seals which are common in later strata at most Mesopotamian sites, but of such seals two impressions came to light, made on wet clay which was then baked into a record beyond time's power to destroy.

If we compare them with seal impressions found in Level 11 they are disappointing; among the latter is one which seems to show the earliest brewery (two men stirring the contents of a vat with long poles) and a number show ably carved naturalistic sheep and other animals.

These seals were used to consecrate,



Seal impressions found in level 11, one showing human figures, and the other the horned heads of rams

that is, identify, property. Their designs were, in effect, monograms of their owners. From inconspicuous finds important deductions can often be made. If individuals had property, the Tepe Gawrans were not communistic nor, at the other political extreme, did all the property belong to one ruling noble. Again, if an enemy destroyed the town to take its fields, we may guess that 6000 years ago mankind had already felt the pinch of hunger.

The presence of even primitive seals is very encouraging; frequently they carry religious scenes of these people, or record incidents in the phantom lives of their mythological heroes. By these means it is often possible to follow the thin thread of racial tradition where the absence of written records leaves no other clue.

No matter what vast gaps remain when Tepe Gawra has been dug and we have learned all the history its 20 cities contain, we know already that the same essential story of humanity will come out. The first find made in Level 13, at the edge of the mound where an impetuous Kurdish workman sank his pick below the floors of 12, was a slender little vase. It once held the kohl with which some far-away beauty darkened her eyelids against her lover's visit.

A LINK IN A CHAIN OF

Wheeler Dam . . . Completed Next Year . . . Will Produce Power . . . Has Navigation Lock . . . Operated With Other Dams, Will Control Tennessee River

By HERBERT F. GOUGH

WHEELER DAM, on the Tennessee River in northwestern Alabama, is the second major construction project now being carried out by the Tennessee Valley Authority. It forms one of the major links in the Authority's integrated program for the development of the water resources of the Tennessee River basin.

The Act of Congress in 1933 creating the Tennessee Valley Authority has granted broad powers for the fulfillment of a project, the first of its kind in American history, calling for the complete development of an entire watershed. Next to the soil, the most important resource of a region is its water, whether in the form of rainfall or rivers. In a steeply rolling terrain, however, a heavy rainfall may become a danger as well as an asset, and such has been the story of the Tennessee River watershed. A mean annual rainfall of 51.2 inches, about 145 billion tons of water, takes its toll of the river valley annually to the extent of about 2,000,000 dollars in flood damages. Furthermore, the river has carried downstream untold millions of tons of eroded soil during these seasonal fluctuations, building up sandbars and reducing the river's effectiveness as a navigable water-way.

THE Authority's answer to these problems is a two-way control program. On the one hand it checks erosion at the headwaters through forestation measures, and on the other, it controls the river itself through an integrated system of storage and run-of-river dams. Storage dams on the large tributaries, such as Norris Dam on the Clinch, will hold back the run-off during the rainy season, thus leveling the flow of the river for navigation and flood control. Run-of-river dams, such as Wilson Dam and Wheeler Dam, in the Muscle Shoals area, graduate the flow of the main stream through a series of long narrow lakes which further reduce flood dangers and are useful for water-borne traffic. From Knoxville, Tennessee, to Paducah, Kentucky, the Tennessee drops 505 feet; narrow stretches of deep water connected by navigation locks will carry river traffic down a gigantic stairway 650 miles in length. Wheeler Lake, one of the steps in this stairway, will be 88 miles long.

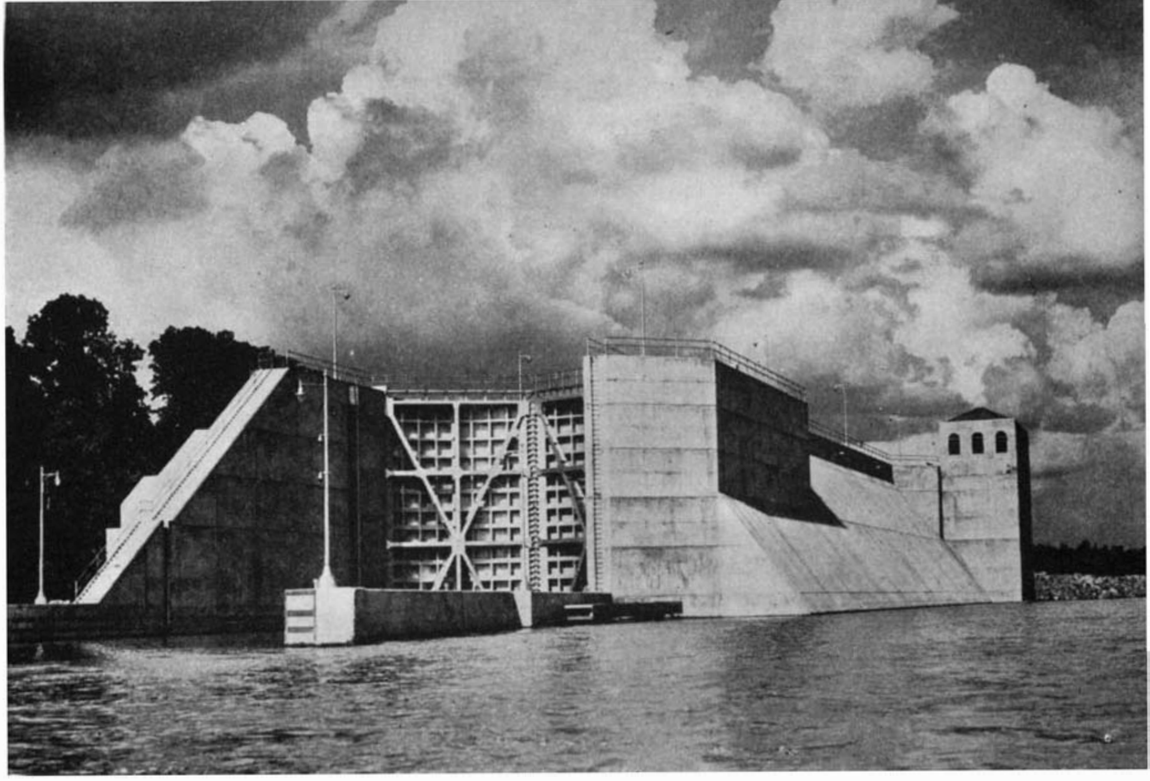
Wheeler Dam, named for General Joseph Wheeler, Confederate general and a commander of United States forces in the Spanish-American War, was originally Dam No. 3 in the United States Army Engineers' survey of the power and navigation resources of the Tennessee River. Prominent in the War Department's recommendations during the past concerning this inland waterway is the development of Muscle Shoals.

The Muscle Shoals area in the Tennessee River is one of the nation's great hydro-electric power sites. From Brown's Island, a few miles west of Decatur, Alabama, the Tennessee River forms a series of rapids over what the geologists term the Cincinnati Anticline. The greatest fall in this series of rapids, extending over approximately 37 miles of river bed, is 134 feet, only 33 feet less than Niagara Falls.

Wilson Dam, completed in 1925, while taking advantage of the power possibilities at the lower end of the Shoals area, eliminated 16 miles of the rapids as a menace to navigation. This factor largely determined the location of

Wheeler Dam in June 1935. The navigation lock is on the opposite side of the Tennessee River

DAMS



One end of the navigation lock, among the highest single-lift locks anywhere in the United States

Wheeler Dam, at the upper end of Wilson Lake.

When completed, Wheeler Dam will be a gravity concrete structure 6,335.5 feet —more than a mile in length —across the Tennessee River. This is 1340 feet longer than the great Dnieper River hydro-electric project in Russia. Beginning at the south bank, this huge barrier will be made up successively of a non-overflow section 157 feet long, 613 feet of power house, another non-overflow section 715.5 feet long, 2700 feet of spillway, 1756 feet of non-overflow, 159 feet of navigation lock, and a non-overflow section 235 feet long which will tie into the north bank. The non-overflow section is 55 feet wide at the base and 70 feet high. An inspection gallery, six feet wide by eight feet high, extends throughout the length of the dam.

THE spillway section of the dam will be 54 feet high, and 124 feet wide at the base, including the apron. The toe of the apron, approximately 24 feet below the river bed, will have concrete dissipators to break the force of the water flowing into the stilling pool below the spillway. End training walls, five feet thick, will rise 12 feet above the pool, while ten intermediate training walls will just reach the water surface below the dam. The spillway is divided into 60 bays, each bay being surmounted with a radial gate 15 feet high and 40 feet long.

Reinforced concrete piers will support a 20-foot roadway along the crest of the dam. A rising grade in the approach to the navigation lock, reaching a clearance of 57 feet over the reservoir pool level, will permit the uninterrupted flow of highway traffic across lock and dam without interfering with the passage of river boats through the lock.

The Wheeler power house will be of the outdoor type, with no housing over the crane or the generating units. It is planned for an ultimate installation of eight main generating units, having a total capacity of 288,000 kilowatts.

The generators will be protected from the weather by metal covers. The initial power house construction will consist of foundations for two units and complete installation of one 45,000 horsepower propeller type turbine, generator, and the necessary auxiliary equipment.

The dam will create a reservoir 88 river miles long with an average width of 1.3 miles. It will be 73,500 acres in area, or about 115 square miles, at an elevation of 555 feet above sea level. This will be the normal level of the lake.

Construction work commenced on the Wheeler Dam navigation lock under the supervision of the Corps of Engineers of the United States Army in December, 1932. The original plans provided for a 60-foot by 360-foot lock with a 37-foot lift, but the Tennessee Valley Authority arranged for the lift to be increased to 50 feet. The lock, now completed, is one of the highest single-lift locks in the United States.

In October, 1933, surveys of the site and preliminary plans for the dam prepared by the Army Engineers were turned over by the Authority to the engineering staff of the Bureau of Reclamation for preparation of a final design.

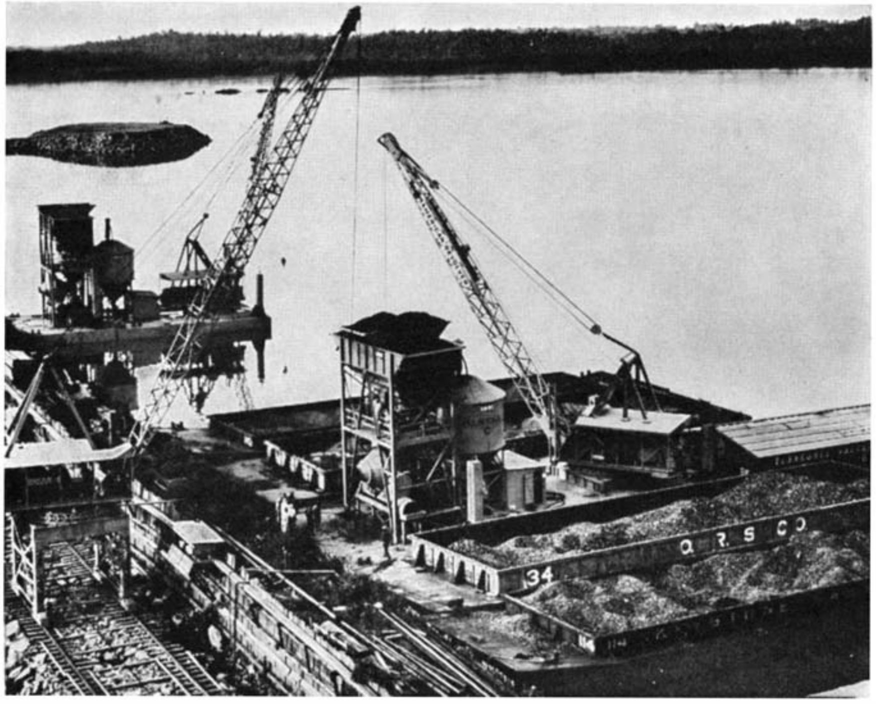
By the latter part of November, 1933, much of the preliminary work was well under way. The construction camp, commissary facilities, warehouses, and office buildings were erected. The approach roadway to the site was graded and culverts installed. The bridge over Big Nance Creek was strengthened. A 17-mile, 14,000-volt transmission line was built from Wilson Dam to the new project to serve the construction equipment. An arrangement was effected by the Authority with the Corps of Engineers of the United States Army for the lease of seven barges, three derrick boats, a dipper dredge boat, a Diesel-electric powered tow boat, a smaller tow boat of the pusher type, two small launches, and a fuel barge to handle its transportation requirements.

Actual work on the dam itself began on November 27, 1933, at which time the first crib of the first-stage cofferdam was erected. This first cofferdam, five of which are necessary for the diversion of the stream during construction operations, is approximately 1400 feet long and 400 feet wide, extending outward from the south bank of the river. It was made by confining an earth fill between two lines of wooden sheeting spaced 20 feet apart. Filling material for the wall was dredged on the north river bank, loaded on barges, towed across the river and unloaded into the wall with clam-shell buckets operated from derrick boats. The first cofferdam was completed and unwatered in January, 1934.

THE second cofferdam was started on February 19, 1934, with the building of two rock ramps to the top of the outer arm of cofferdam Number 1 from the river floor inside the cofferdam. The walls of cofferdam Number 2 were made of rock taken from the power house excavation, it being trucked up the ramp and dumped into the fill extending around the cofferdam. Afterward a blanket of clay was placed on the river side of the rock fill to make it watertight. This cofferdam was finished about August 1, 1934.

Cofferdams Numbers 3 and 4 followed according to schedule. Foundation excavation was finished in Number 3 during the latter part of June, 1935, and begun in Number 4 about the same time.

The damming of a river over a mile wide calls for a construction schedule adaptable to variations in the flow of water. This is the reason for the five cofferdams. Beginning with that on the south bank, which encloses the power-house site, their lengths are respectively 1425



Floating concrete mixing plants at Wheeler Dam. The gantry crane at the left swings the two-yard bucket of concrete into position and lowers it to the job

feet, 1238 feet, 1147 feet, 1100 feet, and 1004 feet. It is the intention to have only two adjacent cofferdams closed for any considerable time.

The dam, except that portion of the non-overflow section in cofferdams Numbers 4 and 5, will be built in alternate 15-foot and 30-foot wide blocks. As soon as the 30-foot blocks are built up to elevation 506, which is one foot above the level of Wilson Lake, the 15-foot blocks are built up above flood height, and the cofferdam may be removed and water diverted through the 30-foot openings. Water may also be diverted through the powerhouse intake tubes. During different stages of construction, flood water will be passed through various combinations of intake, 30-foot diversion openings, and whatever part of the river channel remains open.

A FORCE of 4000 men is working day and night in four six-hour shifts on Wheeler Dam. At the time of writing, practically 90 percent of the estimated 550,000 cubic yards of dolomite rock to be displaced has been removed from the foundation. As soon as each section of foundation is in readiness, a thorough job of low-pressure grouting is done with a neat cement grout. As soon as 10 feet of concrete has been placed, high-pressure grouting at approximately 150-pound pressure completes the job of sealing all cracks in the foundation for prevention of leakage or possible shear and sliding of foundation bedding planes.

Two thirds of the estimated 650,000 cubic yards of concrete to go into the structure have already been placed. In the power-house section most of the concreting has been completed. The 85-ton gantry crane to serve the intake gates has been erected. Erection of the 20-foot highway bridge structure along the crest of the dam is under way in several sections. Mass concrete is being placed almost continuously in spillway and non-overflowing sections.

All concreting materials reach the job by way of the Tennessee River. Some 15 miles below Wilson Dam, the floating equipment of the Cumberland River Sand Company is at work filling a contract calling for between 1,000,000 and 1,250,000 tons of sand and gravel. The aggregate is transported up the river in barges carrying about 400 tons each. The barges are tied up alongside the Authority's concrete-mixing barges.

The contract for cement at Wheeler Dam calls for delivery to the job in barges also. Members of the Authority's staff sample and test the cement before it leaves the plant. When it receives their recommendation, it is shipped by rail to Sheffield, Alabama, from which point it is transported by barge to the job.

Approximately 600,000 barrels of cement will be used in the construction of the dam. A "modified" Portland cement, having a heat rise somewhat less than a "normal" Portland cement, is used in all the work. This lower heat rise tends to cut down the expansion and contraction of the concrete during the setting and hardening process. The majority of the concrete being used gives a minimum strength of 3000 pounds per square inch at 28 days.

At the job all of this material—sand, gravel, and cement—is transferred to the TVA floating mixing plants, where it is combined in the proportions desired into concrete. There are four such floating plants.

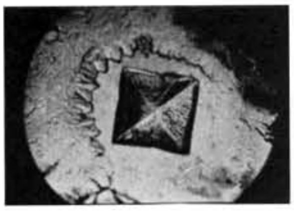
Each plant is mounted on a steel barge 90 feet long, with a beam of 40 feet and 7 feet deep, specially designed and reinforced to sustain torsional stresses and all loads the mixing plants may impose. At one end of each barge is a whirling type crane with a 75-foot steel boom. It is designed for operation of a 2½-yard clam-shell bucket in transferring the aggregates from the river barge to the mixing plant bins. The 150-ton capacity aggregates bin occupies the other end of the barge. It is of steel construction, supported by a steel superstructure. Directly beneath the bin is the batching equipment which measures exactly the right proportions of materials going into each batch of concrete. On the deck beneath the batchers is the two-cubic yard concrete mixer. Between the aggregates bin structure and the crane stands the 500-barrel capacity cement bin.

Each of the four mixing plants is capable of producing a two-yard batch of concrete in two minutes, 19 seconds. The mixer discharges into a two-yard bottom-dump bucket which is swung into position and lowered into the forms by an electric revolving crane equipped with a 95-foot steel boom. Several of these cranes, mounted on gantries, operate on wide-gage tracks along the length of the cofferdams as illustrated on this page.

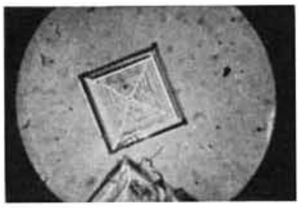
WHILE work has been progressing at the dam site, operations have also been carried forward in the area to be inundated. In January, 1934, the 115 square miles of reservoir area was mapped from the air. Since the survey, over 3000 men have been at work clearing the tract of timber and brush. Though much of the reservoir land is under cultivation, between 20 and 30 thousand acres remain to be cleared by the Authority's forces.

It is expected that Wheeler Dam will be completed in the spring of 1936. From its operation there will be a by-product of hydro-electric power. This by-product electricity is not to be wasted, but will be made available to the residents of the Tennessee Valley and contiguous areas at "yardstick" prices.

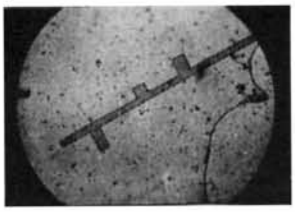
Were Wheeler Dam operated for power purposes alone as a separate and distinct project, it would be at the mercy of seasonal flowage. Operated as a unit in a system of dams that eventually will control the flow of the entire stream, however, it is a highly valuable investment. And as the Authority's program develops, and more storage dams are erected on the headwaters, the value of the Wheeler investment rises in proportion.



2: Strontium nitrate 600X



3: Potass. bromide 600X



4: Potass. bichromate 600X

5: Potass. ferrocy. 150X

WATCHING CRYSTALS GROW

Under the Microscope . . . Perfect Specimens . . . Photomicrographs of Almost Any Chemical

By BENTON STONE, JR.

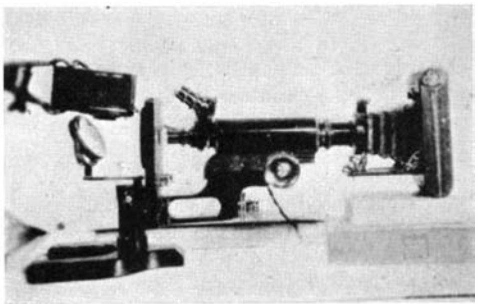


Figure 1: The set-up for the work

FEW things can be more fascinating than watching, under the microscope, very minute seed crystals grow as the solution reaches its saturation point. Gradually the water evaporates, leaving crystalline masses behind.

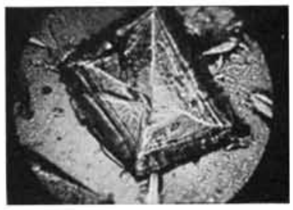
Permanent records may be obtained by the use of the camera in connection with the microscope. Almost any kind of camera will do. With large cameras the best way to make the exposure is by inclining the microscope to a horizontal position, as in Figure 1. The camera is set for a time exposure and focused at infinity. It is then placed with its lens against the eye-piece of the microscope and the exposure is made. Experimentation is the only means of determining the correct exposure. When used with a Kodak Vollenda with an *f*/3.5 lens, or any camera with a high-speed lens, snapshots of one half to one fifth of a second may be made.

Almost any chemical will form interesting crystals. The more slowly the crystals form the more perfect they will be. A very simple way to slow up the rate of concentration of the solution is to place a cover slip over the drop of solution. Usually from three to six hours is sufficient for the crystals to form.

To make a solution of the salt to be examined, place a small drop of water on a microscope slide; then, after dissolving a few crystals of the salt in it, set the slide aside until the crystals begin to form. When the solution begins crystallizing, watch for small seed crystals near the center.

Some of the chemicals that are easily crystallized are: strontium nitrate, Figure 2; potassium bromide, Figure 3; potassium bichromate, Figure 4; potassium ferrocyanide, Figures 5 and 6; and chrome alum, Figure 7. The complex compound potassium mercuric-iodide will form the very beautiful crystals, seen in Figures 8 and 9. This compound is made by dissolving mercuric iodide in a solution of potassium iodide. Figures 10 and 11 show hexagonal crystals of lead iodide which was made by placing a small lump of lead acetate in a solution of potassium iodide. Cupric chloride, Figure 12, and magnesium sulfate, Figure 13, are excellent examples of needle crystals.

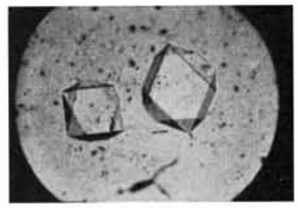
Crystals may also be obtained by sublimation of various salts. Most of these are ammonium salts. Place a little of the salt on a strip of metal and heat until it begins to vaporize. Then collect this vapor by holding a cool microscope slide in the fumes. If ammonium chloride is used, and not enough of the vaporized salt has been collected on the slide for crystals to form, the slide, when examined, will appear as in Figure 14. In this case, allow the slide to remain in the fumes longer and the crystals will form as in Figure 15.



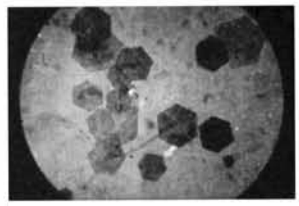
6: Potass. ferrocy. 600X

7: Chrome alum 600X

8: Potass. merc.-iodide 600X



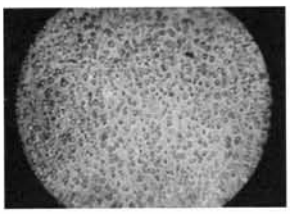
9: Potass. merc.-iodide 600X



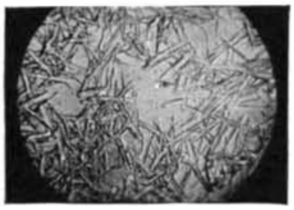
10: Lead iodide 600X

11: Lead iodide 600X

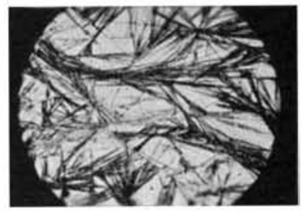
15: Ammonium chloride 600X



14: Ammonium chloride 600X



13: Magnesium sulfate 150X



12: Cupric chloride 150X

WORLD ASTRONOMERS MEET

Every Three Years an International Body of Astronomers Meets, Mainly to Coordinate and Facilitate Cooperation of National Groups

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE meeting of the International Astronomical Union, in Paris, from which the writer is returning as these words are penned, was an unqualified success, and fully justified the long journeys necessary for its existence. If anyone might have doubted this it would have been the courteous and long-suffering press representatives who, inquiring day after day of the astronomers what news there was, met day after day with the response, "Oh, really nothing at all of general interest." But their disappointment arose, not from any lack of scientific activity, but from the very nature of the meeting itself. The Astronomical Union is definitely a working organization concerned deeply with actual investigation, but not at all with the announcement of its results. No great discoveries are made public at its meetings: indeed, it holds no sessions for the presentation of scientific papers, small or great; this is left to professional societies or academies of science. As in most other efficient bodies, the greater part of its work is done in committee—here, indeed, practically the whole.

There are more than 30 of these committees, dealing with subjects of all sorts, from the sending of astronomical telegrams to the internal constitution of the stars. Some have as few as five members, some more than 30, but in all cases membership is restricted to those who are working actively in the particular field.

MANY months before the meeting the chairman of each committee prepares a preliminary report and sends it by mail to the members—scattered, it may be, over three or four continents. From the replies, comments, and suggestions, he constructs a "draft report" which is sent to the general secretary of the Union, printed, and distributed to the members generally. These reports, for the Paris meeting, form a volume of more than 240 printed octavo pages.

Five working days, morning and afternoon, were devoted in Paris to the final sessions of the various committees. To adjust these so that no committee member was obliged to be in two places simultaneously must have been no small task, but it was accomplished with almost complete success. At these sessions the draft reports are discussed, bit by bit, not only by the committee members but by any other astronomers (for the meetings are open to all members of the Union), and put into final form, accompanied by such specific recommendations as are required. After this thorough-going and democratic preparation, all that remains at the subsequent "general assembly" of the Union as a whole is the formal acceptance of the reports and a specific consideration of requests for appropriation of money from the smallish funds which the Union has in its hands.

More than 30 nations belong to the Union, and 24 of these were actually represented at Paris. The French delegation was naturally the largest, with the British second. Next came the Americans—indefatigable travelers; then the Belgians; and so the list ran on to those small, remote countries which had but a single representative.

This disparity was not allowed to influence the Union's policies. The important special committees on finance, and on the personnel of the new committees, were composed of national delegates, one from each country. A somewhat similar scheme of voting by countries is provided, in event of a close decision at the general sessions, but no such differences of opinion arose this year. The chief practical inconvenience in working this well-designed scheme—and one which is unavoidable at a purely international gathering—is the old Curse of Babel. French and English were equally the official languages of the meeting but, alas, the number of astronomers who had really a mastery of both was all too small. Very few Frenchmen spoke English—a few or fewer Americans could manage with French. The Englishmen were a bit better, but honors fell, as always, to the Dutch and Scandinavians, practically all of whom were fluent in English and many in French as well.

Most of the delegates could read the other language almost as easily as their own. But only the painful attempt shows how far this reading knowledge is from the power to speak. Fortunately there were a few first-rate linguists who carried off admirably the difficult duties of interpreters. After every important speech in committee or in debate it was repeated in the other language, and the same was done for each motion before it was put. The writer recalls with gratitude the Belgian secretary of one committee—appointed despite his disclaimer of much knowledge of English—who, immediately after the conclusion of each man's remarks in a lively and technical discussion almost all in English, entered on his minutes an accurate and lucid abstract in French.

SO much for the machinery of the conferences—what of the results? These are naturally as varied as the subjects with which the committees deal. For example, that upon the constitution of the stars has always reminded the writer—who belongs to it—of the Scotsman's description of "four and twenty pipers each playin' his ain tune." Pioneering is not done according to rule. But the meeting of the committee, at which Sir Arthur Eddington, its chairman, called on half a dozen or more people who knew something about the subject for brief discussions of the present problems, was one of the high spots of the week.

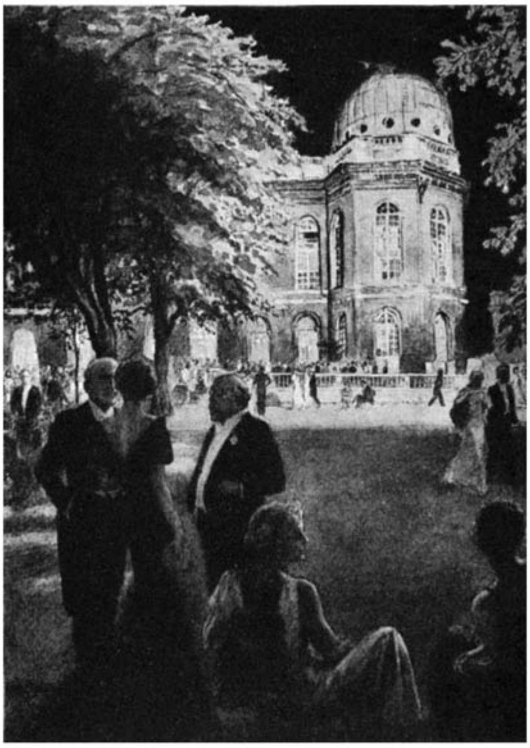
Some committees have laboriously worked out results which, when finally put into shape, are likely to remain standard for many years. The committee on standard wavelengths, for example, gives tables of lines of neon and krypton, measured with the greatest care by three or four different observers in various countries, for which the extreme range of difference among the results averages less than one part in 10,000,000, and discusses the details of laboratory technique necessary to secure an accuracy of one part in 50,000,000! Others, with no less labor, must deal with a human element. The

AGAIN

committee on notations and units presented a list ten pages long of proposed symbols for the quantities which are most often used in astronomical discussions. Some of them are already almost everywhere in use, such as *z* for the zenith distance of a star—alpha (α) for its right ascension. For others, various investigators have used quite different letters, to the great discomfiture of the student who tries to compare one paper with another. After discussion of a number of details, the committee voted to recommend the list for publication as a preliminary set of suggestions, inviting anyone who advocated changes or improvements to write to the chairman, in the hope that at the meeting three years hence some definitive list might be recommended—not, of course, imposed on anyone by compulsion, for the Union has no such authority. One chairman at least will probably be kept busy!

PERHAPS the knottiest problem that anyone had to consider was the terms used to describe our time reckoning. Before 1925, astronomers counted the hours of the day from noon (so that the local time was identical with the sun's hour angle), while the day began by civil reckoning at midnight, 12 hours before. It was internationally agreed ten years ago that the astronomical reckoning, too, should in future be made from midnight. No confusion would arise if the new time reckoning had a new name and, outside of England, it was usually called Civil time, while astronomical mean time was counted from noon. The abbreviations G M T, for Greenwich Mean Time, and G C T, for Greenwich Civil Time, have been used ever since in the American Ephemeris. But—so gossip has it—when these letters came to the attention of a distinguished British admiral, he remarked, "This won't do at all—G C T is Gunnery Control Tower." Be this as it may, admiralty orders appeared compelling the British nautical almanac to use G M T to denote time counted from midnight. To add to the tangle, it appeared that, under English law, "civil time" denotes the reckoning established by Act of Parliament, so that when "summer time" was thus adopted for daylight saving, this and only this could lawfully be called civil time!

Now Greenwich time has long been used as a base for general international reckoning. Before these complications arose it had been suggested in Germany that time according to this reckoning be called *Weltzeit* (W Z)—that is, world time, while a French suggestion was U T, which in French or English stands for Universal Time. Both expressions mean exactly the same as "Greenwich mean time counted from midnight," neither of them has yet been used to mean anything else. One or the other of these (or very likely both, W Z being the German translation of U T) is likely to be generally adopted to clear up the muddle. The writer regrets a little that the new phrase is not "world time," but the French symbol has clear priority and may therefore be adopted, though it reminds one a little of the beauty contest promoters who propose, after selecting "Miss Europe" and "Miss America," to decide which of the two deserves the final honor of being "Miss Universe." But the White Knight was right when he told Alice-through-the-looking-glass, "What a thing is, and what is its name, and what it is called, are all quite different."



An evening party at the Observatory of Paris, in honor of the International Astronomical Union. Drawing by J. Simont, in *L'Illustration*

NO less valuable than the formal meetings were the informal discussions in between. The writer, for example, is much indebted to Dr. Antoniadi of the Paris Observatory for his details of his observations of Mercury with the great telescope at Meudon. In agreement with others, he finds that the planet keeps the same face toward the sun, and exhibits darkish patches somewhat like those on the moon as seen with the naked eye. These markings are permanent, but at times he has found one or another to be "obscured" and practically invisible. He explains this by the presence of a thin atmosphere—too little to produce twilight effects but enough to stir up at times clouds of dust which veil the surface. While it is not certain that this is the only explanation, these reports by one of the most skilled of planetary observers leave the question of Mercury's atmosphere open again. Though the planet certainly could not retain the lighter gases, there appears to be no conclusive reason why it might not have some atmosphere composed of heavy molecules such as carbon dioxide or denser gases. Adams and Dunham have detected no spectroscopic evidence of atmosphere, but an amount much too small to pass this test would suffice.

To return to the Astronomical Union: A New Committee on Comets was formed, and an old and inactive one on Lunar Nomenclature was revived as a general committee on the moon dealing both with its physical characteristics and with the theory of its motion and the observation of occultations. Professor Baldet, the discoverer of the characteristic "comet tail" spectral bands, is an appropriate chairman of the first, and Professor Brown, known to all men for his lunar theory, of the second.

An invitation to hold the next meeting of the Union in Stockholm was enthusiastically accepted, and only the election of officers remained. Dr. Esclangon, Director of the Paris Observatory and our principal host during the meetings, was elected president. Among the vice-presidents are Adams of Mount Wilson and Spencer Jones, the Astronomer Royal. Dr. Oort of Holland is the new General Secretary.

The social side—always a pleasant part of the international meetings—was unusually so this time. A long series of receptions, excursions, and dinners culminated in a banquet on July 14th upon the Eiffel Tower, whence the brilliant illuminations and fireworks of the national holiday made a splendid spectacle, and in a reception by the President of the Republic, who thus showed most gracefully his interest both in science and in international good will. Deep appreciation of the cordiality of our reception, no less than of the success of our scientific work, forms the final impression of the conference.—*At sea, M. V. Georgic, August 2, 1935.*

NATURE FAKING AGAIN

Silly Stories and Pictures to the Contrary Notwithstanding . . . Quite Unthinkable . . . Often Laughable . . . Nonsense . . . Fancy Yarns

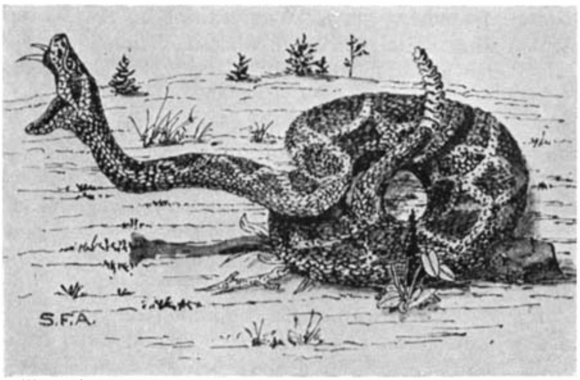
By S. F. AARON

EXAGGERATED wild yarns by observers who are not only to be respected for their love of nature but also for their delightful portrayals, are far too many in number and importantly presented. As such, these observers do much more harm than the spinners of wilder stories who should confess to entire ignorance. It is not altogether surprising that palpable nature fakers find opportunity to get into print, for they tell much that is faithfully illuminating. Generally the editors of literary and popular periodicals and books know even less about these things than the writers, and thus they accept without question many remarkable stories, and brag about the writers to boot. In most cases a boot should be applied somewhere.[1]

Recently we have seen the remarkable assertion, on the part of the editor of a leading magazine, that the author of a certain nature yarn was the best informed upon his subject among naturalists anywhere. A fine compliment, this, to the scores of capable investigators! It followed the telling, by the boasted and boosted one, about a horse which feared the odor of a rattlesnake (which is a direct untruth), and it even referred to the maker of mud-dauber wasp cells as being of the masculine gender!

Many of our recent nature narrative writers who have sought to emulate White of Selborne, Burroughs, Thoreau, and especially Seton, have floundered, sometimes badly, in the quagmire of lack logic. Seton himself, remarkable for his wide knowledge, was not altogether free from small errors, as when he made Wully, the dog, close the window through which he returned after a sheep-killing foray. No canine will close a window nor a door after entering, unless especially trained with much care. Marvelous ferocity is also ascribed to the fisher, listing among its victims the fox, badger, beaver and even the otter and bobcat. Much of this will not hold water, for some of these creatures could not be overtaken if they chose to retreat, while others are too powerful for the fisher.

It should be well known that, however savage and blood-thirsty any killer may be, whether cat, wolf, bear, or of the weasel family, there is always uppermost a distinct respect for others of like nature and anywhere near the same size, for the severe wounds given in a contest are disabling, and no hunting mammal can well afford to be thus handicapped, even though it is sure of getting the better of the scrap in the end. Thus the puma and the bear respect each other, various silly stories and pictures to the contrary notwithstanding. The same may be said of the



Illustrations by the author

How a rattlesnake strikes: It requires a solid base—half or more of its body on the ground—to permit the forward one third to do its work effectively

puma and the big timber wolf, the fisher and otter, the wildcat and raccoon, the fox and mink, and the mink and weasel, all of which seek the course of least resistance even when tidbits may be a cause of envy between them, for a law of the wild that holds the captor or first possessor of food to be the rightful owner is generally obeyed.

Bloody warfare between killers and other creatures—often battles to the death which never occur even between rival lovers—is the most fruitful subject for nature narrative thrills, and it is an unusual book or article by any of the fakers that does not include some such incident, often one at least to each chapter. Thus we have our two wildcats meeting and fighting on general principles, and this is quite unthinkable. We have a badger and a coyote disputing for no worldly reason; and so on through the list of killers, even down to the tiny shrew which one of our nearly unlimited exaggerators calls "little death" in a chapter devoted to such remarkable adventures as the killing of a water snake by the brave insectivore.

Studies of the food habits of reptiles depict numerous shrews and mice being swallowed by water snakes, milk snakes, king snakes, young black and garter snakes, and even by the slow-moving spreading adder.

NATURE narratives are also noted for their superlatives galore: the strike of a rattlesnake is said to be "the swiftest motion in nature;" the heroic duck hawk "the speed king of the air;" the leap of a stag as the floating of thistledown; the tireless speed of a wolf as unequaled; the bloodthirstiness of a weasel as quite beyond compare—all these to be virtually contradicted later when other creatures are the chosen heroes. All of these statements are untrue.

These stories are often laughable, as for example the narratives of the delightful writer who is a member of scientific societies and whose works are always eagerly read. In one article he presents the peregrin falcon, *i. e.*, the American duck hawk, as the swiftest of all birds and doing unbelievable stunts in the air, in addition to its well-known swoop from on high. In another magazine he declares the northern gyrfalcon to be the swiftest of all birds, and in an account of a Mongol emperor's falconry he tells of two of these rival hawks swooping at each other in mid-air until one is killed, the description being such as to give the impression that by contact of the breast bone, or some such bomb-like influence, the victim was burst open. This is al-

[1]The author evidently believes that editors would prove to be reformable!—*Ed.*

most unworthy of comment; these hawks strike with their talons to rip and kill, and two of the same or allied species will not fight each other. Never more absurd yarn was written.

And this last-mentioned author also quite eclipses himself in writing for one of our leading fiction magazines about wildcats. The climax is reached by admitting the yarn of an old southern hunter, that one of his hounds killed a full-grown bay lynx by gripping its chest and bearing down upon it. Now, imagine a hound's force shutting off the vitality of a creature that sometimes survives for a time the crushing weight of a dead-fall. What would the eyes, ears, jowls, tender nose, neck, and belly of that hound resemble after the cat's awful claws had been busy for a few seconds? Is it not strange that faculties of observation sufficient to permit a fellow's becoming any kind of naturalist would not set him straight enough in a matter of this kind to avoid repeating such nonsense?

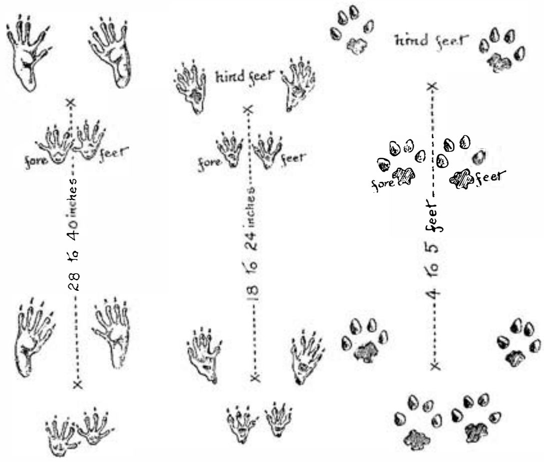
ERRORS due to ignorance are much too common in the form of assertions after quotations repeated from sources that are often unknown. The function of cocoons as a protection to the chrysalides "from cold" is as old as Drury and Westwood, but unfortunately the thickest and strongest and warmest cocoons are found in tropical countries where the bills of parrots are most powerful. Common sense should indicate that there is not enough heat within the insect body to withstand cold in any covering.

This leads to the common and oft-repeated impression that cold weather destroys insect life. As a matter of fact, it does nothing of the sort, but only suspends vitality, and the consequently inert insects that have not lived their natural lives are destroyed by their enemies.

The statement is also made that cold weather is fatal to reptiles—this in a nature narrative by an exceedingly presuming nature student. But the finding of snakes wintering under shallow stones, frozen stiff but easily revived by warmth; also the existence of salamanders and frogs under similar conditions, proves the contrary.

Ephemera or day-flies are commonly believed to live only 24 hours but many species that do not immediately mate and lay their eggs after leaving the pupal form in the water survive for more than two weeks.

It is more than amusing to read of venomous snakes leaping at their enemies or prey; a score of writers have so stated. But naturalists well know that no snake can strike more than one half its length, and that snakes rarely attempt to reach more than one third. Then we have the common impression that the bite of poisonous reptiles is always fatal, and this has been the backbone of more than one fancy story. Records prove that about one such bite in 20 is fatal.



The rapid running tracks of the raccoon (left), gray squirrel (center) and bobcat (right) are evidence that the hind feet overlap the others

THE speed of snakes, especially the black snake and racers and the western coach-whip, is often ridiculously exaggerated. Even that great naturalist and paleontologist, Edward D. Cope, was once misled regarding this matter, but by test it has been proved that no snake can travel faster, under any conditions, than a person can walk.

Repeated attention must be called to that oft-told and absurd yarn that infers hypnotizing powers possessed by the weasel. The little killer's motions are so swift, its fearlessness so marked, and its successes so common, that it is hardly more than natural for the fakers to capitalize upon these powers. We are not only led to suppose but we are indeed plainly informed that, when the weasel desires rabbit for dinner, it has merely to find Molly and almost calmly cut her throat with little or no protest on the part of the victim, who apparently knows the futility of trying to escape. Squirrels also come under the spell. How ridiculous indeed is the notion that any creature endowed with the primal desire for self-preservation should not practice it with extreme energy at all times![2] As a matter of fact, for every rabbit that is killed by weasel or mink a score of them escape and, were it not so, there would very soon be no rabbits. Every experienced field naturalist has witnessed Molly breaking away through briars and leaving the baffled killer behind, or by powerful kicking and leaping and superior speed saving her life.

With regard to this power of the mustelid killers, there is every reason, based on wide observation, to contradict the statement in "Wild Animals of North America," published by the *National Geographic Society*, that the comparative slow-going fisher captures snowshoe rabbits in fair chase, and squirrels without difficulty in the treetops, as also do martens.

IN the line of faking, because of the nature of the contribution, the limit of error has almost been reached in a popular periodical. Under a caption that infers that it is well not to let the world get ahead of the seeker for information, the statement is made that the greyhound, hare, and kangaroo are the only animals that hit the ground with the hind feet in front of the forefeet when running. All the active rodents, such as the squirrels, the kangaroo rat, many of the mice and lemmings, the woodchuck and whistler, the little chief hare, the raccoon, the mink, weasel and fisher, the wolves, cats, and the prong-horn antelope, and very probably the many deer species all the world over, so place their feet when in a hurry, and there is good evidence also that a running race horse does the same, though more irregularly. A paragraph in the same article states that there are yet *millions* of fish and insects still unclassified. This also is an absurdity; the exploring naturalists and collectors have brought from every part of the world nearly all kinds of plants and animals, and the systemists have named and placed them in their proper genera and species.

The weasel is a ferocious animal but is not capable of climbing as fast as a chicaree. On the ground the two are about equal in speed

[2] *Editor's note:* As the author states, the idea of an animal abandoning the instinct of self-preservation surely is ridiculous. Even so, we once watched a cat on the ground, five feet from the base of a tree, and a squirrel ten feet above, each for some time steadily eyeing the other. Then we saw the squirrel trot quite slowly down the trunk and along the ground, not in some other direction but straight to the cat's jaws. The squirrel definitely went to the cat, which did not move. On the grounds advanced by the author this was indeed odd conduct. We do not claim that there was hypnotism, or that we understand it; we merely describe what happened.

LIGHT WAVES IN INDUSTRY

Gage Blocks . . . Master Gage Blocks . . . Optical Flats . . . The Master Controls

By EVERETT W. MELSON
Bausch and Lomb Optical Company

ONE of the primary factors in our ability to turn out masses of products that are satisfactory in performance is the ability to create machinery of unusual accuracy. This accuracy has come about by methods of measurement which have cut the tolerances in machine tools to fractions undreamed of 50 years ago. In the production of machine tools few things are more necessary than precision gage blocks. A steel block about one inch in length is just a piece of steel, but with proper heat treatment, extremely refined lapping, and measuring processes, it may be finished until the length is definitely known to be one inch within a limit of one-millionth. This is a gage block. Without such an instrument, manufacturing in mass on a basis of interchangeable parts would be impossible.

It must be apparent that, behind the ordinary measuring tools and gages used by the machinist in controlling everyday production, there are other and still more accurate measuring and checking devices for testing the accuracy of his tools. Since all tools inevitably wear, warp, or lose temper with use, the work controlled by each will vary to such an extent that parts will not interchange and mass production becomes impossible, unless their precision is restored. Accordingly, in most large industries there is an inspection department, headed by a chief inspector, who has under him foremen inspectors for the various departments.

IN metal working, the chief inspector is usually a trained metallurgist acquainted with the materials of machine construction, testing of materials, and the hardening and tempering of steel. It is necessary for him to know that brass or bronze, for example, will stretch, and that holes reamed or drilled in these materials are usually smaller than holes made with the same tools in cast iron. He must know that tools used in machining aluminum require more rake, or cutting angle, than is used for steel because aluminum is lighter and more ductile. Inspections are dependent on the nature of the material being worked and the tolerance permitted. In working some of the nonferrous metals with a tough texture and a peculiar flow, an inspection of tools may be required after every operation. Daily inspections are necessary on many screw thread jobs, but weekly and monthly inspections suffice in many industries.

As the life of machine parts is determined by the kind of metal on which they have to work, so the life of gages is determined by the metal in the machine parts. Cast iron, because of the presence of crystals of cementite or carbide of iron in the metal, is likely to wear the surfaces of a gage at the rate of 0.00025 inch for about 10,000 parts inspected. Aluminum, containing alumina or aluminum oxide in crystalline form, may be expected to wear a gage 0.00025 inch for 11,000 parts tested. In steel the lapping effect is not so great and a gage may inspect 30,000 parts before losing its tolerance.

Ordinarily four sets of gages are used for inspection work on machine parts—master, checking, working, and tolerance. Master gage blocks, themselves accurate within five millionths of an inch for the small ones, are checked against still more accurate pieces of glass or quartz, worked so nearly to a perfect flat that if the surfaces were extended for 75 miles they would deviate not more than an inch from a straight line at the terminus. Thus gage blocks and optical flats are the master controls of modern mass production, to which all tools are referred in final analysis. Small as they are, their significance to industry is large.

As difficult as is the mechanical achievement of securing accurate flatness and parallelism in the surfaces of such blocks, the problem increases in difficulty when it is necessary to attain, in addition to the flat, parallel surfaces, a given length within one millionth of an inch. The process is still further

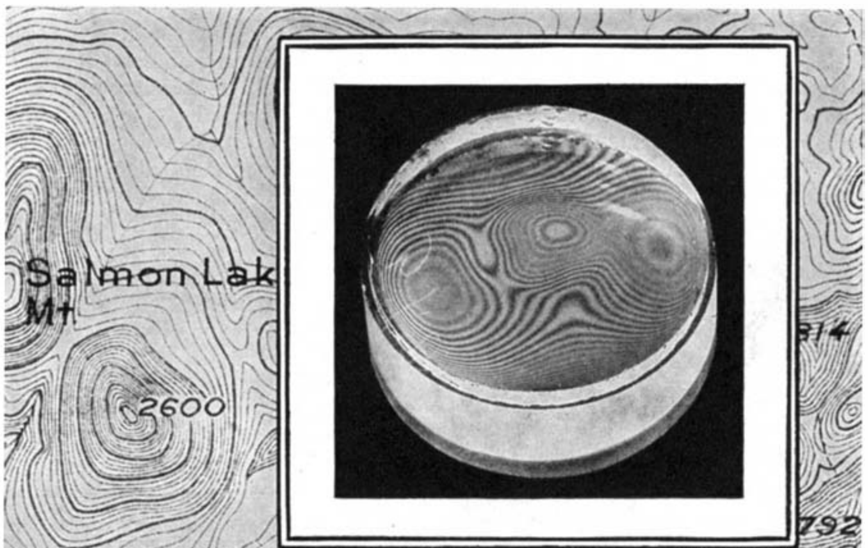


Figure 1: **Interference fringes between a flat and a surface which is about 20 fringes (equalling 10 wavelengths, or 1/5000 inch) curved, and irregular. The fringes are interpreted precisely like contour lines on a topographic map, the "contour interval" being one half wavelength, or about 1/100,000 inch**

complicated when a complete series of blocks must be produced by progressive increases in size, or increments of one ten-thousandth inch.

Since the kind of steel used in a gage block has much to do with the final success of the work, extreme care must be exercised in its selection. Many experiments have been made by the Bureau of Standards and gage manufacturers to determine the formula that offered the important qualities of permanence and stability. Carbon steel and chromium steel have proved most satisfactory.

As durability and permanence are important factors in making gage blocks, the heat treating process is an important and critical operation. The smallest variations in condition or structure may ruin the blocks. The stabilizing treatment must be controlled within a narrow range of temperature, as this process is largely responsible for the permanence of the finished gages.

Owing to thermal expansion, material standards of length can be correct to their nominal sizes only at one particular temperature. Therefore, in machining parts to accurate dimensions it must be determined at what temperature the sizes shall agree with the figures specified. The measuring instruments are adjusted to suit that temperature, commonly known as the standard temperature, or temperature of adjustment. In America, 68 degrees, Fahrenheit, is the standard in general practice in the engineering industries. While it is impossible to avoid some contraction and expansion in the blocks with changes of temperature, once a block is made to a predetermined size at a fixed temperature, it will usually return to that size when subjected to the original temperature.

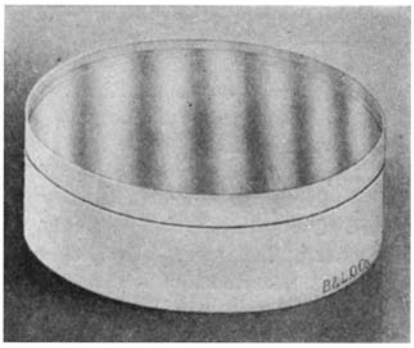


Figure 2: **Straight fringes—the upper and lower disks are flat to at least a millionth of an inch**

No matter how accurate a precision gage block may be to begin with, it is useless as a standard unless it retains its original accuracy. Changes which ordinarily would be unimportant are very serious in blocks made to obtain a range of dimensions varying by only 0.0001 inch. Here, errors of a few millionths of an inch cannot be tolerated.

And now the question is, how do we know that these gages are correct to within one millionth of an inch?

Most of us have noticed the iridescence in a drop of oil floating on water. The tiny rainbows that appear are due to light wave interference. When light waves strike a surface they are reflected, and when two surfaces are close together, such as the top and bottom of an oil film, light waves are reflected from both surfaces; but because the distance is greater to the second surface, the reflections interfere, producing bands of colour instead of white light. These are called Newton's rings.

Light waves possess all the necessary properties of fundamental units of length, the most important of which are constancy, reproducibility, accuracy of measurement and ease of application. Because they vary in length, different color sensations are received by the eye. When two trains of waves from one point in a source, having traveled different paths, fall upon a point on the retina, the resultant amplitude of vibration determines the brightness. If they are "in step" maximum brightness results. But if the troughs of one arrive with the crests of the other, destructive interference takes place, resulting in darkness. If the two trains travel different distances, so that the difference in path is some whole number of wavelengths, then the waves will reach the eye in phase.

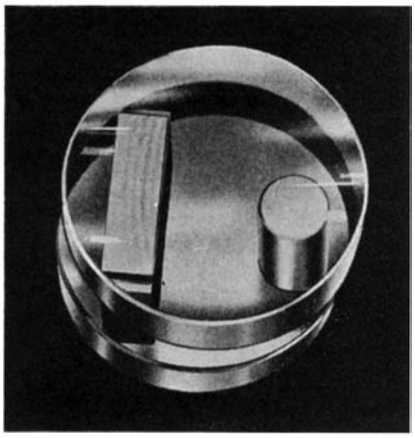


Figure 3: **A gage block between a pair of flats, for testing a part**

By the use of optical flats, light waves are utilized in testing plane surfaces. If we take two perfectly flat pieces of glass, or preferably quartz, and lay one upon the other, touching at one edge but slightly separated at the other, a wedge-shaped space will be left between them. If the surface being tested is irregular, the pattern produced by interference assumes the appearance of a contour map, as shown in Figure 1. The position and number of bands or "fringes" shows the exact location and characteristics of the surface irregularities. If the surfaces are absolutely flat, alternately colored bands will appear—parallel and straight (Figure 2). The distances between the surfaces at the first dark band is approximately half of a wavelength or one one-hundred thousandth of an inch; at the second, two one-hundred thousandths; and so on.

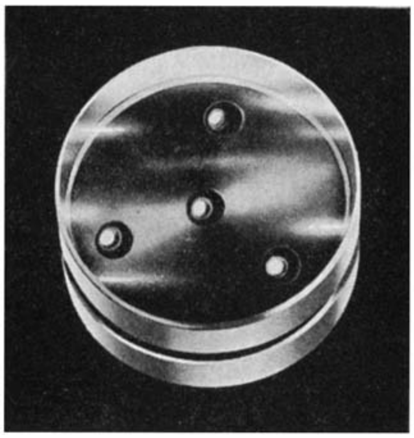


Figure 4: **This is not an optical test but a purely mechanical one**

With light waves it is as easy to measure in units of hundred-thousandths of an inch as it is to measure in thousandths of an inch with a machinist's micrometer caliper, but the accuracy of light waves, measured with the same degree of care and skill, is a hundred times greater than the micrometer. Furthermore, as the experienced machinist estimates tenths of graduations with a micrometer, the user of light waves estimates in millionths of an inch by a kind of interpolation.

In the comparison of a precise part, having plane surfaces, and a standard gage block, two optical flats are used. The part and the gage block are wrung on to the lower flat with a twisting pressure of the hands and the upper flat is held securely touching the top of both the part and the gage, shown in Figure 3. From the position, direction, and spacing of the lines, the exact amount that the part differs from the standard can be determined in millionths of an inch. In sodium light the presence of each Newton ring discloses a separation of half a wavelength, equal to 12 millionths of an inch.

The adherence which can be obtained between two gage surfaces through the feature of "wringing" is itself an excellent criterion of their flatness. A general curvature amounting to more than 0.00001 or 0.00002 inch at the center of the surfaces is sufficient to affect materially the tightness of the wring, unless the curvatures of the two surfaces tend to match. It is possible to wring together a number or train of gages with a combined twisting and sliding

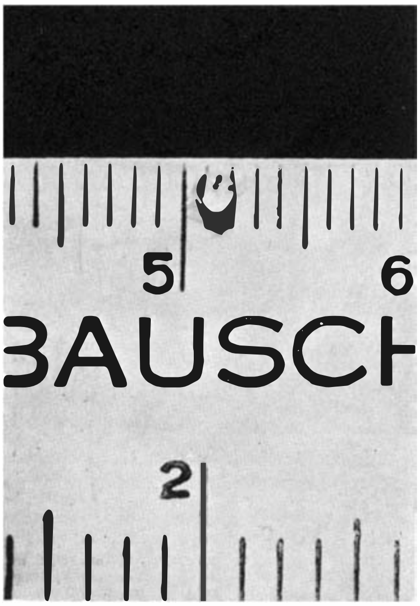


Figure 5: **A tiny lens, worked to a precision of a millionth inch**

motion. When brought together in such a manner, it is found that the gages adhere strongly and thus form a single gage whose length is the sum of the component gages. The adherence is due almost entirely to the presence of a liquid film between the faces. This can be shown by carefully cleaning two gages with alcohol or ether, after which no appreciable wringing effect can be obtained. But the mere touch of the fingers or hand deposits enough moisture or grease to restore the wringing effect.

Although the presence of a liquid film is practically essential for cohesion to take place between the gages, the thickness of the film is very minute if the gages are properly wrung. A large number of measurements show that when two very plane surfaces are brought into contact in this manner the separating film is not more than one millionth of an inch thick. If the gages have a high optical finish more intimate contact is possible, because the capillary film is thinner. Then the required separating force may range from 95 to 100 pounds per square inch. Gages with less than half a square inch of surface area have been known to sustain a separating force of 220 pounds.

THE closest approach to ideal flatness and smoothness of surface is achieved in the high quality optical flat. It is very dangerous to allow such surfaces to come into intimate contact, since the molecular attraction across the interface approaches that across a plane through the solid glass and the flats tend to become one solid block. That such a tendency does exist is shown by the fact that efforts to separate two optical flats which have been firmly wrung together almost invariably results in partial destruction of their surfaces, small pieces of glass being pulled out of each face by adhesion to the opposite surface.

In addition to plane surfaces, the diameter of a ball or cylinder may be easily measured in comparison with a gage-block. Steel balls are frequently used in tool rooms and inspection departments as standards for testing micrometers and for gaging cylindrical and taper holes. Periodical measurements of steel balls have shown a marked tendency toward shrinkage to occur with age. This necessitates re-standardization at frequent intervals. One method of doing this is to place a gage block, and the ball to be measured, between two optical flats. The ball serves as a taper gage, with the dark interference bands as graduations of .00001 inch. With only two flat surfaces and a gage block standard, any piece that is ordinarily measured between the flat surfaces of a micrometer or measuring machine may be easily and accurately measured with light waves. Another way is to choose three balls by comparison with gage blocks. These are placed equidistant around an improvised retainer and held between the flats (Figure 4). A larger hole in the center of the retainer holds the ball to be tested for size. Moving the top optical flat will cause the three outside balls to move if the center one is too small, but if the outside balls fail to move the center ball is too large.

The extreme precision secured with light waves may be illustrated by an apparatus consisting of a solid steel bar five inches in diameter with end supports 36 inches apart. A gage attached to the bar, and an optical flat fastened to the channel iron structure above the bar, serve to set up interference bands. A slight downward pressure of the fingers on the bar causes the gage to move away from the optical flat and the bands to move. It is very easy to bend the bar with the fingers to show a movement of the bands two or three times the distance between successive bands, or two or three hundred-thousandths of an inch.

In measuring with light waves it is convenient to reckon in millionths of an inch or tenths of a unit indicated by each dark band. Thus the hundred-thousandth of an inch is ten millionths; the ten-thousandth is hundred millionths and the thousandth is thousand millionths. Such a small unit of measurement is hard to conceive. It may be understood better perhaps by knowing that a half inch steel bar projecting twelve inches from a vise is bent downward approximately one millionth of an inch when a common house fly alights on the end of the bar.

THERE are many possible applications of light waves to industrial requirements and for scientific research. In the largest optical institution in America, scientists bend light with utmost precision in lenses and prisms. In the precise work of making prisms for military range finders, lenses for large telescopes and high power microscopes, such a slight irregularity as a millionth of an inch is a serious matter. The right angles of prisms, whose sides are about an inch long, are machined to within one second of arc: that is to say, were the sides of the prism to be extended, the error from the right angle would be less than a foot at a distance of 43 miles.

In the group of roof prisms shown in Figure 6 is a very small prism with four polished and two ground faces, the largest dimension of which is about one-eighth of an inch. The angles are within ten seconds of the specified values. In Figure 5 the front lens of a microscope objective is shown. This little hemisphere is but three hundredths of an inch in diameter but is accurate in dimensions to ten-thousandths, while the surface errors are reduced to millionths of an inch.

In hundreds of plants where interchangeable parts are made by the thousands and millions, light waves are the court of last resort in determining whether a machine tool is meeting the specifications required. Back of all the complicated machinery that whirs in industry are a few small bits of flat surfaced glass that keep it on its course.

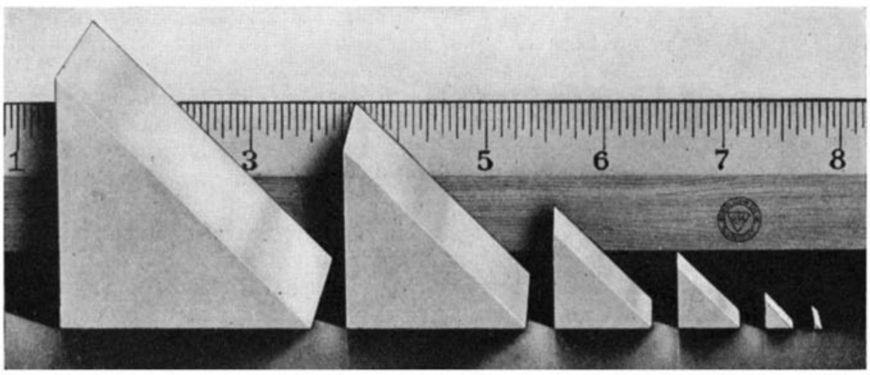
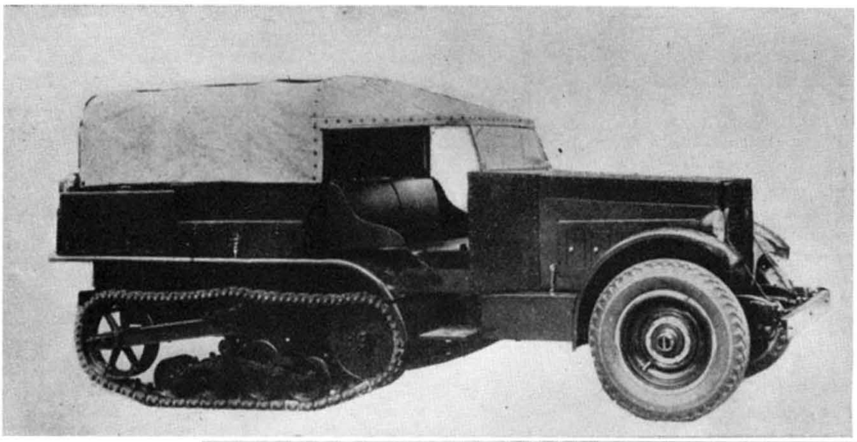


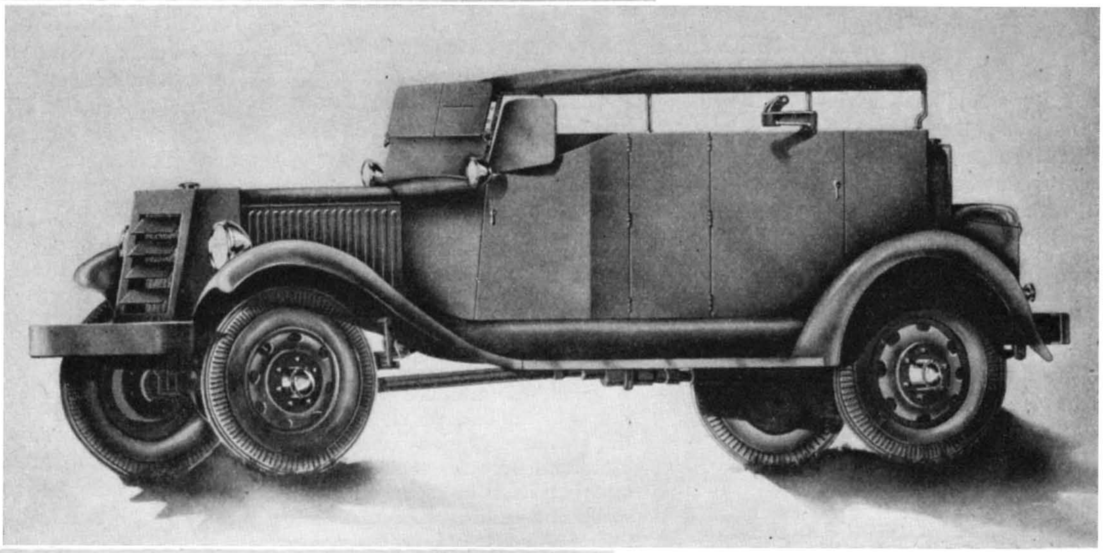
Figure 6: **When the flatness usually required in high grade work, two millionths of an inch, is combined with high angle precision, the problem is compounded**

Military Motorization



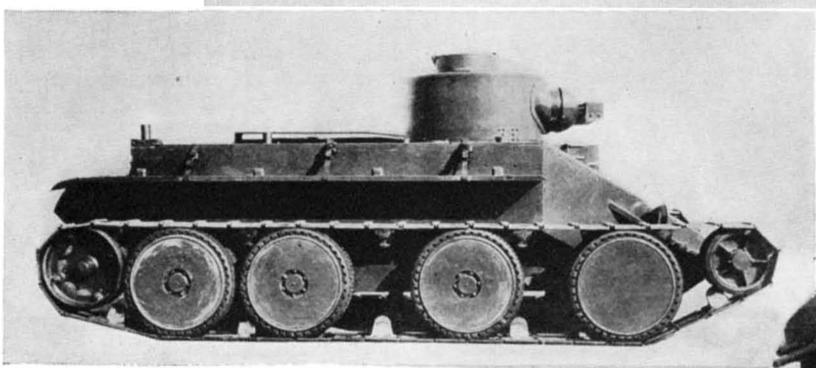
ONE of the many important lessons taught by the World War was the necessity for increased mobility of all sorts of vehicles under fire. Military designers have, therefore, put considerable effort into the problem of building up a motorized army. On this page are shown four of the newer units that have been developed. The armored cars, intended mainly for reconnaissance, will not be subjected ordinarily to machine gun fire and thus have pneumatic tires for greater speed. It is believed, however, that a non-deflatable, soft, sponge-rubber tire may soon be worked out.

A hybrid with great potentialities because of its top speed of 45 miles per hour and its ability to negotiate comparatively rough terrain with ease. Called a "half-track" car, this vehicle was designed in 1933. Its cruising radius is 100 miles



On cars for scouting purposes, even less armor is required than for other types. Adapted from a light commercial truck, this scout car is but slightly armored in its most vulnerable parts. It has a speed of 50 miles per hour

Photographs courtesy *Army Ordnance*



A versatile fighting unit is the Christie tank, shown above. This medium tank, designed in 1930, speeds 30 miles an hour on tracks; with tracks removed, it makes a speed of 60 miles an hour on its solid-rubber-tired wheels. Cruising radius, 100 miles

This armored car, designed in 1932, is a formidable unit. Carrying a crew of four men, it has a cruising radius of 250 miles and a maximum speed of 60 miles an hour. Our criticism is that its tires seem too much exposed and vulnerable to rifle fire

What is Scientific Proof?

The Commonest Mistake . . . What the Real Method of the Scientist Demands . . . Hard-boiled, Cold, Rigorous Logic . . . Two and Two are Not Nine

By T. SWANN HARDING

HAVING been trained in science I have what I find to be a particularly bad habit of saying, "But that is not true scientifically." Scarcely anything is more annoying to a person's habitual associates, especially to his wife, than that habit. I am therefore asked in return, and sometimes with scant courtesy: "Then what is scientifically true? How do you prove anything by science? What sort of evidence would convince a scientist?"

Now there are scientists and scientists. Some of them are quite as credulous as other people, particularly about matters removed from their special field, and very often even about matters well within that field. We all err in the matter of belief upon insubstantial evidence. Nevertheless there is such a thing as scientific evidence, and scientific proof is not based upon casual and fortuitous association of events. Let us take a commonplace example.

One of the oracles who runs a very popular newspaper column today remarks that, while Houdini scoffed at superstition, and deliberately made himself 13 at dinner in the June before he died, he did pass on the following December. Moreover, at least one other June diner also died later. Hence one infers that Houdini died because he made 13 at dinner, just as one is expected to infer that every scientist who was at King Tut's tomb dies as a result of an ancient Egyptian curse, whenever and wherever he ultimately dies.

This is not scientific evidence. It is a perfect example of the most respectable and almost the most unavoidable fallacy there is, the one called *post hoc ergo propter hoc*, which means, translated into the vulgate, that because this event has taken place after that event, it was caused by that event. Yet while there is one chance that the preceding event did cause that which followed, there are literally millions of chances that it did not. Other relevant factors were not controlled, as they should be, and there is the rub.

A few years ago an elderly American physician gave an example of the same sort of thing when he wrote: "In 1888, at an international medical congress, I ventured to offer a paper in which I

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A good old-fashioned cold cure, in use as far back as 1175 B.C. In the ancient Egyptian scene, magicians and apes are making magic by tying knots in ropes, muttering spells, and shaking these spells into their hand nets, whence they were cast over the monsters at the right, to rob them of their baleful power and the cold they were causing. "Depart, son of a cold," was the incantation, "every god curses thee." This was as efficacious as saying, "Seven, come eleven!" Probably our best modern treatment for a cold is 24 soft linen handkerchiefs. No progress since 1175 B.C.

suggested that summer diarrheas of infancy might be due to poisonous milk. When the paper was opened for discussion a learned, elderly man arose, and after making some feeble complimentary remarks directed to the writer, proceeded to demolish all his claims, and finally to suggest that the higher infantile mortality, which was becoming greater and greater every year, could be attributed to the more common use of the baby perambulator because, he said, that the death rate among children in this country has increased since the baby cab had come into use. When I arose to open the discussion, I said that I would withdraw all I had claimed concerning poisonous milk, that the argument adduced could not be contradicted, but I would suggest that the high infantile mortality was due to the fact that we were more in the habit of carrying umbrellas than our ancestors, or that possibly it might be due to the fact that we eat more tomatoes than our grandfathers did."

This amusing paragraph needs little or no comment. In the same way it may be that increasing appendicitis is to be attributed to the fact that far fewer men carry canes today than some years ago; and so on. What science tries to do, not always successfully, is to survey all the factors in a given situation, to hold all of them constant except the one to be tested, to vary that one, discover what happens, and then connect cause and effect if possible.

Not long ago a gurgling flapper told me that she avoided colds by gargling a popular liquid antiseptic, but that if she did get a cold—of course because she failed to gargle—she ended it more quickly by putting certain drops up her nose. She said the gargle had been proved effective scientifically, because 500 people had been divided into groups, and that some gargled with one preparation and some with another, but those who gargled with this liquid antiseptic had fewest colds. I said that was not a scientific test at all and she became abusive.

IN the first place, there were no "controls," no group of people who did not gargle at all. In the second place, gargling with a weak antiseptic solution could only momentarily reduce the number of germs in the mouth; it would almost certainly leave intact a few of the more virulent varieties which could breed a simply countless progeny in a few minutes. In the third place, careful tests have shown that all common cold remedies give "definite improvement" in from 35 to 42 percent of cases—which is precisely the percentage recovery obtained by the use of milk sugar tablets or by no treatment at all.

Unless recent work at the University of Minnesota (which, by the way, took us back to Dover's Powders and indicated that certain opium derivatives were effective in palliating colds) proves out in the long run, science today knows no definite way either to prevent or to cure colds. Specialists who have made colds their life study, and who have recently issued a tome of nearly 1000 very large pages, agree that the cause of colds is unknown and that, generally speaking, whereas an untreated cold runs two weeks a treated cold usually runs a fortnight. It is definitely known that no form of gargle can prevent colds, as well as that putting various chemicals up the nose after a cold has developed usually prolongs the cold, and certainly gets the nasal tissues into such a condition that the development of really serious infective complications is enormously facilitated.

But surely vitamin A wards off colds? You can buy that concentrated in cough drops now! Someone actually told me that—forgetting that the cough appeared after the cold had developed, and that this was entirely too late to use a preventive agent with the slightest hope of success. Moreover it has merely been shown on experimental animals that their full complement of vitamin A helps them avoid certain abnormal conditions in certain tissues, those of the respiratory tract among them. There is no evidence to show that a full supply of vitamin A enables human beings to avoid colds.

Indeed, if the gargling flapper had persisted in her argument that she thus avoided colds, because she didn't have colds when she gargled, I might first have inquired into her exercise and eating habits, into the amount of clothing she wore, if any, and her attitude towards ventilation and a thousand and one other factors which were likewise disregarded in the cases of the 500 people who were divided into several groups to gargle with different preparations. Finally I could have remarked that, though vitamin A is reputed to protect against colds, my wife recently caught a perfect hummer of a cold right while she was imbibing a vitamin A and vitamin D concentrate!

IF proof is lacking here, let us consider another story. A few months ago a child died in a midwestern state after having eaten five apples daily for an unspecified period. Her father was a physician and her mother a nurse. The death certificate flatly stated that this tragic end was caused by eating apples which bore arsenic spray residues left upon them by a careless grower. The child was diagnosed as a case of arsenic poisoning, by good physicians who not only examined her excretions and considered her symptoms carefully, but who found that her hair contained an abnormal quantity of arsenic, while that of her brother, who did not eat the apples, was normal in this tell-tale respect. If ever there was a clear-cut case of positive scientific proof this appears to be it, yet there is an obvious and tell-tale flaw in it that gives the whole thing away.

Can we truly say that, because of these things, therefore the child died of arsenic poisoning? We can not. Why? Because the accused apples were never apprehended. They were never analysed and shown to contain dangerous quantities of arsenic. Indeed the apples that were shipped into the state concerned at the time the girl was eating hers were, according to the record, well within the tolerance for arsenic spray residue. Moreover, some persons are very susceptible to arsenic and may be poisoned fatally by minute quantities of this substance, derived from two or more sources, that would have no apparent effect upon normal individuals.

A heifer afflicted with trembles, caused by eating certain plants

Other questions might be asked. What about the possible effects of this sudden and abruptly started habit of eating five apples a day? Isn't that rather a considerable change in diet for a young girl? Might not that factor alone affect her health? Again, might not a few of the apples eaten have by accident contained really excessive quantities of arsenic or, what is more likely and far more dangerous, lead spray residue, which sickened the child? For not many apples could have been so affected, since dozens of other children ate them and went unharmed. Finally, the child may have made up her total minute toxic dose of this drug by accumulating other small quantities of it in other foods.

It is very easy to put 2 and 2 together and make 9 in such instances. Two hasty and ill-informed writers recently put 2 and 2 together and called it 100,000,000 and began, in their hysterical dreams, to imagine that we all were guinea pigs. But, aside from all other considerations, it is the devil's own job to prove that persons are afflicted with arsenic or with lead poisoning. It takes weeks or even months of the most careful laboratory investigation to do this.

Consider lead poisoning, for example. Certain patients enter a certain clinic, assumed to have lead poisoning. Very soon the laboratory workers burst out into a song of joy because they have found "excessive" quantities of lead in the urine of all these assumed victims of lead poisoning. The case was "proved," indeed, until some skeptic asked: "What is an 'excessive' quantity of lead in the urine?" Nobody had thought of that, so they went to work again, still thinking they had found an infallible means of easily diagnosing lead poisoning.

But they next discovered just as much lead in the urine of other sick people in the clinic as in that of those supposed to have lead poisoning. Then they found lead in similar quantities in the urine of several "normal" people who had merely accompanied their sick friends to the clinic. Last of all they found no greater quantities of lead in the urine of certain cancer patients who had been treated with nearly toxic doses of lead, than in the urine of "normal" people. So the theory simply blew up, and a new way of proving that certain people have lead poisoning must be devised.

TO illustrate what scientific proof really means, suppose we take two cases in which the scientists were more successful. Lincoln's mother died of a dread ailment called "milk sickness." That offers us an excellent example. What caused milk sickness? Until scientists in the United States Bureau of Animal Industry recently found out, we did not surely know. The disease was long a violent scourge, with a 25 percent mortality, and it has been known in this country since colonial times.

It was described by physicians as early as 1806 to 1810. One of them wrote: "The yellow fever and the sick stomach (another name for milk sickness) I take to be the same disease, their difference being chiefly in external circumstances. They are both, properly speaking, the bilious fever." This was a blind essay in classification which, however, offered little real enlightenment. But very gradually it came to be seen that sick stomach or milk sickness (also puking fever to some) was most prevalent in late summer or early fall. At this same time the disease called "trembles" was prevalent among cattle. Hence it looked as if the cows consumed some poison at this time and passed it along to the humans who drank their milk.

What could that deleterious substance be? Some said it was poisonous dew or volatile mineral substance that evaporated from the earth at night, condensed on the herbage, and awaited the cattle. Others attributed it to "miasmata," the illegitimate grandfather of germs and the germ theory of disease. Others declared some sort of micro-organisms to be guilty, while others still attributed "trembles" to poisonous combinations of silver, copper, lead, or cobalt found in certain springs. There were those, however, who persisted in believing that the disease appeared when cows ate certain herbs.

Next it became necessary to say what

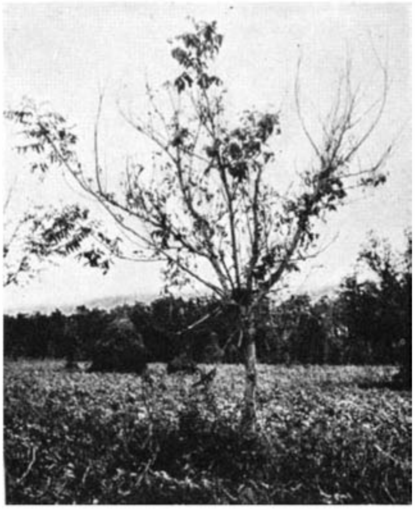
these herbs were. The following came under suspicion: Virginia creeper, Indian hachy, Indian tobacco, Indian hemp, crossvine, Indian currant, marsh marigold, spurge, fool's parsley, mushroom, and wild snakeroot. As early as 1840, decoctions of wild snakeroot were made by two physicians who convinced themselves that this plant caused "trembles" in cattle, and who treated it with sodium bicarbonate, the recognized remedy today. But many still held then that fungi, or mold on plants, made the cattle ill.

The disease caused in humans, the milk sickness, was a frightful pestilence; it literally devastated parts of the country. The odor of acetone was strong on the breath of victims, indicating faulty metabolism with what is called "ketosis." About 1909 it was demonstrated that there actually was acetone in the urine of these patients. Finally, organic chemists went to work on some of the plants that had so long been supposed to cause trembles in cattle whose milk gave human beings milk sickness. In wild snakeroot or milbane, in rayless goldenrod, and in a close relative of the latter called *Aplopappus fruticosus*, Couch, of the Bureau of Animal Industry, in 1928-1929, found a viscous oil with a pleasant, aromatic odor, of the composition $C_{16}H_{22}O_3$, which classifies chemically with the higher alcohols, and is insoluble in water, acids, and alkalis, but is soluble in most organic solvents.

THIS compound Couch called "tremetol" because, when he administered it to sheep, he could produce "trembles" in them experimentally. It was also shown that the milk of animals which consumed tremetol, either direct or in one of the poison plants, could cause milk sickness in human beings. The meat of such animals remained unaffected and was fit for food. The tremetol passed into the milk. If grazing animals are kept away from the three plants mentioned they never become afflicted with trembles; consequently their milk can not cause milk sickness in human beings and the whole problem is solved scientifically.

It is solved because one factor was isolated. This one factor could then be varied while all other factors were held constant. This was no matter of having 10 groups of 50 people each use different gargles while they dressed, exercised, worked, ate, played, breathed as they pleased, and then trying to conclude that, when all these many factors varied, the one factor, the gargle, prevented or cured their colds. Instead, a definite organic chemical was prepared from plants causing trembles. It was purified. When fed it would cause trembles to a greater or lesser extent depending on the quantities fed.

When human beings drank the milk of cows that had developed trembles from consuming tremetol they got milk sickness. That was the one important factor. But the one factor of supreme importance is not always so easy to find. I will give one more instance to demonstrate this. It concerns a disease of pecan trees called rosette. This disease makes a pecan tree simply curl up and die, and is no end disastrous to the profits of its owner. So scientists from the Bureaus of Plant Industry, and of Chemistry and Soils, began experimenting with various available dips and sprays to prevent or cure the disease, if possible.



A pecan tree "curling up and dying" from rosette. It took a lot of sherlocking to find the cause of it

Finally they found that by dipping the rosetted pecan leaves in a solution of iron sulfate they were able to prevent rosette on young leaves and to improve the condition of older diseased leaves. They therefore sprayed pecan trees the next season with iron sulfate solution, practically certain that this one factor would prevent the development of the disease. But their case was not proved. Rosette appeared just the same. So they checked back on what they had done the previous year.

The analysis of the iron sulfate solution then used disclosed the presence of a considerable quantity of zinc. Where did that come from? Why wasn't there zinc in the iron sulfate solution they were using now? Because last year the solution had been mixed up in galvanized buckets; this year it had been mixed in glass. So-called galvanized water buckets contain zinc. Possibly some of the galvanic coating of the water buckets dissolved in the iron sulfate solution, and perhaps that zinc was the factor preventing rosette. Result? Zinc sulfate was tried; it proved a preventive and a remedy; it was cheap and practical. *Voila!*

We begin to see how difficult it is to connect cause and effect. People who have an itching place on their skin, or pimples, or an eruption, and who try an advertised salve, may in time effect a cure. The laws of chance would account for that. But the cure also may have come about because they threw away leather garters, or changed their dietary habits, or banished begonias from their living rooms, or for any of a number of other reasons. So long as they do not know the cause of the condition it is ridiculous for them to assert that a variation in any one factor of their varied existence effected an absolute cure.

In 1891 a scientist was studying pear blight, and blight is a modest term for what that does to a pear tree. He produced the disease experimentally by brushing its germs into a number of pear blossoms. These germs multiplied in the nectar and entered the nectaries. But how on earth could the disease, thus entering the blossoms, suddenly affect the whole bloom of a tree? That was a mystery till the scientist watched a bee alight on a pear blossom and suck up the nectar. It then flew to another flower, wiped its feet there, and got some more nectar. Therefore it must be the agent carrying this injurious blight from one tree and from one blossom to another.

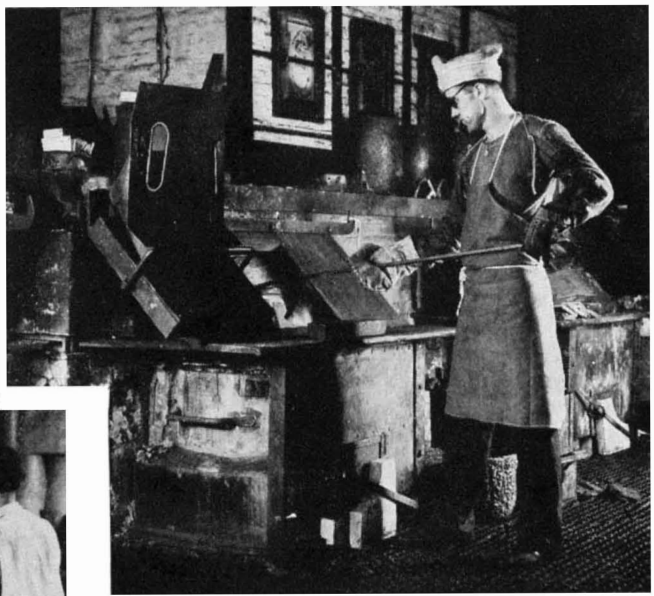
SO the scientist got some sterilized test tubes. He caught three bees in the act of sipping infected nectar. He examined them under a microscope and found the disease germs in their mouths. From these germs he developed cultures. The organisms which grew on his cultures were typical pear blight germs because they produced pear blight when inoculated into pear trees. The disease so produced was proved to develope again the same kind of germs, which could again be taken from the nectar of the pear blossoms by the honey bee. The case was proved scientifically and it is that sort of thing I have in mind when I demand scientific proof.

It is a good method to test out the stories we hear about cures and other things for *post hoc ergo propter hoc.* We should ask: Did this cause that? How many factors were varied? How much care was exercised in proving that the factor cited actually did produce the result attributed to it? Do rheumatics who take fake remedies that consist, in the ignorance of the victims, of salts, actually cure themselves of rheumatism, or do they merely feel better because they needed a dose of salts anyway . . . or because the weather changed . . . or their diet changed . . . or because they ceased driving in an open car, or sleeping next an open window . . . and so on and so on?

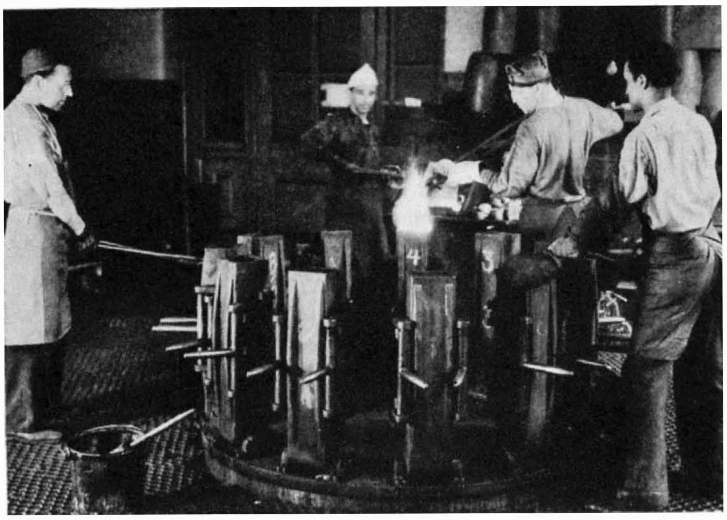
Scientific proof is most difficult to establish. But it is well worth the effort just the same.

From Metal to Money

Scenes in a U. S. Mint

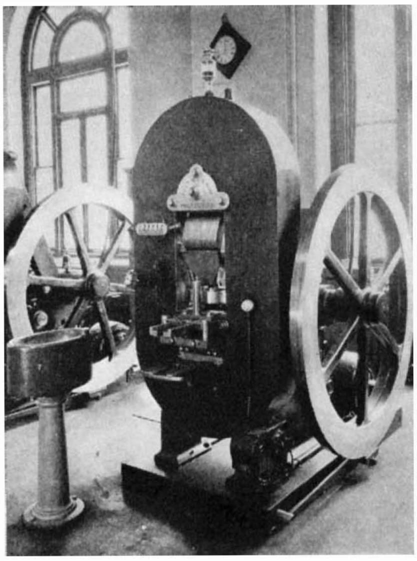


Precious alloys for coinage are melted in these gas-fired furnaces for casting into uniform ingots. Each furnace is built of refractory material and covered with sheet steel. A gas burner fires into the furnace, so that flames envelop the crucible containing the metal

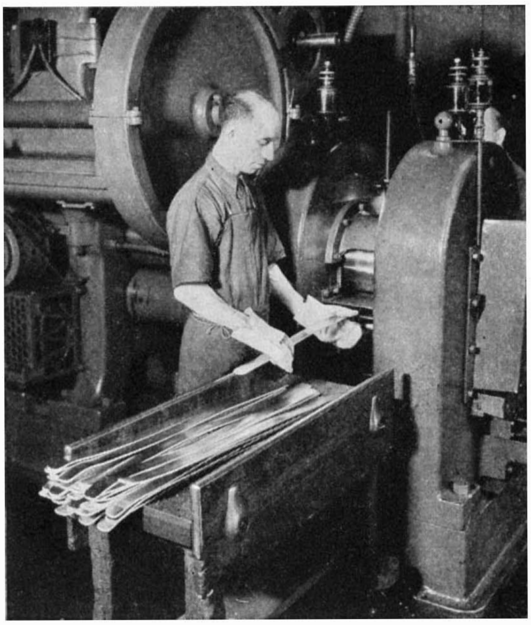


Molten gold or silver is transferred from the furnace crucible to this pouring table where it is cast

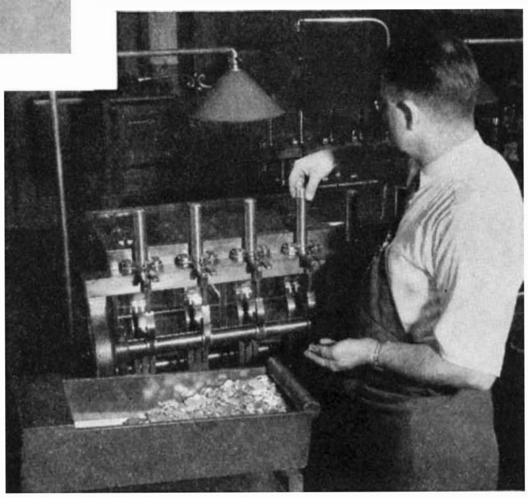
A LARGE part of the wealth of the nation, in the form of gold and silver, is housed in the U. S. Mint at Philadelphia, where these unusual photographs were taken. Gold U. S. coins are 90% gold and 10% copper; silver, the same ratio of silver and copper.



After the ingots of precious metal are rolled to the required thickness, the strips are put through blanking presses where blanks are cut to the exact sizes for various coins. These blanks are then annealed, cleaned in an acid bath, and coined in a stamping press such as the one shown above. The blanks are pressed between engraved steel dies, surrounded by a collar which mills the edges at the same time



When the ingots leave the casting table in the form of bars $2\frac{3}{8}$ inches wide, $\frac{1}{2}$ inch thick, and a foot long, they go to the rolling mills where they are reduced in thickness to the required dimension for the coins to be stamped



The Philadelphia Mint is equipped with long lines of the various machines required for coining—rolling mills, blanking presses, coining presses, and so on, all power driven. After the finished coins are inspected by trained observers, they are individually weighed in the device shown at the left. Coins are pushed from the tubes, one at a time, automatically weighed, and dropped into a container

EYES OF THE FLEET

By ANDREW R. BOONE

WHEN the *Ranger* joined the Battle Force at San Diego, California, recently, the effective power of fighting airplanes with the Fleet was increased nearly half. The first aircraft carrier designed and built by the United States Navy expressly for that purpose, the *Ranger* carries 79 planes, bringing the Fleet's carrier-based armada to a total of 271 fighters, scouts, bombers and torpedo planes.

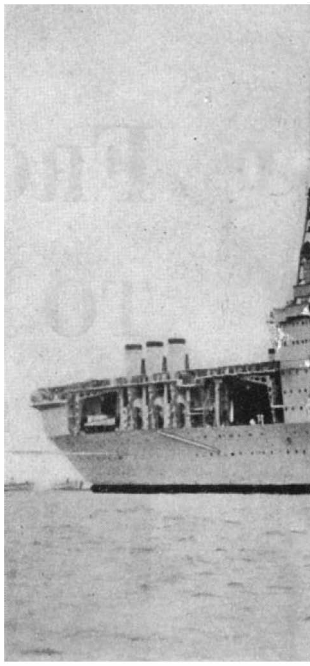
Although only about half as large as the *Saratoga* and *Lexington*, whose keels were laid down as battle cruisers, the *Ranger* carries as many planes as either. She attains a high speed of more than 30 knots, faster than any battleship, and can, through sheer speed, escape from an enemy fleet in broad daylight. She is twice as large as the *Langley*, first of Uncle Sam's carriers.

Like the larger carriers *Saratoga* and *Lexington*, the *Ranger* has a clipper bow and an "island" on its flying deck for navigating stations. With a displacement of only 13,800 tons, the *Ranger* is 769 feet long, as compared with 888 feet and 33,000 tons for the two larger carriers. The *Langley*, converted from the collier *Jupiter*, is 542 feet long and is now 23 years old.

How planes are "arrested" when landing on the *Ranger's* deck is a closely guarded secret, but tests have demonstrated that her brood can land on the long flight deck and be stowed away below by means of quick-action elevators faster than on any other carriers. The flight deck, longer than two city blocks, is 85 feet wide.

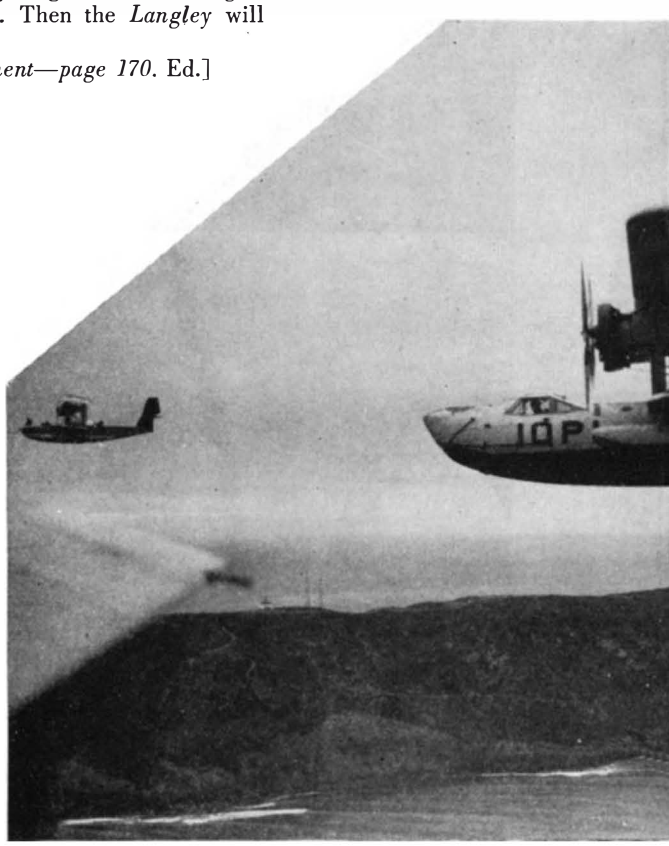
These four carriers will accompany the fleet during all war games until the *Yorktown* and *Enterprise*, each slightly larger than the *Ranger*, are completed in 1937. Then the *Langley* will be retired.

[*Important Announcement—page 170.* Ed.]

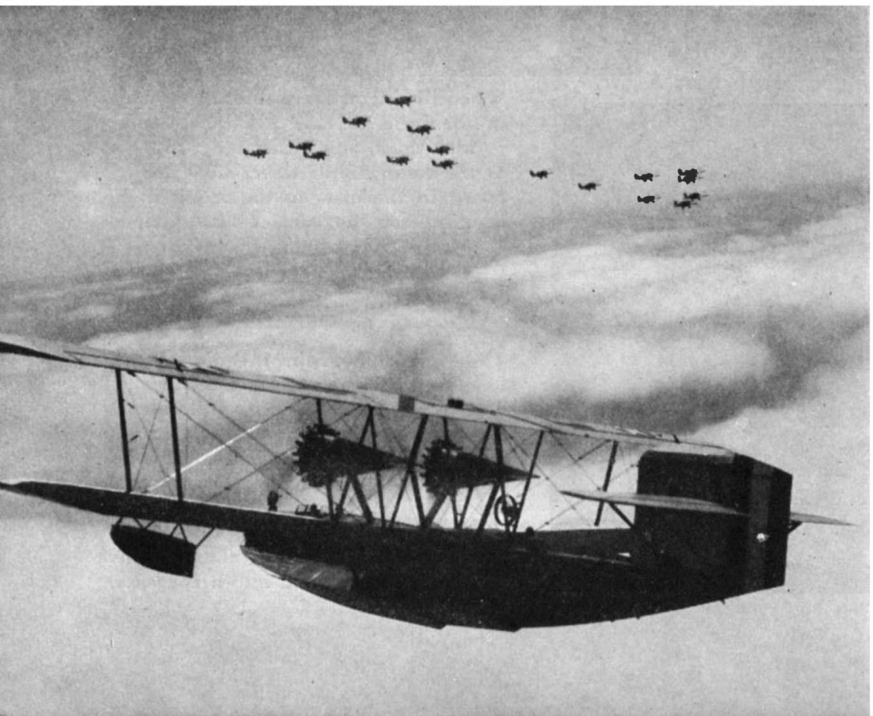


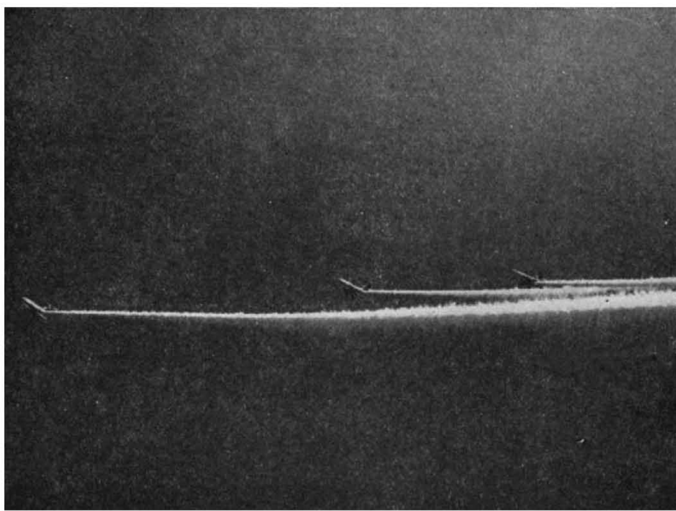
A view of the *Ranger*, new
stacks that may be folded.

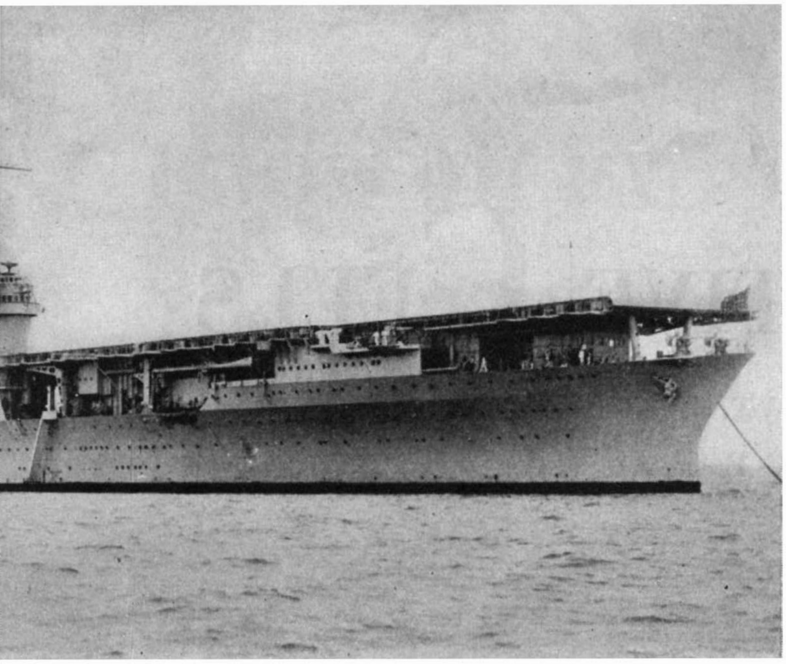
Left: Admiral J. M. Reeves, Commander-in-Chief of the United States Fleet, has at his disposal one of the world's most powerful naval air forces now in existence



Below: Ships that pass over the fog. A giant Navy patrol flying-boat roars past a squadron of bombers high above the Pacific



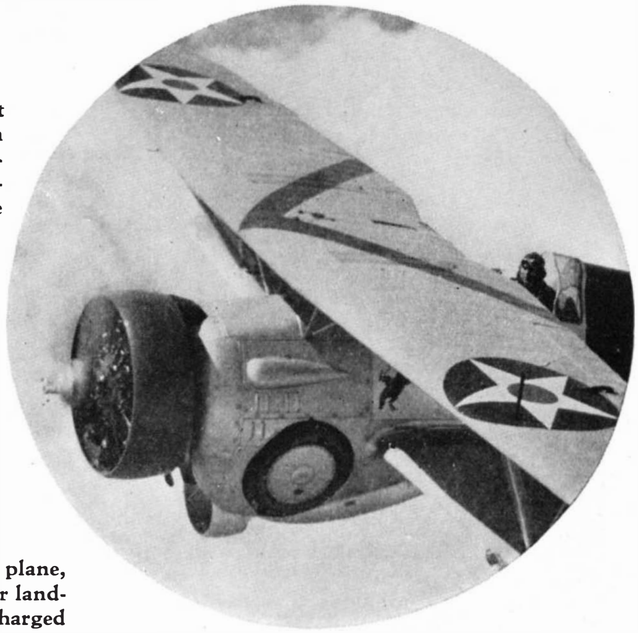




est and speediest of our aircraft carriers, showing the "island" and the three Aboard the *Ranger* are based 79 fighting, observation, and bombing planes

Three fast Navy fighters of the same type as is shown in the circle below

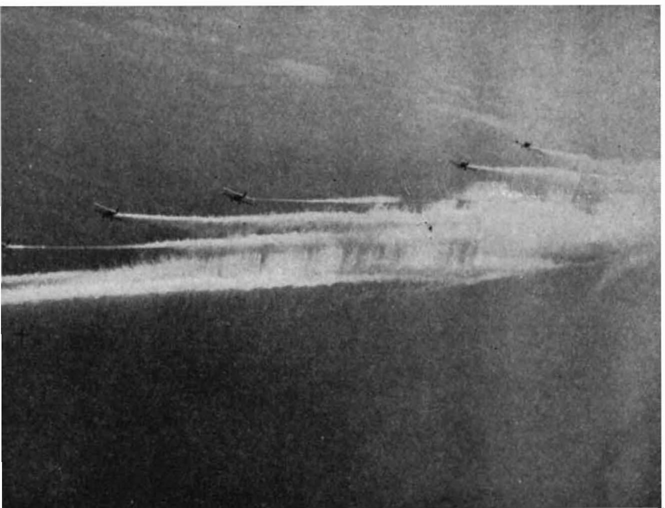
Right: One of the latest Navy fighters, based on the *Ranger*. Note the landing wheel retracted within the fuselage of the plane

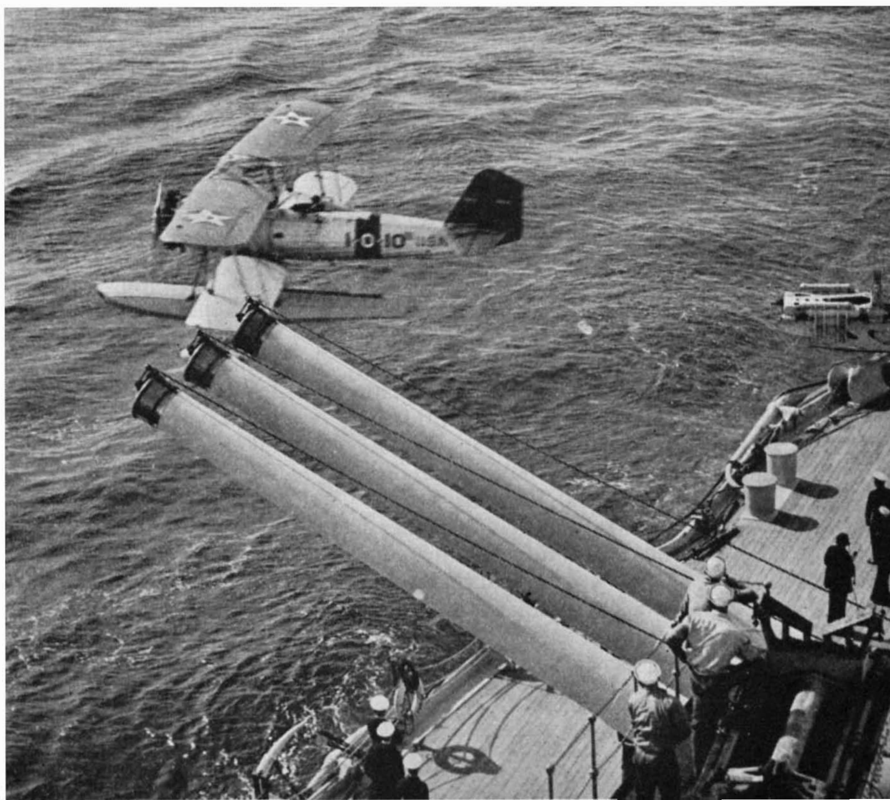


Lower right: A spotting plane, equipped with pontoons for landing on water, being discharged from a catapult on board ship

Left: Latest type of long-range battle plane used by the United States Navy. These ships are capable of carrying heavy loads and flying long distances without refueling

Below: An unusual view from the air, showing eight bombing planes laying a smoke screen during battle maneuvers on the Pacific Ocean





MAKE YOUR OWN

LIGHT-SENSITIVE CELLS

Supply Five To Ten Milliamperes . . . Operate Relays . . . Easy To Make . . . Low In Cost

By JOHN H. RADU
Instructor in Metal Science and Glasswork
Stuyvesant High School, New York

VARIOUS kinds of light-sensitive cells are on the market, but the cuprous oxide cell to be described here can be produced in any size desired, and without complicated equipment. It is very reliable and sensitive, and with it many interesting experiments can be performed in the home or shop. This cell will produce sufficient current to actuate a relay without additional batteries, when a beam of light is thrown upon it or when a beam of light is intercepted.

Everyone who is familiar with the relay knows that there is no end to achievement with it when positively actuated. For example, it will sound burglar and kidnap alarms, open and close doors, and turn lights on and off. Yet the writer has seen no published instructions that include all the essentials required to produce a reliable cell for actuating such relays. After many experiments he has devised the following simple and inexpensive method which may be pursued in producing such a light-sensitive cell.

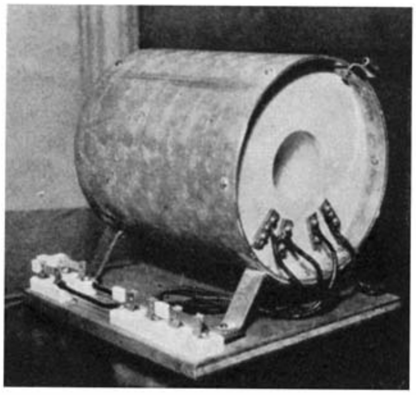


Figure 1: **The author's furnace used to make cuprous oxide plates**

Before we can construct the actual cell we must first have a good furnace. While a gas furnace may be used, if hot enough, a small electric resistance furnace, large enough to allow the plate of the cell to be suspended within it while being treated—one that will heat the copper to almost 1000 degrees, Centigrade (about 1800 degrees, Fahrenheit), or close to the melting point of copper—will serve better than any other kind. So let us first describe the construction of such a furnace, and then of the actual cell.

If constructed by your own hand an electric furnace will require only a small outlay of money. Furthermore, it may be put to many uses besides making the cuprous oxide element—for example, baking enamel. By an arrangement of switches (without using a rheostat in the circuit) you will be able to obtain various degrees of heat. For the cuprous oxide element, however, you will switch the coils in parallel, and when connected in this way the current consumption will be about nine amperes at 110 volts, giving a temperature of approximately 1000 degrees, Centigrade.

THE cuprous oxide photo-voltaic cells described in this article will provide the basis for considerable experimental work in the field of photo-electricity. They also make available to the experimenter a reliable unit for use in connection with many devices to be operated by a beam of light. Information on relays to be used with these cells will be supplied upon request. Please send a stamped addressed envelope.—*The Editor.*

IN preparing the several parts of the furnace, accuracy of measurement is important. Therefore it is recommended that the builder adhere to the directions exactly as they are presented.

Secure the following, which should total less than ten dollars[1] in cost.

(1) A 20-gage galvanized sheet iron cylinder, 10½ inches long and 9 inches in diameter, for the shell of the furnace. Rivet the seam or bead it. (Figure 1.)

(2) Two pairs of hoops made of iron or mild steel, 1 inch wide and about 1/16 inch thick, of such diameter that each pair, one on top of the other and their joints opposite, may be placed in either end of the cylinder. This is shown in Figure 1.

(3) Four disks of ¼ inch asbestos board to fit the inside of the cylinder. (Figure 2.) In each of two of the disks cut a hole having a diameter the same as the inside of the quartz tube (item 4, below). Cut holes in the remaining two disks, large enough so that they will fit comfortably on the outside of the tube.

(4) A Vitreosol molded pipe, 8 inches long, with a 3-inch bore.

(5) Two coils of No. 20 B & S gage "Nichrome IV" wire.

(6) Five pounds of Alundum cement RA-162.

(7) Four terminals (Figure 1, beneath central hole).

(8) Some sheet mica—purchasable locally.

First, make a double twist 3 inches long, at each end of two pieces of the Nichrome wire 43 feet in length, leaving two resistors each 42 feet long. Firmly anchor one end, with the twist about an inch from the end of the tube, and begin to wind, spacing the turns ⅛ inch apart.

Apply pieces of sheet mica (ordinary mica, but not Micanite, will be suitable) ranging from .005 to .010 inch in thickness, under the wire as you proceed. It is most important that the mica separate the wires from the quartz tube,

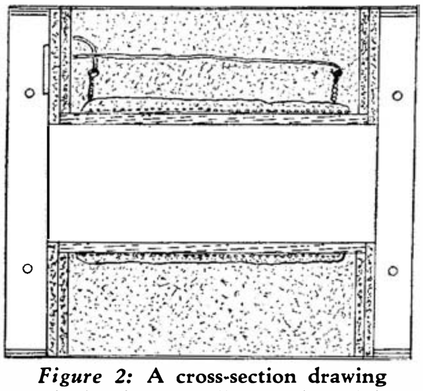


Figure 2: **A cross-section drawing of the furnace illustrated at left**

[1]A list of supplies and dealers may be obtained from the Editor.

in order to avoid any reaction. When you reach the other end, anchor it also, and wind the second wire between the coils of the first one. It is usually good practice to wind a cord along with the wire, to keep one wire separate from the other; on completion remove the cord.

With Alundum cement and water, prepare a *thin* paste, and cover the wire well with it. When it is partially set,

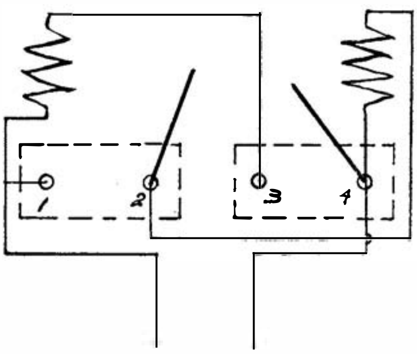


Figure 3: **Two switches make it possible to change coil connections**

make a *heavy* paste of the same material and completely cover the wires until you form a wall approximately ¼ inch thick. Allow this coat to dry slowly, thus preventing it from cracking.

Attach securely to each of the four ends you have twisted (on the original lengths) a piece of No. 14 B & S gage copper wire that is long enough to reach the terminals on the outside of the asbestos disk.

Cut in either asbestos board disk some small holes to permit bringing out the wires, and attach the four terminals to the outside of one of the disks with machine screws.

SECURE a pair of hoops to the inside of the shell at one end, with six No. 10-24 or similar screws and nuts, the holes for these to be equally spaced. Set the tube on end and insert the disk with the terminals, and then the disk with the holes for the wires, keeping the holes in a direct line with the terminals. Put in place the quartz tube with its coils, and fish the wires through the holes of the asbestos disk you have already placed. Fill the space between the coils and the outside cylinder as compactly as is possible with infusorial earth or magnesium oxide, within ¼ inch of the end of the quartz tube. Slip one disk with a large hole over the end of the tube, and then the fourth disk on over that one. Put in place the second pair of hoops and fasten them as you did the first pair, thus completing the heating element of the furnace.

It is sometimes convenient to use the furnace in a horizontal position, and at other times in a vertical position. If you mount the furnace on feet, fastened to a board, in order to steady it (Figure 1), you will find your work considerably reduced during experiments with it when it is kept in a horizontal position. But note also the lug in the upper right hand part of the furnace. This serves as a leg when you wish to use it in a vertical position. In either horizontal or vertical position the furnace requires a plug at one end. This may be made of fire clay, obtainable locally. The vertical position, which is best for suspending cuprous oxide plates, calls for a plate of fire clay or a piece of mica on the top of the furnace, but when you use it horizontally two plugs will be necessary.

Figure 3 shows the wiring and switching arrangement, using two single-pole, single-throw switches (Figure 1, at nearer end), so placed that you can throw the knife of one switch into the jaws of the other. When you connect points 1 and 2, one coil will be in circuit; when you connect points 3 and 4 the other coil will be in circuit. When you throw in both switches you connect the coils in multiple, and when you connect points 2 and 3 the coils will be in

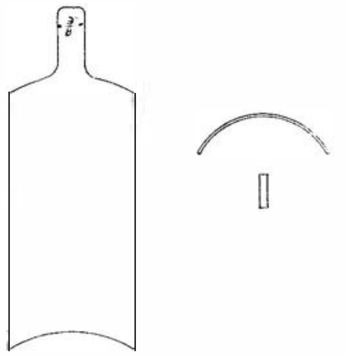


Figure 4: Left: **Shape of copper plate.** ***Right:*** **Position of elements**

series. (See the wiring diagram in Figure 3, at the left.)

Whenever you start the furnace, always connect the coils in series, in order to heat it gradually. Next, if you desire full heat, connect one coil for a few minutes before using two coils.

Now to return to the light-sensitive cell:

Procure a sheet of 18-gage copper (.040 inch thick). Electrolytic copper will prove to be the most satisfactory kind. A desirable sized plate to begin with is about 2 inches wide and 3 inches long, and curved to fit a glass container of suitable size. After shaping each plate (Figure 4) on which you will include a lug at one end, remove all sharp edges and corners with a file.

Hammer the lug into cylindrical form. If you make use of copper having the same thickness, and the same lug dimensions as recommended in Figure 4, you may thread the lug with an 8-32 die, thereby making provision for mounting and connecting with 8-32 nuts.

When the copper plate is ready, clean it in a hot solution of 5 to 10 percent sulfuric acid, then wash it in clean water. Suspend it in the furnace until it nearly reaches its melting point. Keep it at this temperature for about five minutes. You will observe the surface becoming glossy, an indication of the formation of cuprous oxide.

Cool the plate slowly. If you use the electric furnace, merely cut off the current, but if a gas furnace is used, shut it off completely. Let the copper remain inside until cool. This slow cooling process will prevent the cracking and peeling of the material formed on the surface. While cooling, a black film of cupric oxide forms a cover over the dark red cuprous oxide. You may easily remove this by dipping the plate into a weak solution of potassium cyanide (a poison). Take great care not to leave the plate in this solution too long. Should any exposed copper appear, paint out those spots with hot beeswax or paraffin, in order to prevent the electrolyte from attacking the copper and ruining the cell.

YOU have now completed the most important part of the light-sensitive cell. Next make a second element, which consists of a thin strip of lead (Figures 4 and 5) secured to a lug or screw for mounting purposes.

Next, the assembly: A glass cylinder (a flat-bottomed jar about 3¾ inches high and 1½ inches in diameter will answer; those in Figure 5 are common pickle jars) should be selected before you shape the plate. Fit the cork or other stopper tightly into the top of it. If a cork is used, dipping it into a hot solution of beeswax or paraffin will add to its efficiency. On this, mount the cuprous oxide element and also the strip

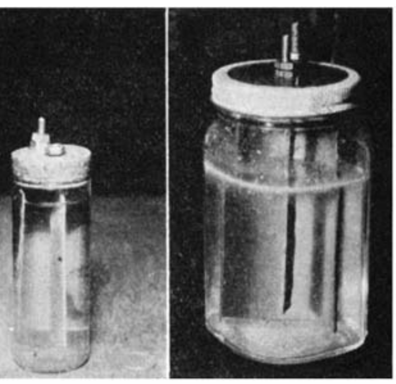
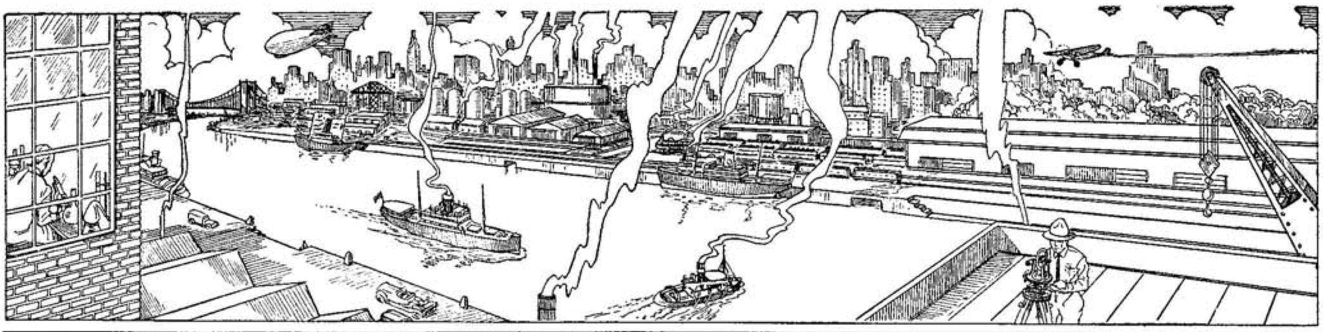


Figure 5: **Two completed cuprous oxide cells made by the author**

of lead; approximate the positions shown. Pour lead nitrate solution (strength 1 to 1½ percent) into the cell until the liquid rises to a point within half an inch of the cork, after the assembling.

A cell, if accurately made in accordance with the above description, and if the plate is properly coated with cuprous oxide, will supply from five to ten, and sometimes more, milliamperes, according to the strength of the beam of light cast upon it.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
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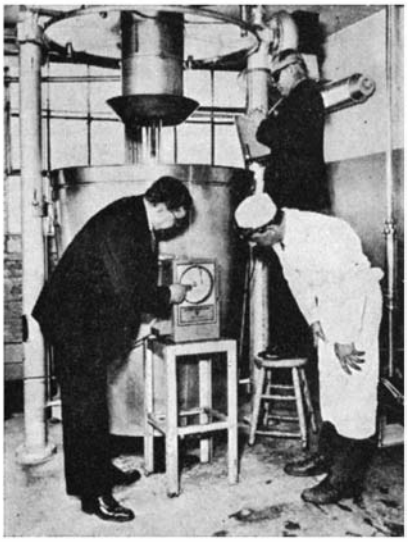
A. E. BUCHANAN, Jr.
Lehigh University

Measuring the Sunshine in Milk

PARENTS and physicians alike rejoiced when it became possible to put vitamin D into milk. Milk is in many ways an ideal food for infants and children but it is sadly deficient in the sunshine vitamin, as vitamin D is often termed.

Now scientists have gone a step further and found a way to measure the amount of sunshine vitamin in the milk when it is put there by the action of ultra-violet light. This is important. Baby specialists and nutrition experts have recently pointed out that lack of such a measure was one serious drawback to relying on vitamin D-enriched milk as the sole source of this vitamin.



Measuring the amount of ultra-violet light playing on milk during the irradiation process. Man at top of the vat is holding a photo cell sensitive to ultra-violet rays

The method of measuring the sunshine in milk was developed by Dr. H. C. Rentschler of the Westinghouse research laboratories and tested by Dr. G. C. Supplee in the plant of the Borden Company.

Strictly speaking, Dr. Rentschler's newly-announced method does not measure the actual amount of the vitamin. Instead it measures, by the photo-electric cell, the amount of ultra-violet light playing on the milk during every minute of the irradiation process.

This is all that it is necessary to measure, Dr. Supplee explained, since scientists have known for years the amount of irradiation needed to impregnate the milk with the required amount of vitamin D. The big thing was to find a way of making sure that this required amount of ultra-violet light was reaching the milk constantly during the process, so that every quart of the irradiated milk delivered to a baby's home would contain the actual amount of vitamin D it was supposed to have.

Other ways of putting vitamin D into milk have been found besides the irradiation method, but Dr. Rentschler's new measure is only useful for determining the vitamin-D content of irradiated milk.—*Science Service.*

WATER WEIGHT

NEVER before has man placed such an enormous weight on one spot of the earth's crust as he has in impounding the water behind Boulder Dam. It is estimated that the weight of the lake alone is 41½ billion tons. It is almost certain that this additional weight will cause adjustments in the earth's crust in the locality of the dam.

Fingerprints "Raised" from Cloth

A NEW weapon is being placed in the hands of crime fighters in the form of a fingerprint detection system being developed by the Technical Research Laboratory of the New York Police Department in collaboration with Honorary Police Surgeon, Dr. E. M. Hudson. The new method makes it possible to disclose fingerprints on materials such as cloth, paper, wood, and so on, which will not yield prints by the ordinary powder method. The silver nitrate method is based upon the reaction which takes place between a chemical and the body salts which are always deposited when a fingerprint is left anywhere. One of the most fertile fields which this method opens is the development of latent fingerprints on clothing.

Essentially the procedure is as follows: The material on which it is suspected that a fingerprint has been placed is treated with a 10 percent solution of distilled water and silver nitrate to which has been added a small percentage of acetic acid, or the material is immersed in about a 10 percent solution of acetic acid after immersion in the silver nitrate solution. The solution of silver nitrate is applied by brushing, spraying, or immersing, or the cloth or paper is passed through a clothes wringer having a well from which the solution is applied to the rollers. The material is then placed to dry in a dark room. After drying it is exposed to sunlight or to ultra-violet light. The silver nitrate reacts with the sodium chloride left by the fingers, forming silver chloride which turns dark on exposure to light much faster than does silver nitrate which has not come in contact with the body salts.

After the light has developed the fingerprints to the desired intensity, the material is washed in water to remove as much as possible of the excess silver nitrate. The silver chloride, being insoluble in water, remains. The developed latent finger impressions on the material are now fixed by treating them with about a 5 percent solution of ammonium hydrosulfide or applying a weak hypo fixing solution. When the latter chemical is used, great care must be exercised to prevent the destruction of the

A fingerprint developed on cloth by the chemical process described

silver chloride and consequent ruining of the print. The material is again washed in water to remove all substances therefrom except the silver chloride, and then placed to dry, after which heat is applied by a laundry iron.

The silver nitrate method can be used on cloth, paper, wood, and other similar materials for developing latent fingerprints, and can also be applied to paper for bringing out or developing latent or contact impressions of writing left by a pencil, pen or other similar object.

PROGRESS In This Age Of Science

As Told to Scientific American

By LEWIS H. BROWN
President, Johns-Manville Corporation

PRACTICAL application of science to everyday life is so common to the present generation that we are prone to take it as a matter of course, especially in the fields of transportation and communication. The building industry has also made great strides in development of better building materials and better construction methods.

Science has put at the disposal of the builder and architect materials that are fireproof, more permanent, and more economical to apply in erection of modern homes or commercial buildings. Methods that were hitherto impossible, because of the limitations of available materials, have resulted.

Ways and means of increasing our personal comforts in office and home have also been developed by science. Today it is possible to have a building completely insulated against extremes of outside temperature, winter or summer. Air-conditioning equipment likewise has been perfected to the point of practicability for even a modest structure.

Elimination of harsh, unwanted noise, so disturbing to thought and nerves, by use of sound absorbing materials that transform noisy offices and workshops to places of comparative quiet, with great increase in workers' comfort and efficiency, has been gained by science after years of laboratory research.

Business and governmental agencies of recovery are focused on the building industry, and with the widespread public interest in new homes, it is not too much to expect that new and greater contributions to building will be forthcoming from the research laboratories of industry.

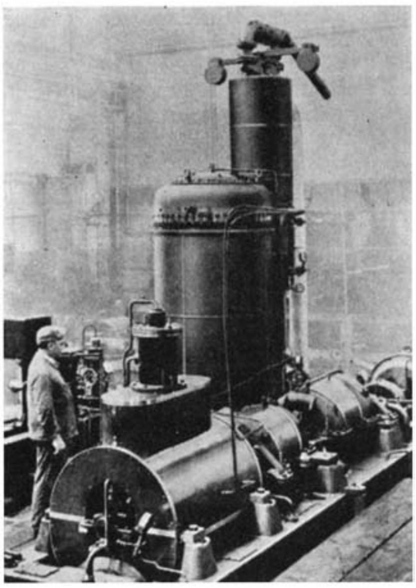
GAS TAX

NEARLY 40 percent of the motorist's bill for gasoline goes for federal, state, and local gasoline taxes. The average gas tax on June 1, 1935 was 5.28 cents per gallon.

Steam Competitor of Diesel Engine As Power Source

A STEAM boiler which may bring a new era into the generation of power aboard warships, especially those of the destroyer class (and perhaps submarines) was described in a recent issue of *Mechanical Engineering*. So efficient is the device that it makes steam a competitor of the Diesel engine.

The ultra-modern boiler is highly compact, light in weight, and can be easily adapted to the narrow hulls of destroyers, according to Adolphe Meyer of Brown,



The new Velox steam boiler that holds great promise for the future

Boveri and Company, Baden, Switzerland. The boiler is already coming into use throughout Europe. Because the fuel gases travel faster than sound in some parts of the boiler, it is called "Velox," coined from the word velocity.

The weight of the Velox steam generator is only one fifth that of the ordinary oil-fired water tube boiler, while it occupies only one half as much space as even the most modern marine boilers.

"In submarines," says Mr. Meyer, "the small masses, the possibility of rapid cooling by running cold air through the boiler, and the small dimensions of the exhaust pipes enable the time required to prepare for submerging to be reduced to an extent hitherto only to be obtained with Diesel engines.

"In comparison with the Diesel engine," adds Mr. Meyer, "the Velox steam generator has the advantage that every kind of oil can be used and there is no restriction as to the use of the more expensive gas or Diesel oil."

In warships, the Swiss engineer explains, the full steam output is ordinarily obtained by forcing the boilers to about three or four times the amount which such a boiler would normally give if used for other purposes. An efficiency of 75 percent or less is obtained under such forced conditions. By comparison, the Velox boiler has an efficiency of between 88 and 90 percent. An additional naval advantage is that the exhaust gas from the boiler is completely invisible even at maximum output.

Special advantages of the new type boiler are:

1. It can be brought up from a cold condition to its full load steam generating capacity in from four to eight minutes.

2. Changes in load can be handled quickly. A drop of 50 percent in the load can be dealt with by an automatic control device in but 20 seconds. Even when the full load is cut off suddenly, the boiler will not blow off.

As in warships, the best features of the Velox type boiler—small space requirements, light weight, and high efficiency—exactly fit the needs of railroad locomotives.

The Velox generator operates essentially as follows:

Air and fuel are mixed in a burner at the top of the combustion chamber and are blown into the chamber to burn. The entering velocity is over 1200 feet a second. Lining the walls of the combustion chamber are hollow evaporator tubes containing many small pipes. These small pipes are part of the water circuit of the steam generator.

Power is obtained from the device in two ways:

1. By the action of the swift-moving exhaust gases on a gas turbine which drives a blower. The blower is used to mix the air and fuel in the intake burner.

2. By the action of superheated steam on a steam turbine which drives an electric generator directly coupled to it.

Following through the mechanism by which the exhaust gases are used directly to obtain power for the blower, the first step is the partial loss of the heat of combustion to the outer walls of the evaporator tubes. Still more heat is lost as the combustion gases go down to the bottom of the combustion chamber and then back up inside the evaporator tubes. This heat is transferred to the water inside the pipes filling the evaporator tubes.

Continuing on their way, the exhaust gases, now down to a temperature of 1500 degrees, Fahrenheit, enter the superheater. By the time the gases have left the superheater, their temperature has fallen to 900 degrees, Fahrenheit, and their velocity is between 330 to 600 feet per second. Traveling at this rate, they strike a gas turbine.

The gas turbine, in turn, drives a blower which is used to send more air and fuel into the device.

Finally the exhaust gases, now down to a temperature of 700 degrees, Fahrenheit, pass out through the chimney on whose inner walls are pipes containing the water which will eventually become steam in the water-steam system of the machine.

The water-steam system starts therefore in the chimney of the steam generator. The incoming water is warmed here and passes into the evaporator tubes inside the combustion chamber, where the real heating takes place.

The steam and hot water thus formed issue from fine nozzles into a vertical drum. This drum acts as a centrifuge to separate steam and water, the latter falling back for more heating and the steam passing on to the superheater.

The steam at 600 pounds to the square inch pressure and temperatures as high as 850 degrees, Fahrenheit, passes to a steam turbine driving an electric generator directly coupled to it.

Safer Airplanes?

THE most interesting part of the recent Detroit Aircraft Show was the controversy between Eugene L. Vidal, Director of the Air Commerce Bureau, and the manufacturers of airplanes for private flying. Speaking before the Association of Aviation Editors, Mr. Vidal served the following warning on the manufacturers: "We are thinking now in terms of three classes of airplane licenses: One for the safe, easily operated ship, which the Bureau of Air Commerce is striving to develop to popularize private flying; one for the present-day airplanes of the private owner type, and a third for fast-landing, high-speed craft of the modern transport type. The public has a right to know that there is a vast difference between the flying characteristics of such ships, and we mean to label them so it at least won't have to go into aviation blindfolded."

This position would be a very sound one to take, were it demonstrated beyond all doubt that the new planes sponsored by the Department of Commerce are indeed highly developed from a safety point of view. Manufacturers are not at all convinced that this is indeed the case, and give as their opinion that the Department makes premature announcements, which decrease sales.

The controversy between the "New Dealers" in aviation, and the manufacturers who believe in evolution began more than a year ago with the 700-dollar "flivver" airplane. Mr. Vidal announced the early advent of the cheap, popular airplane, to the temporary detriment of private plane sales. The flivver plane never materialized and Mr. Vidal explains this by saying that the Public Works Administration "welched" on a promised appropriation of 900,000 dollars.

After the controversy regarding the 700-dollar airplane had subsided, the Air Commerce Bureau organized a competition for a "safe" private airplane. The Hammond Y, built by the Hammond Aircraft Corporation and illustrated in our photographs, was the winner in this competition, and an order for 15 machines was placed. The Hammond Y is powered with a four-cylinder in-line Menasco air-cooled engine, and has full instrument and other equipment, with provision for 40 pounds of baggage and a parachute for each passenger. The fuselage is of all-metal construction and the door is near to the ground to facilitate entrance.

The Hammond is a pusher with the engine to the rear of the cabin, and a scoop delivering air to the engine compartment. The tail surfaces are carried at the end of two booms extending backward from the wings. The landing gear is of the three-wheel type with one castorable and steerable wheel placed ahead of the fuselage or nacelle.

Here are the arguments in favor of the new aircraft:

1. Very large dihedral, and large vertical tail surfaces, providing good lateral stability.
2. Low wing loading and no tendencies to go into a stall-spin condition.
3. With the engine to the rear, exhaust fumes, motor, and propeller noise do not affect the passenger.
4. With the pusher arrangement, there is perfect visibility ahead.
5. With the front wheel landing gear, it is impossible to nose over. No matter how little skill the novice may show in landing the plane, it will immediately settle into its normal position on the ground, and brakes may be violently applied with impunity.
6. Upon take-off, it is only necessary to pull the stick back, and then to open the throttle. The plane will take off without further worry.
7. The rear wheels being fixed and back of the center of gravity, there is no danger of "ground looping" in taxying; that is, of an uncontrollable turn on the ground. This is particularly important in cross-wind landings.

The arguments against the design are:

1. The public does not like pushers, and will not fly with an engine at the back of its neck.
2. Conventional planes do not nose over, spin, or ground loop except under very rare circumstances.
3. For the same weight and horsepower, conventional planes are apt to be very much faster. The stumpy nacelle, the two booms, the struts to the wing from the nacelle, make the Hammond rather slow, and it is an open secret that the Y has not met its maximum speed requirements by more than ten miles an hour, and is in process of refinement or "cleaning up."
4. Light wing loading is a hazard in gusty weather and exaggerates bumps.

Nobody will ever settle the argument. There is no doubt that eventually an improved and speedier Hammond will enjoy favor in many quarters, although previous examples of this type of design (as the Stout Sky Car of 1930) never made a hit with the flying public. At the same time private conventional airplanes capable of 150 miles an hour and more will still attract the majority of buyers, giving them the speed which is the main justification for flying, with a safety considered quite reasonable. The new type three-wheel landing gear is perhaps the one feature of the Hammond which it would be most desirable to see incorporated in the conventional tractor airplane, and in any case the new designs will bring controversy and discussion—which invariably advance the art.—*A. K.*

AIR BUSINESS

THE civil aeronautics industry in the United States produced aircraft, engines, equipment, and spare parts valued at over 44 million dollars in 1934, and furnished employment for more than 18,000 persons, according to the Bureau of Air Commerce, Department of Commerce.

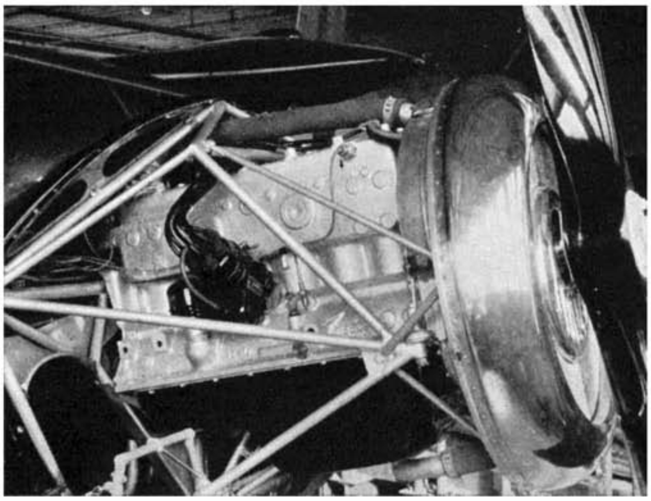
Airplane versus Bird

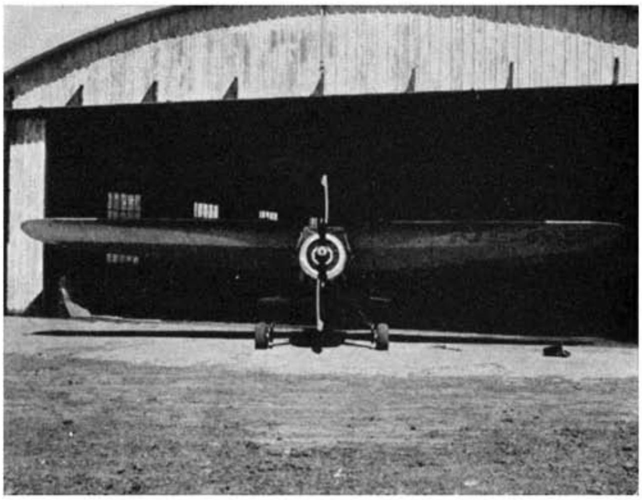
WE have often been asked what would happen to an airplane if it struck a large bird. The Navy Bureau of Aeronautics answers the question authoritatively. A Navy pilot flying in an observation plane to Cape May, through thick mist, was surprised to see a large bird loom directly ahead and in line with his propeller. The pilot and bird maneuvered to get out of each other's way but neither was quick enough. The bird

Front of the Hammond pusher, described above, powered with a Menasco four-cylinder, in-line, air-cooled engine

Side of the Hammond plane, showing the three-wheel landing gear, the attitude of ship at rest, and the booms

An ordinary automobile engine, adapted to and installed in an airplane, that has passed its 50 and 100 hour tests





A front view of the high-wing monoplane, equipped with a converted automobile engine, which is described below

struck the leading edge of the right upper wing at the outboard strut and jarred the whole airplane. The pilot flew back to his station with one wing flying several shredded pennants. An inspection of the damage showed eight broken compression ribs, with several feathers measuring about ten inches long still held by the torn fabric and bent metal. It was concluded that the bird had a probable wing spread of 30 inches and was one of the larger species of sea gulls. —*A. K.*

AUTOMOBILE ENGINES IN FLIGHT

MANY motorists will recognize the engine used as the power plant of an airplane, as shown in one of the accompanying photographs. A few hundred a year constitutes "production" for aircraft engines; automobile engines are built at the rate of hundreds of thousands a month. That is why automobile engines are far cheaper than the aircraft engines of to-day. Accordingly, the Department of Commerce in its "low price for airplanes" campaign has placed a number of orders for the conversion of well known automobile engines to airplane use.

A standard Plymouth engine has recently passed its 50-hour aircraft engine test, as well as its 100-hour manufacturer's tests, without a hitch. A minimum of changes was found necessary for the conversion. The engine was stripped of its flywheel, electrical equipment, and radiator fan. An aircraft magneto, updraft carbureter, and sheet metal exhaust manifolds were installed. An aluminum cylinder head was used to reduce weight and to raise the compression ratio from 6.7 to 7. A 2-to-1 reduction gear was provided to reduce the propeller speed to 1800 revolutions per minute, more suitable for plane operation than the high automobile engine speed which is now standard practice on the road. The weight of the converted engine is 398 pounds, and it develops about 80 horsepower. This gives a weight ratio of about five to one, which is more than twice as high as would be the case for an aircraft engine of equal power. This comparatively high weight ratio is of course a handicap in plane design, where every pound counts.

Nevertheless the converted engine has given excellent service in a high wing monoplane, enclosed cabin type, built by the Fahlin Manufacturing Company. With a weight empty of 1075 pounds, and over four hours cruising radius with pilot and passenger, the Fahlin has a top speed of 115 miles per hour and is giving satisfactory flying service in every way.—*A. K.*

THE ULTIMATE IN RESISTANCE REDUCTION

THE resistance of the airplane may be divided, broadly, into three parts as follows:

1. That due to lift (induced drag as the technicians call it). At the tip of a wing there are end flows and energy losses. These losses become smaller as speed increases. At very high speeds, the losses due to lift become negligibly small, and that is precisely the reason why the speed of the airplane has been increasing so rapidly of recent years.

2. Eddy losses due to projections pocketing the air. These have almost disappeared in the modern airplane, with its beautifully streamlined forms, retractible landing gears, and so on.

3. Skin friction losses. These are present no matter how well streamlined the airplane may be. When the airplane is flying very fast and is well streamlined, it is mainly skin friction losses that remain to be conquered.

Next to the very surface of the wing or fuselage, the air is at rest relative to the body. Within a narrow layer, termed the "boundary layer," the velocity rises from zero to the velocity of the machine itself. Near the leading edge of the wing, the flow is "laminar" or smooth, with the sheets of fluid slipping over another without mixing. Some distance from the leading edge, the flow is no longer laminar but "turbulent," with the particles crossing from one layer to another and generally behaving in irregular fashion.

Now turbulent skin friction is *eight times* as great as laminar skin friction. The next important step is therefore to study the flow in the boundary layer, and to devise means for maintaining the laminar flow over the entire surface of the body—by extra smoothness, by the application of suction, perhaps by moving surfaces, or perhaps by learning something from fishes.

This problem of maintaining laminar flow is a real challenge to aerodynamicists, engineers, and inventors. Its solution will have far reaching results—*A. K.*

'PLANE SHOES

WHEN traveling through the air at speeds of 200 miles per hour paint, wood, fabric or even metal parts of a plane are abraded by rain and hail. Rubber absorbs the force of these blows and as a result is not destroyed. Rubber abrasion shoes have been placed over these exposed surfaces and are entirely satisfactory.

SOUND AND AIRCRAFT

ANYONE who has heard an Army airplane pass over head will remember the peculiar sound which it produces, and which is mainly due to the propeller. The airscrew produces sound of a higher intensity level than the engine, and hence the motor and exhaust remain relatively inaudible. As the airplane speeds away, the noise subsides to a boom or steady roar. As it returns the boom is supplemented by the higher pitch sounds, and renews its piercing qualities.

At the Langley Field conference there was recently given a splendid and highly scientific demonstration of these phenomena. An electrically driven airplane propeller was placed in front of a microphone and connected through an acoustical filter to an amplifier. The filter was manipulated to "band pass" various frequencies with sharp definition. When all the frequencies developed were allowed to pass through the filter, one heard the sound of the propeller precisely as if a squadron of single seater fighters were passing through the air. When the higher frequencies were filtered out, the audience had the impression of airplanes flying away, as the noise gradually passed into the booming roar. Then as the higher frequencies were again passed through the filter, one felt that the airplanes were approaching once more.

This method of simulating approach and departure is readily explained. The propeller gives out noises of every frequency between zero and several thousand cycles per second. The lower frequencies represent the

The equipment that is carried by the pilot of a transport plane

"rotation noise," dependent on the revolutions per minute and the number of blades striking the air. The "rotation noise" is of the character of sound waves which pass through the air without dissipation, though of course with lowering of intensity by distance. The higher frequencies are due to the shedding of vortices from the tip of the blades (analogous to the tip vortices at the tip of an ordinary wing), and these vortices are rapidly dissipated as they pass through the air. Hence the "vortex noise" is not heard so far away as the "rotation noise." —*A. K.*

The Transport Pilot's Kit

THE Chief Pilot of a modern airliner begins to resemble the master of an ocean liner in his duties, training, and equipment. With the automatic pilot to relieve him of much of the fatigue and boredom of long-distance flights, he can now turn flying into a really scientific profession. Our photograph shows the equipment which such a pilot now carries in a leather bag. Included is a profile map showing the elevation of all points on the course, together with the radio beam stations and courses. A computer is used for calculation of ground speeds, wind drift and velocity, and gas consumption. At the bottom of the photograph is shown a protractor, used for determining the true course as laid out in advance of the flight. Radio range maps, drift tables, tables showing cruising speeds necessary to make schedules, company orders, Department of Commerce regulations, and so on, are all included in this paraphernalia.—*A. K.*

The Robot Plane

THE *Queen Bee,* the British "robot airplane," has created quite a sensation on both sides of the Atlantic. On its first flight, with the pilot in the cockpit not touching a single plane or engine control, but merely going along as a precautionary measure, it took off, performed every sort of evolution and landed—all under remote control. A robot airplane has obvious possibilities for target practice by military pilots and by anti-aircraft gunners on the deck of a battleship. We can also conceive of the robot as a weapon of attack, carrying a heavy load of bombs and dealing destruction to a battleship or a city without risking the life of a single pilot.

As shown in the photograph (for which thanks are due to the Society of British Aircraft Constructors) the Tiger Moth light biplane, with a 130 horsepower Gipsy engine, offers no particular interest. There is nothing exceptional about the performance of the machine. Under perfect radio control it can climb to a height of 10,000 feet, reach a speed of 100 miles per hour and fly, until the fuel gives out, to a distance of about 10 miles from the operating center. The airplane has catapulting points for launching, and a fixed aerial.

The rear cockpit carries the really interesting control mechanism and with regard to this the British are naturally secretive.

Remote control is by no means new. John Hays Hammond, Jr. thus "drove" a small motorized box-on-wheels years ago. Dr. Hammond has also succeeded in directing a torpedo by wireless. During the War we remember seeing a remote controlled automobile riding around the Army Air Station at McCook Field, Dayton, Ohio, without an occupant and doing remarkably well. The present experiments seem to constitute an improvement in precision and flexibility. What are the secret methods employed?

Thanks to the aid of Lt. Myron F. Eddy, expert on aircraft radio, we can make the following conjectures about the new ship.

As is well known, a radio receiving circuit can be so constructed that it will respond to only one frequency, and a transmitter can be so built that it will send out only one frequency. With short wave radio, tuning is possible within a very narrow band, which makes for the closest coordination between transmitter and receiver.

The newspapers report that the officer in charge issued the following commands in rapid succession: "Left, Dive, Right, Straight, Level, Glide, Climb." It would seem therefore that about seven coordinated electrical systems would be sufficient for complete control. We can imagine on the ground a control cabinet with seven switches, therefore, each switch putting into action an electrical system corresponding to the above commands. When a particular transmitter comes into play, the corresponding receiver through an amplifying relay actuates either an electric motor or perhaps opens a valve in a hydraulic system. The electric motor or the hydraulic piston, through a readily imaginable control system (probably not dissimilar to the usual control system of an airplane), actuates the elevators, rudder, or ailerons in appropriate fashion.

Of course skill is needed for such a design, but any competent electrical engineer working with a mechanical aeronautical specialist could probably achieve a similar apparatus without much trouble—once it has been shown that the idea is practicable, of course!—*A. K.*

Packages by Air

MOST of us know that there is a Railway Express Agency which handles packages for the railroads, but it is not so generally known that this Agency has an Air Express Division, with some 120 special offices for the handling of packages to be sent by air. This branch of express work is growing very rapidly, and its scope is almost unlimited. Everything can be shipped by air except inflammables, explosives, and live-stock. Nor is it a question of just small parcels. Packages up to 200 pounds, and 106 inches long are carried regularly. Even heavier packages can be sent by special arrangement. Parcels can be sent from anywhere to anywhere.

Ordinary packing, automatic insurance, and, above all, speed are what the Air Express Division has to sell. Huge presses have been set in motion by the speedy ar-

There is nothing mysterious in the appearance of the British "robot" plane

rival of an electro by air, serums and instruments have been flown 2000 miles to save a patient's life, corporation records have arrived in time to swing a big deal.

Here are typical rates and speeds: Los Angeles to New York, 21¼ hours, one pound for \$1.74 and 10 pounds for \$10.20; Chicago to New York, five hours, at \$1.25 a pound or \$3.44 for 10 pounds. No wonder that the Boeing 247 has provision for packages with a total weight of 1050 pounds in its nose, and a special package compartment in the rear of the passenger cabin. —*A. K.*

Small Samples for Clever Chemists

How the chemist analyzes a sample of metal so small that it has to be gathered up in a drop of oil is described by Beverly L. Clarke and H. W. Hermance, of the Bell Telephone Laboratories, in *Industrial and Engineering Chemistry.*

Contact points of various metals and alloys are widely used in telephone apparatus, as in relays and switches. Rapid qualitative analyses are frequently required to identify the alloy. Usually only a single contact is available and this must not be destroyed. Sufficient sample for a qualitative analysis is obtained by drawing the metal across a roughened spot on a microscope slide. The resulting streak is dissolved in acid, transferred to a clear glass slide and evaporated. Identification of this residue is made by reactions carried out under the microscope.

If the quantitative analysis is desired, samples may still be removed without destroying all of the contact point by means of a dental engine using a tiny rounded burr. The operation is carried out under the microscope, the fine particles of metal being retained by a drop of oil from which they are subsequently recovered by centrifuging and washing with a suitable oil solvent.—*A. E. B.*

Kitchen Modernity

How the plumbing industry is providing the impetus for a revival of building activity through the creation of new style-appeals in the kitchen is shown by the accompanying view of a model kitchen exhibited in Chicago recently by the plumbing division of the Briggs Manufacturing Company.

The kitchen cabinet sink is an example of drawn metal construction which has started a new trend in plumbing style and utility. The sinks are available in any color or color combination desired. The enamel is acid resisting. The small unit at the left of the sink is a dish washing machine developed by the same company. At the right of the sink is their new styling of a refrigerator.

In the foreground is a round electric stove which was created by engineers as a suggestion to the industry. The stove rolls on castors and permits cooking from any angle.

A modern kitchen equipped with a circular electric stove

Road-Rail Truck in Successful Test Run

The road-rail truck during its recent trial run

A new rail-highway motor truck recently made a successful test run from Akron to Cleveland over the Baltimore & Ohio railroad tracks, turned off the rails at West Third Street and then proceeded to its destination.

The truck, made by the Hendrickson Motor Truck Company for C. C. Nugent of the General Transportation Company, Boston, Massachusetts, developer of this road-rail truck idea, has combination wheels which carry special truck tires, developed for this purpose by Goodrich engineers, mounted beside steel flanged railway wheels.

The truck is driven on the rails at any crossing. The rubber tires are then deflated, so that the truck settles down with its steel wheels on the tracks. The front wheels are locked when the truck is on the tracks and the driver has no steering to do.

When the truck arrives at its rail terminus, tires are inflated simultaneously from the engine by the same air system that is used for brake operation.

New Radiator Cleaner

A new automobile radiator cleaner that exhaustive tests show will not rust or otherwise damage aluminum or aluminum alloy or other metal parts in auto motors or radiators has been developed by the Du Pont company. Many of the more modern motors use aluminum as a part of their cooling system.

Tests show that permanent spots will not develop on lacquer, baked enamel, or chromium if this cleaner drops on them. Chemists even boiled chromium-plated metal and aluminum and aluminum alloys in a solution of the new cleaner, but found no tendency even to spot the metals.—*A. E. B.*

Inheritance of Pigmentation

The question is constantly asked whether or not parents who are light in color, that is, one of whom has a small amount of Negro blood, may give birth to a coal-black child. Indeed, newspaper stories of the birth of a black child to white parents whose ancestry shows a slight trace of Negro blood several generations back appear with amazing frequency. The question is also asked whether or not pure Negro children may be born to mulatto parents who occasionally pass as white. The answer is of course in the negative.

The entire subject was analyzed by Irene Barnes (Barnes, Irene: The Inheritance of

Aluminum paint is being used on the San Francisco-Oakland Bay Bridge

Pigmentation in the American Negro, Human Biology 1:321 [Sept.] 1929), who was concerned particularly with the question of whether or not the crossing of persons of different color results in a blend of pigmentation.

The conclusions reached were that the offspring of parents of different color tend to resemble the parent with the greater percentage of dark pigmentary supply more than they tend to resemble the parent with the less percentage. However, pigmentation is not inherited by blending nor is it produced by the action of one or two factors that act as mendelian dominants. The studies made by the Davenports indicate that two nearly white hybrid parents can have offspring somewhat darker than themselves but that it is not genetically possible for non-hybrid parents to have Negro children unless a melanic mutation should occur. There is no evidence that such mutations do occur, and the appearance of a Negro child from a white parent naturally has a much simpler explanation.—*Journal of the American Medical Association.*

Aluminum Paint for Bridge

After more than two years of debating, architects and engineers have finally agreed on aluminum paint as a final coating for the new San Francisco-Oakland Bay Bridge; in fact, painters are already at work on the giant span.

The principal paints under consideration were black, gray, and aluminum. Architects favored gray from an appearance viewpoint; engineers preferred black because of its durability. A happy compromise was found in aluminum, which is satisfactory from an appearance viewpoint, and at the same time possesses durability equal to black paint.

The complete paint system for the bridge involves several paints. Over the bare steelwork go two coats of rust inhibitive red lead, followed by an intermediate base coat of black graphite paint. The aluminum field coat concludes the job. This system, in the opinion of paint experts and engineers, will furnish a fool-proof coating that offers maximum endurance with a minimum of maintenance worries, at the same time presenting an attractive appearance from all viewpoints.

Synthetic *vs.* Natural Camphor

Unlike synthetic indigo, which long since supplanted the natural product, synthetic camphor, although a comparable triumph of organic chemistry, runs nip and tuck with the natural camphor. Only by virtue of a protective tariff can American synthetic camphor compete with the natural product. Uncle Sam has imposed an import duty of five cents per pound on natural camphor, but has warned the synthetic manufacturers that they must produce more than one half of the domestic camphor used, or lose the benefit of this protection.

The United States Tariff Commission has checked up the figures for the first six months of 1935, and found that more than half of the camphor used in the United States is of the synthetic variety.

New Cutting Edge Welded on Worn Tools

A new arc-welding electrode which is designed for restoring worn cutting edges on tools of all kinds and which is said to permit savings of 20 to 25 percent in tool cost is announced by The Lincoln Electric Company. This new electrode, known as Toolweld, is the product of several years of research. By using this electrode, lathe tools, bits, milling cutters, drills, cutting and forming dies, and all other tools which have become worn in service can be given a new and harder cutting edge than has heretofore been possible. Tools can be refaced an unlimited number of times, and new tools, using ordinary steel in place of high-speed steels, can be provided with a cutting edge at tremendous savings.—*A. E. B.*

Intense Sound Makes Milk More Easily Digestible

Make a loud enough noise at milk and the baby will digest it more easily. That, in effect, is the discovery reported by Dr. Leslie A. Chambers of the University of Pennsylvania. Dr. Chambers spoke before the American Dairy Science Association, meeting jointly with the American Association for the Advancement of Science.

The apparatus used in the experiments consisted of a heavy steel diaphragm, driven by an oscillating electric current. Similar devices are used for submarine signalling. Over the diaphragm Dr. Chambers flowed a thin stream of milk, while he caused it to vibrate very strongly at various rates. The lowest vibration rate he used was 360 cycles a second, which is the pitch of F-sharp in the middle of the piano keyboard. The highest rate was 3000 cycles a second, about three octaves higher than middle F-sharp.

The effect was to alter the curd-forming character of the milk. Whereas the milk used normally formed a hard curd, difficult to digest, when acted upon by the pepsin of the stomach, after treatment it formed a soft, easily digested curd. Soft-curded milk is especially desirable for feeding babies, as well as older persons with "weak stomachs." Some cows naturally produce soft-curded milk, but many do not. Dr. Chambers' experiments have demonstrated a simple mechanical method to make soft-curded milk at will, out of any kind of milk.—*Science Service.*

Insulating Cement

A new insulating cement known as Sonittep, useful for both high-and-low temperature insulation, which can be applied both to hot and cold surfaces, has recently been developed by George F. Pettinos, Inc., Philadelphia, Pennsylvania. The cement requires no reinforcement and withstands temperatures to 2000 degrees, Fahrenheit. It is said to be reclaimable when used at temperatures not exceeding 1400 degrees, Fahrenheit. The cement is shipped dry and requires only the mixture of water for application. A quantity of 1000 pounds of cement will cover 50 square feet to a

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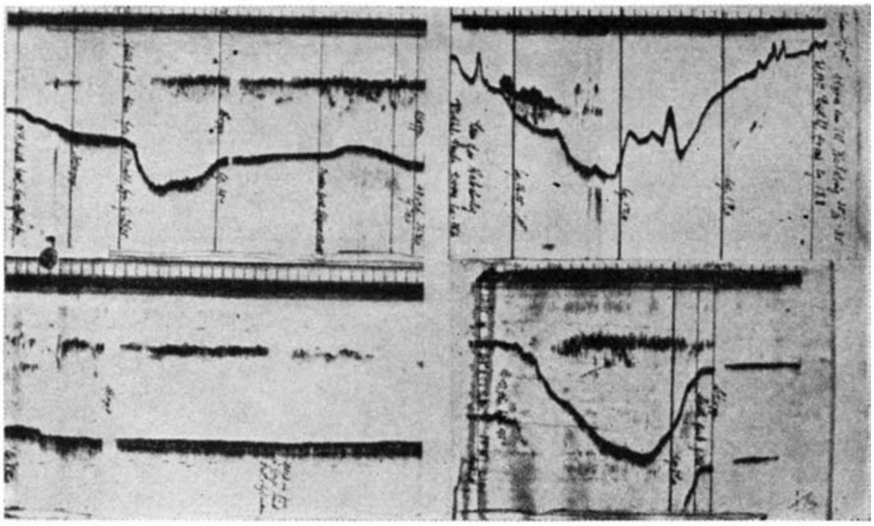


Courtesy *Nature* (London)

Four echo records, showing the presence of spawning cod. In each instance the lower dark line represents the bottom of a fjord—its upper edge the mud bottom and its lower edge the rock. Spotty, horizontal areas higher up represent fish

depth of one inch, and can be applied by unskilled labor. It is said to have about three times the covering capacity of asbestos cement and four times the insulating value, showing a heat transmission considerably below that of 85 percent magnesia.—*A. E. B.*

Echo-Sounding Apparatus Finds Schools of Fish

ECHO-sounding apparatus, now widely used on ships to make continuous records of bottom depth, can also be turned to good account in the fisheries industry in locating large schools of commercial fish.

In a letter to the editor of the British scientific weekly, *Nature,* Oscar Sund, well-known Norwegian fisheries scientist, reports four instances when the apparatus on the research vessel *Johan Hjort* disclosed the presence of large numbers of codfish spawning in midwater. The records demonstrated clearly the hitherto unsuspected fact that when codfish lay their eggs they pay no attention to the bottom, but maintain a position at a uniform depth beneath the surface.

Sound waves sent out from the ships' bottom were reflected off the fishes' backs and returned to the listening device just as they do from the rocks or mud of the sea bed. The length of time between the start of the sound and its return as a submarine echo indicates the depth.—*Science Service.*

Dr. Sund's letter is as follows: "The vessel used for the annual oceanographical investigations in the Lofoten area (the *Johan Hjort*) had a Hughes echo sounding gear (magnetostriction system, frequency 16,000 cycles per second) installed before leaving Bergen last February. The gear worked smoothly all along the coast and besides furnishing a great number of interesting sections, revealed many features hitherto unsuspected; among others, that the clay flooring of deep fjords is invariably about 10 meters thick and generally very flat.

"Marks referable to fish were seen on the record only after the arrival at that portion of the Lofoten fishing area where the most prolific fishing has been going on during recent years—at Hola—a bight of the West Fjord of very restricted dimensions, say, ten miles by four miles. At this place fish were indicated continuously along straight courses of two nautical miles and more. The nature of the indications may be seen from the photographic reproduction of four separate records, partly obtained while the ship was stationary among the hand-line boats, which got the fish exactly at the depth indicated.

"It is interesting to note that this spawning concentration of cod has apparently no relation to the bottom. This was well known before, but no one could have imagined the fish to be limited to such a sharply defined layer of only 10-12 meters in thickness, extending widely above deep water and shallow, always at the same distance from the water surface. This distance was 72 meters at the first encounter with the spawning shoals (March 11) and 50 meters at the conclusion of this investigation on April 5. Concurrently, the temperature in the 'fish' waterlayer had decreased from 6·5 degrees-6·0 degrees to about 3·0 degrees, Centigrade. In some instances a perceptibly lower oxygen and hydrogen ion concentration was observed in this water-layer than in the layers immediately above and below."

Filter for Home Water Systems

CHARCOAL has long been used for a great variety of purposes in connection with sanitation and cleanliness. It has remained, however, for the K. & S. Foundation, Inc., to adapt to the home water system the properties of charcoal for adsorbing foreign particles, gases, and even smells. The equipment they have developed is the essence of simplicity, as it is essentially a tank filled with charcoal, through which city water flows in its passage to the various faucets. The important point about this equipment, however, is a patented feature which provides for back-flushing the charcoal periodically to remove accumulations of sediment or unwanted chemicals which enter the house from the water main.

In operation—referring to the accompanying illustration—water enters from the right, passes through the tank full of charcoal, and out into the house system, through the pipe at the left. At rather long intervals, water is by-passed through the pipe paralleling the tank, so that it enters at the left end, back-flushes, and drains off to the sewer, through the pipe line at the bottom.

This filter produces crystal-clear water for all household or industrial purposes, for it removes all suspended organic or other matter that would adhere to the inside of the pipes, or which would produce malodorous or discolored water. It does not, of course, take care of bacilli, but in city systems such additional control would not be necessary. The size of the filtering compartment varies, according to the quantity of water used, from 12 by 36 inches to 24 by 96 inches.

"MINING" DRY ICE

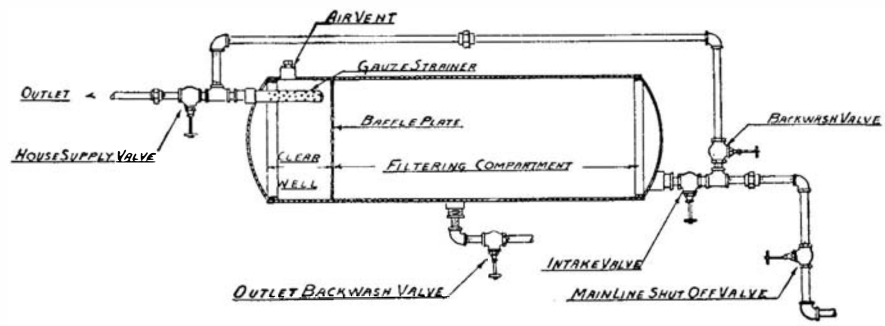
CARBON dioxide is reported to underlie the Salton Sea basin in southern California. From the 35 billion cubic feet of this gas reported in this area, nearly a million tons of dry ice could be manufactured and probably will be at some future date.

Debunking Man-Eaters

MAN-EATING sharks there may be; man-eating alligators there are not. "I know of but one authentic instance of an alligator wilfully attacking a human being unprovoked," declares E. A. McIlhenny, Louisianian who has lived among the big reptiles all his life and now has written a book about them, "The Alligator's Life History."

Mr. McIlhenny makes one qualification: females guarding the hidden nests where their eggs are laid. "Female alligators will attack man to protect their nests and young, but their movements on land are so slow that there is no trouble in avoiding them, and in the water they always give warning if they are about to attack, by hissing and guttural grunts.

"It is a wonder more men are not injured by these powerful reptiles, for those



Later models of this water filter place the outlet backwash valve at the right

who make a business of hunting them for their skins are most careless in handling them; but it is a rare thing for any one to be hurt by an alligator."

But what of the many reports of alligator attacks ending in severe injury to human beings? Fish stories, literally, says Mr. McIlhenny. There is a big, vicious, long-jawed, sharp-toothed fish in the southern lakes and bayous, known as the alligator gar. It has all the strength and truculence of the muskellunge of the north or the barracuda of the warmer salt waters. Several cases of injury and drowning alleged against alligators have been investigated by Mr. McIlhenny, and an alligator gar turned up as the culprit in each one.

When he and his childhood companions were in swimming, they entertained themselves by "calling" 'gators to surround them. "We would attract them by imitating the barks and cries of dogs and by making loud popping noises with our lips. . . . We had no fear of them and would swim around the big fellows, dive under them and sometimes treat them with great disrespect by bringing handfuls of mud from the bottom and 'chunking' it in their eyes."—*Science Service.*

Useful Derivative of Sugar

CANE sugar becomes a raw material for the chemical industry with the introduction of a compound useful in waterproofing and in making molding resins. The new compound, introduced by the Niacet Chemicals Corporation, is known as Sucrose octa-acetate and is announced as the first of a series of derivatives utilizing cane sugar as an industrial raw material. Sucrose octa-acetate is a white, crystalline substance, soluble in a wide range of common organic solvents—a property which gives promise of many applications. For instance, when cloth is wet with a solution of this substance, then ironed, it acquires a glossy, water-repellant surface. Sucrose octa-acetate is also used as a resin plasticizer, in molding resins for electrical parts, for waterproofing insulating paper, and so on.—*A. E. B.*

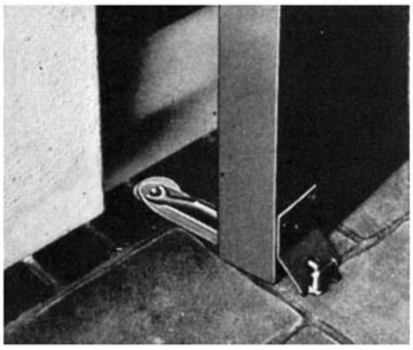
FLY GERMS

THE average number of bacteria carried by a fly was placed at more than 1,000,000 in an investigation by two scientists who recently examined 400 house flies.

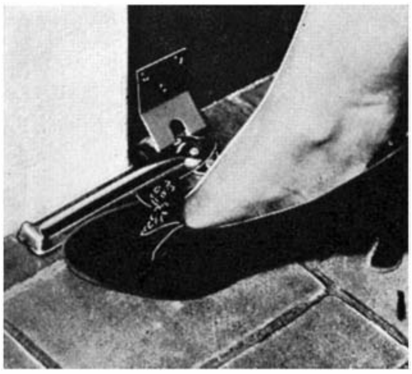
Tantalum Sheets .005 Inch Thick Are Arc Welded

TANTALUM sheets worth 50 dollars a pound and so thin that it takes 200 of them to make an inch are now being arc welded regularly in the fabrication of chemical equipment.

Exacting requirements covering the articles fabricated from tantalum have made it necessary to develop a special technique for welding it. The method finally adopted consists of first forming a straight angle flange at all edges of the sheets to be arc welded. These flanges are then fitted to-



Left: **The Safe Lock for open doors in operating position.** ***Below:*** **The latch is pushed out of the way when not in use**



gether and tack welded in a few places to avoid shifting the assembly. The job is then immersed in a tank filled with carbon tetrachloride so that the edge to be welded is approximately ¼ of an inch below the surface of the liquid.

Immersion in carbon tetrachloride requires higher voltage across the arc than would be needed to weld in air, and at the same time, the thinness of the stock being welded and the necessity for strict localization of the heat demand low welding current. Hard carbon electrodes ⅛ inch in size, held in small light electrode holders, are used.

The welding process was developed by Fansteel Products, Inc., using Lincoln Electric Company equipment.

Safe Lock for Open Doors

A NEW type of emergency door lock—"Safety Catch," manufactured by The Kawneer Company—is a decided improvement over the old-fashioned chain or bar lock. It is inexpensive and inoffensive yet gives positive protection against unwelcome intruders. The photographs show how it is attached to the door and floor and operated by the foot.

FAMOUS LIGHT-WEIGHT

ALUMINUM is about one half as heavy as vanadium and yttrium, one third as heavy as iron, copper, and tin, one fourth as heavy as silver and lead, one fifth as heavy as mercury, one sixth as heavy as tantalum, one seventh as heavy as gold, and one eighth as heavy as platinum.

Increased Use of Soya Bean Oil

EVIDENCE of the growing commercial importance of soya bean oil is found in the fact that approximately one sixth of the total yearly production of 37,200,000 pounds of soya oil was utilized for edible purposes. Refined soya oil, produced by modern methods, is a valuable source of vitamins A and D; a source in which vitamin D is not formed artificially at the expense of the vitamin-A content.

Refined soya oil is used mostly as a substitute for salad oil, often being blended with other oils. In this country it has recently found a new outlet in the mayonnaise industry.

The domestic consumption of soya oil in the production of margarine amounted in 1918 to nearly 6,000,000 pounds; in recent times it is again gaining in popularity as the interest for margarine in this country is rapidly developing.—*A. E. B.*

Ice Lowers 'Phone Subway Line

IF anyone had investigated the excavations in Flatbush Avenue, Brooklyn, adjacent to the Floyd Bennett Airport, on a certain night during last spring they would have seen a long and massive line of telephone conduit apparently reposing peacefully there, with the companionship of the night watchman as he made his rounds to adjust the red lanterns.

But things are not always what they seem and what appeared to be a most inactive piece of telephone subway was actually in the process of being lowered several feet. Weighing 60 tons, a 500-foot section of nine-duct tile conduit, with a concrete slab under and on top of it, in addition to two creosoted wood ducts and two maximum sized cables, was moving downward in strict accordance with the wishes of the telephone construction engineers and workers. Here's the answer: Ice!

Massed ice, for lowering heavy, compact structures of great strength has been used in other construction fields before, but never for long, fragile structures such as telephone conduit.

The methods previously used in lowering duct lines employed blocks, screw jacks, or chain hoists, supported from timbers or tripods, attached to slings placed around the conduit every few feet throughout the section to be lowered. By operating these devices the tile ducts with their brittle mortar joints and concrete base and top were lowered more or less evenly to their desired position. These methods required a large amount of lumber, equipment, and labor and resulted in breakage of tile, mortar joints, and concrete.

The work leading up to the use of ice consisted first of excavating to uncover the conduit in its original position, then of digging under it at intervals of about six feet to provide pits for ice, next placing the ice and then removing the earth remaining beneath the conduit between the pillars of ice. After that there was nothing to do but wait for the ice to melt, which requires about two days. During this period the next section was being prepared and the preceding section back-filled. Some sections were lowered to as much as 48 inches and in these deep places the work was done in two or three stages, depending on the depth desired.

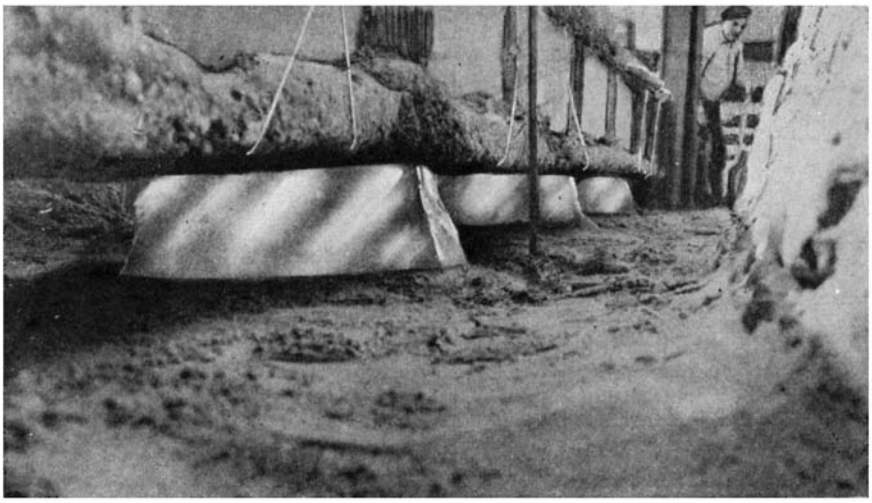
Ordinary commercial cakes of ice were used. The iceman delivered the pieces alongside the trench and cut them into blocks suitable for placement under the conduit.

A total length of 3200 feet of telephone subway was lowered by this method, not only resulting in a substantial saving but also in protecting an important section of the telephone equipment from possible breakage or interruption of the service.

Rancidity-Retarding Cellulose Wrapper

AN interesting display was recently passed on to us for examination. This consisted of a hand-made light-retardation tester, composed of a sheet of sensitized photographic paper over which were pasted strips of several pieces of cellulose wrapping in different colors, and other wrapping materials such as parchment, glassine, and wax-paper. This little device showed a wide difference between these materials in ability to transmit the rancidity-causing rays of light.

For some time it has been known that light is deleterious to many food products. It is for this reason that some foods are now packed in green bottles, and many medicines are in brown. The most remarkable



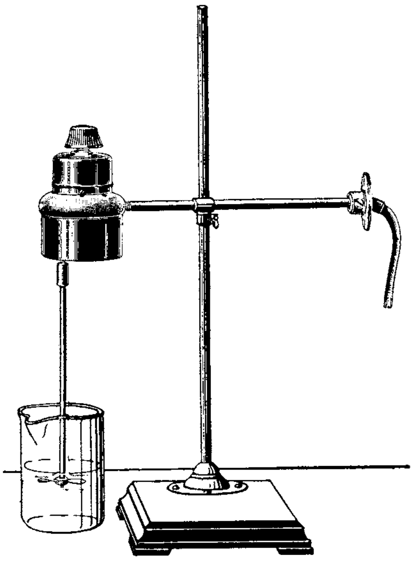
Ice being used to lower a 'phone subway line into place

fact about the exhibit above mentioned is that one cellulose wrapping material retarded these harmful rays more than even the green, and yet gave perfect visibility, and added attractiveness, to the food wrapped within. This is a new product, called Old Gold Sylphrap.

Thus, in this we find a rancidity-retarding material which at the same time creates an attractive and salable package. It is claimed that such products as potato chips, which ordinarily become rancid in two days in colorless transparent wrappers, are preserved in this new material for 30 days or longer.

Electrical Laboratory Stirrer

A fool-proof laboratory stirrer, just released, is a sturdy, well built accessory useful for making emulsions; dissolving dyes, gums and resins, waxes and bitumens, pyroxylin, cellulose ethers, casein,



Stirrer for the laboratory

glue, gelatin, starch, salts; extracting crude drugs and herbs, oil seeds, complex organic materials, and so on.

Actuated by a shaded pole type motor (110 volts, 60 cycle), it will run 24 hours daily without damage. It is non-sparking and will not be injured by fumes and vapors. The speed may be varied as needed by the rheostat. It fits an ordinary clamp holder or may be screwed to a shelf or wall. The shaft and propeller are furnished in chromium plate or Monel. A flexible, six-foot rubber covered cord and soft rubber plug are included.

Black Widow Spider Not As Black As She's Painted

Not as black or deadly as she has been painted is the latest medical verdict on the black widow spider. This partial clearing of the lady spider's reputation is made by Drs. J. M. Frawley and H. M. Ginsburg of Fresno, California, in a report to the *Journal of the American Medical Association.* Fifty-two cases of black widow spider bite have been treated without a fatality in the Fresno General Hospital, these doctors

(*Please turn to page* 215)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

THERE ought to be some definite, quantitative way which would enable the amateur telescope maker to measure, also to express to others, the hardness of the pitch used in laps for polishing lenses and mirrors. Just how hard is a "soft" pitch lap, and how soft is a "hard" lap? The old hands know the answers, but how is the poor isolated beginner to get a clear idea? As a result, many flounder along for months or years before discovering that their pitch has been too hard or too soft—generally the latter. Here is a colloquy we dreamed one night:

Anxious Beginner: "How hard ought a pitch lap to be?"

Seasoned Old Hand: "Well, not too soft, or else it'll turn the edge."

A.B.: "Yes, but just exactly what do you mean by 'too soft'?"

S.O.H.: "Why, it ought to be quite hard."

A.B. (still cherishing hope of getting a definite idea that will help): "How would you define 'quite hard,' then?"

S.O.H.: "Well—aaaa, hard enough so it won't turn the edge."

A.B. (beginning to perspire): "But isn't there any *exact* way to pin it down to definite terms—as you know, I'm only a little fella, working all alone."

S.O.H.: "Yes, you may chew the pitch and judge it that way. You bite down on it, slowly but not too slowly, and not too fast, and if it 'gives' too fast it is too soft, but if it shatters, unless you have bitten too fast, it is too hard. Then another way is to test it with your fingernail. Press quite hard for quite a time, and if the mark is quite long the pitch is probably quite soft, but if it is quite short it may be quite hard. That's all there is to it—it's simple enough."

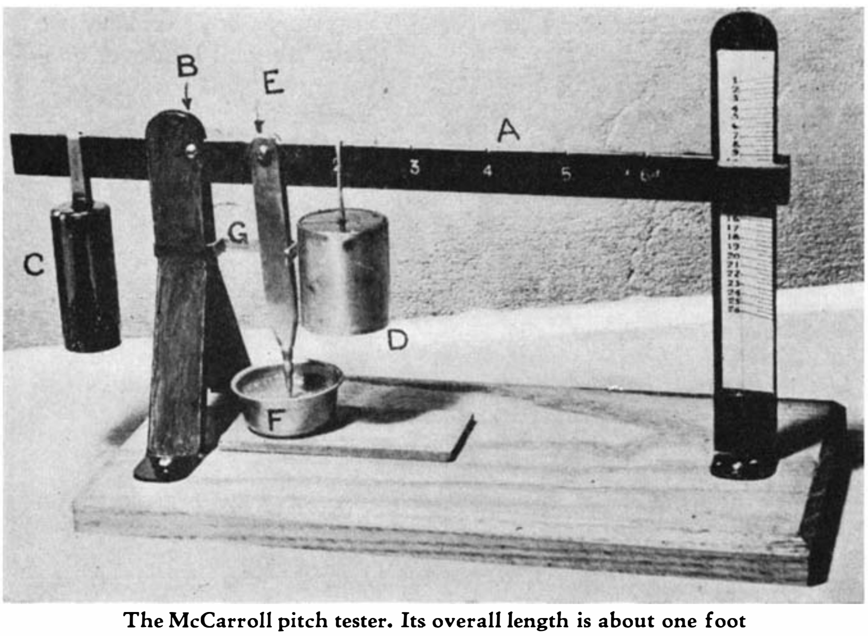
This situation has led Joseph A. McCarroll, 521 Palisade Avenue, Teaneck, N. J., to design a pitch tester. Through the common use of such a machine, workers may now, wherever they are, compare pitch hardness in definite, quantitative terms which will mean the same to all from Maine to California, and from Edmonton to Brownsville. A photograph of McCarroll's tester is shown on this page. It is a simple rig, easy to build, and one ought perhaps to be made and kept available at least in every club group. Making one is not much of a task. And here, for once, we favor "standardization," for without standardization of the essential specifications of the little tester the end sought would be defeated. It is not, however, necessary to standardize the materials from which it is made, or the color of the paint on it. McCarroll writes:

"The principle of the test is the penetration of the pitch by a needle of specified dimensions, under a certain weight for a certain length of time and at any given temperature. The test is in all respects similar in principle to the 'Standard Method of Test for Penetration of Bituminous Materials,' as adopted by the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa. The standards of this society are 'standard' throughout the entire country, in the engineering professions and in industry and commerce generally.

"The pamphlet issued by the Society is known as 'A.S.T.M. Designation D5-25.' A copy may be obtained from the Society for 25 cents. This pamphlet includes a description of a needle (smaller than the one to be described here) and an outline of the conditions under which the test shall be conducted. It does not describe any machine. That is left to the ingenuity of the inventor. The responsibility for the design of the machine shown on the present page must rest with me. The credit for making a really workmanlike gadget of it is due to Mr. Frank Wanderer, a member of our local A.T.M. association.

"The machine shown was made of thin, cold-rolled steel. Aluminum would be better. The arm *A* is 13 inches long and is provided with a guide piece, so that its end straddles the scale post at the right. It works on the principle of the lever. The arm is balanced on the supporting pin *B*. It is counterbalanced by weight *C*. The 1-millimeter needle, supported at *E*, is separated by a 1¼″ space from *B*. The one pound weight *D* is shown resting in a notch which is the same distance from *E* as *E* is from *B*. This gives a pressure on the needle of two pounds, and each successive notch, separated by the same distance, adds a pound to the applied pressure, as shown by the numbers on the lever. The scale is graduated in actual degrees of arc, with center at *B*.

Porter with Dr. J. A. Anderson, executive officer for the 200-inch



The McCarroll pitch tester. Its overall length is about one foot

"*F* is a small pan. It contains one half inch depth of pitch. The pitch is allowed to cool to room temperature before a test is made.

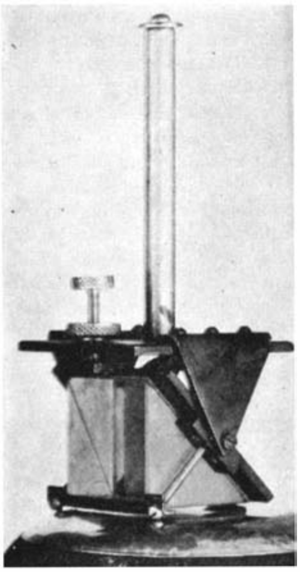
"In making the test the sample of pitch is set in place, the needle adjusted, the weight *D* held in the hand, the temperature noted, the time observed, and at the word 'go' the weight is gently hung on at the two pound notch (usually) and the downward swing of the lever in one minute is recorded. If the sinkage is about three degrees on the scale (using coal tar pitch) with two pounds pressure for one minute, I regard the pitch as medium soft, and suitable for making a lap for general polishing purposes. The specific hardness under these circumstances might be said to be '2P3D,' meaning two pounds pressure and 3° deflection of the lever. The temperature has no significance in connection with *specific* hardness, for the pitch must be, say, 2P3D at whatever the workroom temperature is, and if the temperature should rise five degrees it would be absolutely necessary to use a pitch of higher melting point in order to have the test show the *same hardness.* Any appreciable change in temperature will show in making a test.

"However, if one wishes to describe the *general* hardness properties of the pitch, it is necessary to specify the temperature at which the test is made. This will show the relation to the melting point of the pitch, which should be known in order to facilitate tempering operations, and, of course, for a complete specification of the character of the pitch.

"The use of a scale graduated in actual degrees of arc makes it easy for the individual to design machines of different sizes, but with the same system of scale notation and needle size. The needle has a flat, round end of 1 millimeter diameter, tapering upward to 5 millimeters in a length of 25 millimeters. The fixed hook *G*, attached to the pillar and loosely embracing the needle, is simply for controlling the point of contact of the needle on the pitch.

"The intention has been to make something as simple as possible that will do the work expeditiously and as accurately as is needed. There are some mechanical features connected with the design of this little apparatus which might be improved, but they do not introduce any appreciable error in testing. For example, the pivots might have less friction. Also the needle does not keep in an absolutely vertical position while penetrating the pitch, but since a penetration of about 1/16″ is about all that is ever required, it is obvious that this feature may be neglected. Better ideas for a pitch tester may be forthcoming."

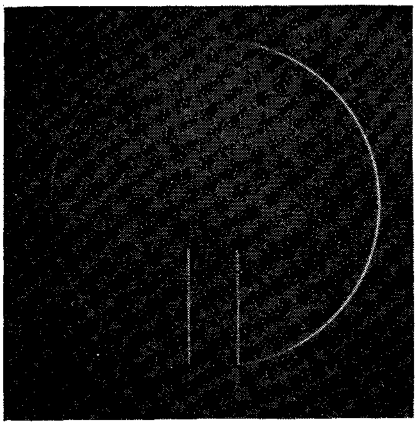
So much for McCarroll's description of a valuable device. The McCarroll tester gives



Wates' diagonal support

us a way to equate hardness with numbers, as in the one example mentioned—"2P3D." There still remains the gradual establishment of a general consensus regarding how many Ps and Ds of hardness a lap should have—general only, because this always will vary some with individual preferences. Note that there would be nothing here to compel, or desire to compel, any worker to conform to a standard set by others. The machine measures the absolute hardness of the pitch, and its terms are always the same for the same pitch at the same temperature. *A* may then say or write to *B*, "I like mine 2P2D," and *B* may reply, "Give me 2P4D." Each retains his pet hardness but each knows exactly what the other fellow means when he uses the common values of the McCarroll scale.

As a start-off, take a lap your scribe has



The Everest edge test: McGuire

just been using—made of coal tar pitch supplied by McCarroll. It was a rather hard lap at 70°, and was composed of two parts coal tar pitch with melting point 170° and one part ditto with 140° melting point. It was hard enough to permit easy maintenance of an unturned edge (by Everest's very critical diffraction ring test, ATM, p. 371) throughout polishing, and to keep a strong oblate tendency on the mirror. Everest tested this same lap by thumbnail and called it "hard" in terms of his own personal estimate. A sample of this lap, returned to McCarroll, was found to test 2P2½D.

THE picture of a diagonal support, which you saw on the preceding page, is one taken by Cyril Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada, and is inserted with the hope that numerous others will send in similarly clear close-ups of diagonal supports. The idea is to make a collection and, some time hence, publish the lot of them together, since workers often ask us for ideas for designing such supports.

The same Cyril Wates is the one whose telescope is shown on the front cover. Those on the staff of this magazine who are responsible for selecting a front cover picture came to your scribe and begged for a good telescope photograph. About 100 unpublished telescope descriptions were gone over and this was the only one of the lot which would pass every artistic test. Not the telescope, though that, too, is arty enough, but the picture—clouds, river, and all the trimmings of good composition. In addition to the little note on page 169, directed to general readers, the following may interest telescope enthusiasts:

Wates' mirror has a 9-point suspension. He says "it is not quite true, as some old-timers say, that in this region we have 'nine months winter and three months bad sleighing,' but even the Orion nebula loses some of its charm at 30° below. In the summer, on the other hand, the sky is never really dark. On June 21, at midnight, the sun was only 14° below the horizon, and Vega was the only star visible to the naked eye in Lyra. But we also have skies of exquisite clearness, and a long, lovely autumn season." Wates will not learn, until he unwraps his "Sciam" in mid-September, that his picture is on the front cover.

WE have also been asked by L. J. S. to publish a collection of close-ups of Cassegrain secondary supports. Can't do it, unless we receive the pictures. Make them small-stop, long-exposure close-ups, glossy.

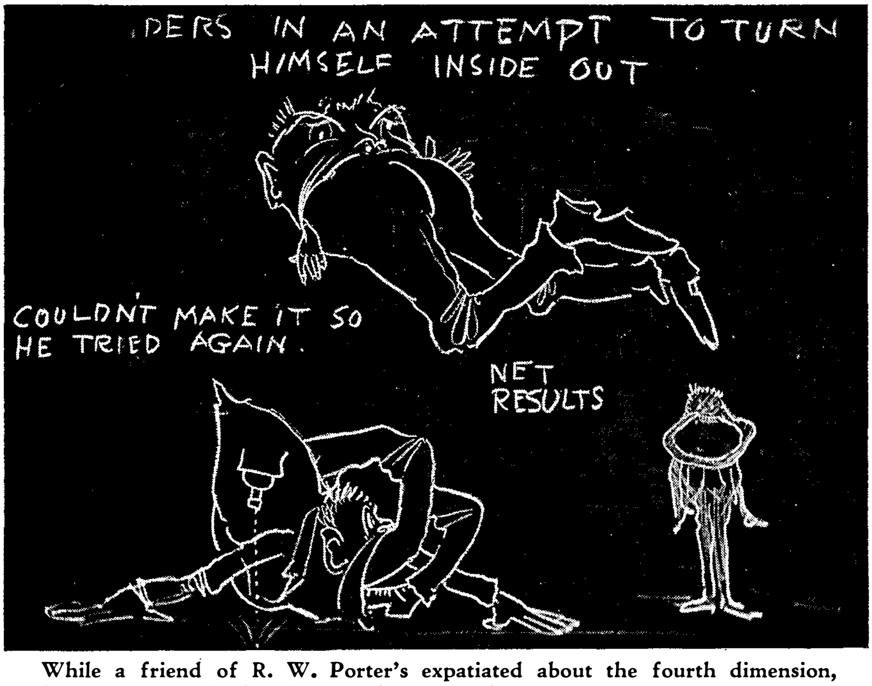
UP there in the northwest corner of this page is a sort of focogram of the Everest diffraction test described in "Amateur Telescope Making," page 371, made by Daniel E. McGuire, of Shadyside, Ohio, on a mirror which, as the test shows, does not have a turned down edge. Our reproduction does it some injustice, as the left-hand cusp of the ring should come out a bit stronger than it does. That test is probably the best of all the tests for turned down edge. Your scribe confesses not discovering it in A.T.M. until quite recently (must read that book, some time) and doubts whether many others have tried it out yet. Recently, on a mirror job, it was tried many times, in each instance immediately following the Ronchi test and the knife-edge test. It seemed to be the most critical of the lot. Do others find it so? Everest, who discovered the test itself, thinks a mirror which will pass it is mighty good—at least for edge. Any old mirror will easily show the right hand cusp; it is the one on the left that is wanted, but there will be a gap of an inch or so at top and bottom, even on a good mirror. McGuire's focogram, or diffractogram, shows the Everest straightedge, as explained in A.T.M. We have seen some mirrors whose left-hand diffraction cusp looked more like a photograph of a black cat, taken at midnight, in a deep dungeon, when the cat wasn't there. But a really swell mirror we gazed at for a long time, at Wally Everest's test rack in Pittsfield, Mass., showed the ring equally strong on either side. (That fellow has no respect at all for a fine mirror. Someone sent in a proposed new stunt for use of HCF, Everest was asked to give it a try, and chose this same fine mirror for the experiment, about ruining its figure. But he brings them back again, between a couple of smokes, and takes mirrors so lightly that perfect ones are used all over the Everest home as door weights. When bored, he picks up the nearest door weight and turns it into something to envy. We sigh.)

WE hear many rumblings and grumblings about eyepieces of the so-so kind—not very bad, not very good. Well, when a majority of persons tease a dealer to sell them "*good* but *low-priced* eyepieces," what can the dealer do? We have now and then been asked where a high-grade eyepiece may be got hold of—one that will not pull a high-grade mirror down. Why not have Kirkham make you one to order, to suit your needs? His eyepieces are beginning to become famous in select circles. But they aren't low-priced—we hope they will always stay high-priced.

LAST month we carelessly reported Hindle as figuring his machine-made mirrors by hand, with small polishers, and now he radios: "I never use hand tools, but figure with part-sized tools machine driven." As Hindle is the outstanding exponent of the machine for the whole job, we guess we pulled a boner that time! Apology, then, to Hindle. We have here the manuscript of a full treatise, by Hindle, on all-machine figuring. Publication later.

Alexander Elan, 4806 Illinois Ave., N.W., Washington, D. C., asks us to broadcast to Washingtonians the call to organize a club.

IT turns out that the use of coal tar pitch for laps is far from new, though no one seems to have mentioned it to us before we inserted a note announcing its "discovery," two months ago. Even so, at the heart of our little "announcement" was not so much the fact that coal tar pitch laps give smooth surfaces but its hardness controllability, through using mixtures of hard and soft pitch, each at *known* melting point. By the way, coal tar pitch requires a little more care than pine pitch, in melting. Some which Stoy of Atlanta melted took fire, fell on his hand and cost him two months' time trying to save the member. When melting it in a can, be sure to melt an escape channel for gases down one side first.



While a friend of R. W. Porter's expatiated about the fourth dimension, hyper-space, and other deep stuff, Porter's facile pencil unconsciously wiggled

THE SCIENTIFIC AMERICAN DIGEST

(Continued from page 211)

report. The right hospital treatment will save the life of the person the black widow bites, they believe. No treatment or the wrong treatment may result in death.

Here are some details of the treatment they recommend: They put the patient to bed and apply iodine to the site of the bite. They require him to drink large quantities of water and of non-alcoholic fluids. They give him a hypodermic to allay the pain and a sedative to permit rest. Then they inject into his veins a solution of magnesium sulfate, more commonly known as Epsom salts. It is the latter treatment that is credited with relieving the abdominal cramps and the other severe symptoms that follow the spider's bite.

An intoxicated man has a poor chance of recovery, once the black widow has injected her poison in him. Nor should any person who has been bitten by this spider be given a drink containing alcohol. Infants or very small children may not recover from this spider's bite, these Fresno doctors believe, because the amount of poison from the bite is large in comparison with their small bodies and the victims go rapidly into convulsions.—*Science Service.*

"Polite" Explosions for Modern Coal Mines

BECAUSE large pieces of coal—the so-called "premium" variety—are more valuable than small ones, and in order to escape the fumes which hamper work and sometimes endanger life, certain coal-mining areas in Illinois and Indiana have discarded dynamite blasting in favor of compressed air. With the new equipment, the coal is "politely" pushed out of place by the air pressure.

The coal dust and chips which are broken out by the dynamite are difficult to handle and bring much lower prices on the market than the larger chunks. With the absence of fumes under the new method, miners can start loading coal immediately after the "shooting" and do not have to wait until the air clears. The mine level does not have to be vacated, as is the case when explosives are used.

With the new method a portable compressor stores air up to 15,000 pounds pressure in a long metal cartridge. The latter is inserted in a hole drilled in the face of the coal and a valve suddenly releases the air, which, in expanding, pushes out the coal in big chunks. The steel cartridges are specially designed and may be used over again. The entire operation is conducted directly at the coal face, and cartridges are filled in 90 seconds. Miners and equipment retreat to a distance of 100 or 150 feet during the explosion.—*A. E. B.*

Nickel-Cast-Iron Skillets

A NEW metal for home utensils is being introduced by the Chicago Hardware & Foundry Company, in its line of nickel-cast-iron frying pans. This nickel iron has been used for years in industries where corrosion of equipment is a serious factor, but the skillet is its initial appearance in the home.

Originally developed for use in such industries as the paper and pulp production, packing houses, soap factories, and so on, this iron contains about 20 percent nickel to enable it to withstand the corrosive attack encountered in such service. This nickel also increases the toughness of cast iron to a marked degree, and changes its gray-black color to a shining silver.

Silvery Monel metal and stainless steel have already made the trip from industry into the home, but this is the first instance of a lustrous cast iron being offered for home service.

EMERY

MOST of the world's commercial emery comes from one place in the world, an island off the coast of Greece.

Oversold Terrors

WAR, if it should come to peoples already "withering away for fear," may surprise them by not being as completely infernal as they expect. Visions of wholesale raids by airplanes, wiping out entire cities with "a few pounds of secret poison gases," will not be realized, assert professional military men, irked at the facile prophecies of civilian "experts" in easy-chairs. Neither will the artificial spreading of disease epidemics wipe out whole populations, declare army medical men.

New chemical-warfare weapons have been investigated intensively since the close of hostilities in 1918, and a number of compounds of possible military value have been turned up. But none of them is any more powerful than the war-time phosgene and mustard gas, and most of them are not as effective.

There may be mass airplane raids on cities, but they are too expensive in losses of both men and planes to be directed merely at areas of civilian houses. Their objectives will be industrial plants, warehouses, transportation terminals, and other concentrated targets of military significance. And modern anti-aircraft guns and counter-attacking combat planes would have a word of their own to say about even that.

It would be possible, either by airplanes or spies, to dump quantities of bacteria into city reservoirs; possible, though with vastly more difficulty, to infect city milk supplies. But to what end? Water can be filtered and boiled, milk pasteurized, populations protected by the measures of hygiene and preventive medicine which they should be using even in peace-time.

Popular fear of these things, in some cases bordering on hysteria, is probably due at least in part to the unprecedented rate at which the World War hatched horrors. No previous conflict ever brought such a combination as poison gas, aircraft bombing, tanks, super-long-range guns, and unrestricted submarine warfare. Imbued as most of us still are with the 19th-Century notion of the "inevitability of progress," we naturally expect the "next war" to begin where the last one left off and go even further. This uninformed terror of "what shall come upon the whole world" is quite conceivably a factor pushing us toward a new war, as we are all fatally fascinated by the very things we fear most. A sober, square look at the actual possibilities of present-day military technology, rather than a shuddering reading of the apocalypses of imaginative writers, might do much to allay hysteria and still leave us with a sufficient distaste for war.—*Science Service.*

New "White" Light Aids Production

AN industrial white light said to be restful on the eyes and to permit increased efficiency in high-bay lighting has been developed by the General Electric Vapor Lamp Company. The new lamp is not

Testing synthetic "daylight"

actually white. It combines light blue and yellow-green which, however, produce a white sensation to the observer. The lamp gives an intensity of 14,000 lumens at a current consumption of approximately one watt per 35 lumens.—*A. E. B.*

New Nitrocellulose Finishes

A METHOD for producing a nitrocellulose plastic coating on any type of material—wood, glass, metal, rubber, and so on—has recently been developed and gives promise of an important advancement in the technique of surface coating, says *Solvent News.* By means of the "Macoid" process, which is patented, pigmented coatings of nitrocellulose may be developed in a wide variety of decorative effects and it is reported that they possess great mechanical strength, plus resistance to wear, weathering, and chemical action.

The process is based on the application of a nitrocellulose plastic in the form of a heavy, viscous solution. Parts to be coated are dipped in the material under controlled conditions of humidity and temperature in the dipping room. Thickness of the coat, usually ranging from 0.005 to 0.020 of an inch, is controlled by the viscosity of the solution and the speed of the dipping operation.

Among the many applications which are said to lend themselves quite economically to the process are: automotive hardware, instrument boards, and fittings; aircraft fittings; and aircraft propellers.—*A. E. B.*

CURRENT BULLETIN BRIEFS

THE METALLURGY OF OXY-ACETYLENE WELDING OF STEEL is an illustrated abstract of a paper read before the International Acetylene Association by J. H. Critchett. It tells briefly and clearly what happens during welding and some of the precautions that must be observed. *Write for Bulletin 1035A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

WORLD CHEMICAL DEVELOPMENTS IN 1934 is a Supplement to Trade Information Bulletin No. 823 and covers such subjects as dyes, heavy chemicals, paints and varnishes, chemical specialties, and so on. Request Trade Information Bulletin No. 824, *Superintendent of Documents, Government Printing Office, Washington, D. C.—5 cents (coin).*

ON HEALTH'S HIGHWAY tells the story of research in cancer control and particularly the rôle which has been played by animals in the study of scientific medicine. Thoroughly illustrated. *The New York City Cancer Committee, 150 East 83rd Street, New York City.—50 cents postpaid.*

BENTONITE TECHNOLOGY AND INDUSTRIAL USES. Bentonite is a natural clay-like substance found in certain parts of the United States which has many applications in various industries. It has a great affinity for water, swelling to many times its original volume when saturated. It is widely and successfully used for stabilizing emulsions of many immiscible substances. A series of bulletins under the above title, bound in loose leaf form, $2.00 postpaid, which price includes, for one year, additional sheets which are issued frequently. *American Colloid Sales Division, Inc., 363 West Superior Street, Chicago, Illinois.*

LIVABLE HOMES MADE WITH PHEMALOID COMPOUND LUMBER tells the story of a new type of building material made of real wood, cross laminated and bound together with a synthetic resin. The resulting material is exceedingly strong and has many advantages for interior and exterior construction. *Write for Bulletin 1035C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

CONCRETE IMPROVEMENTS AROUND THE HOME is a well illustrated and attractive booklet of 46 pages showing exactly how to build all kinds of concrete objects for the home. Cisterns, lawn benches, curbs, posts, sidewalks, sundials, garden pools, and so on are described and illustrated. An excellent section of the book tells how to mix good concrete, and the steps are shown by photographs. *Portland Cement Association, 33 West Grand Avenue, Chicago, Illinois.—Gratis.*

SMITHSONIAN ANNUAL REPORT FOR 1933. A notable assemblage of reprints of scientific articles on gravitation, the galaxy, contents of space, high voltage, meteoric craters, and subjects in general of interest to scientific people. This is the latest volume.—*Government Printing Office, Washington, D. C.—70 cents.*

COLOR HELPS, by Joseph Cummings Chase, gives the essential facts about colors, their selection, mixing, and application. Illustrated with several color plates. Of value to anyone who wants to use color for any purpose whatsoever. *S. A. Eisenman, 345 East 33rd Street, New York City.—50 cents.*

THE LIGHT SEALAIR WINDOW is a circular illustrating and describing an aluminum window frame which is furnished as a complete unit and requires no difficult assembling. *Write for Bulletin 1035B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THREE CENTURIES OF CHEMICAL INDUSTRY IN AMERICA, by Edward R. Weidlein and William A. Hamor, is a reprint of an article which originally appeared in *Chemical & Metallurgical Engineering*, tracing the history and development. *Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.—Gratis.*

AN INTRODUCTION TO NEBRASKA ARCHEOLOGY, by William Duncan Strong. A 316-page illustrated detailed paper-covered book on American Great Plains archeology, Nebraska in particular. Written by an anthropologist at the Bureau of American Ethnology at Washington. *Smithsonian Institution, Washington, D. C.—$1.50.*

THE MOLY MATRIX is a bulletin describing the various uses of Molybdenum as a constituent of alloys. Uses for Molybdenum are discussed at some length and the text is accompanied by pertinent illustrations. *Write for Bulletin 1035D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

STUDIO SPEECH INPUT EQUIPMENT TO MEET MODERN BROADCASTING NEEDS gives technical data on a new line of such equipment. Thoroughly illustrated with photographs and line drawings. *Western Electric Company, 195 Broadway, New York City.—Gratis.*

A FOLSOM COMPLEX is a preliminary report on investigations at the Lindenmaier site in northern Colorado, and will be of interest to those who are trying to keep track of Folsom man in early America. *Smithsonian Institution, Washington, D. C.—30 cents.*

THE A. B. C. OF BETTER IRON AND STEEL is a beautifully illustrated pamphlet which graphically tells the story of the improvement possible in iron and steel when alloyed with Molybdenum. This is a "high spot" story of progress in one branch of metallurgy. *Write for Bulletin 1035E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

CAMERA ANGLES

Conducted by JACOB DESCHIN

"Angle" Photography

WHEN a man operates a camera from an unconventional point of view he is practicing what is known as "angle" photography. Strictly speaking, an angle photograph is any shot other than a straight-on view, but in modern photographic parlance the term "angle" takes on a double meaning—the interpretive as well as the geometric. The mental angle, that is, the photographer's notion of the point of view best suited to tell the photographic story, determines the purely mechanical feature of how the camera is to be pointed at the subject. "Slant" photography might be a more appropriate term, or, perhaps, "slant angle" photography.

"Brother, can you spare a dime?"

By means of angle photography, cameras have often been made to transform the commonplace into the unusual by showing the familiar in an unfamiliar way. Thus, the picture of a panhandler in the act of plying his trade would be just another picture if taken from street level, but take the camera up to the platform of the elevated railway some distance above the street and shoot down and you have something else again. A picture of a woman sitting on the beach might or might not be worth the candle, but get on your back and shoot at the woman's head with the sky for background and see what you get.

While architectural subjects are peculiarly suited to angle photography, street scenes, portraits, and action pictures are some other fields in which the unusual approach will yield striking and unusual pictures. Every camera user alert to picture possibilities has had the delightful experience of accidentally viewing a subject from an unfamiliar angle and "seeing" a picture he never thought existed, whether the subject be a building, a telegraph pole, or just a group of boys playing marbles on the sidewalk.

Many subjects may be shot from street level with the camera pointed upward, but scenes involving people generally call for down shots, which means the photographer has to climb. Handy places are the stairways of the elevated railway or the "stoops" in front of old-fashioned brownstone houses. If the "shooting" is done at home, a ladder may become a very useful photographic accessory. When no elevation is at hand, an angle shot from above may still be made by lifting the camera above one's head, if it is of the reflex type, and looking up at the ground glass while tilting the camera down. If the photographer can afford the price, he will find a telephoto lens very desirable in this type of work. Occasions for its use will come up every day and if he really becomes interested in angle work he will want to carry a telephoto around with him all the time.

Appreciation of design and a sense of composition are essential to success in this work. It is not enough merely to tilt the camera up or down in order to view the subject at an angle. Study the subject carefully and observe it from this point of view and that until the composition looks just right. If, after much experimentation, the first impression proves to have been just a fancy, leave the subject alone. A photograph, after all, mirrors only what the lens faces, nothing more or less. A point to look out for in photographing buildings at an angle is not to get too far away. In shooting a skyscraper at an angle you must reconcile yourself to the fact that you can't get the upper part of the building and the bottom as well and still have a picture worth the taking. If you stand far enough away you will, to be sure, get the bottom as well as the top, but the whole building will look as if it's toppling over. A little study will bring the solution as to just where to stand. Watch for a variety of line, alternating straight lines with curves. Wherever feasible, try to get clouds in the picture, and in general, particularly in the case of down shots, strive for interesting lightings and shadow patterns.

Angle photography should offer the person spending his vacation in a city innumerable opportunities for pictures he cannot buy from postcard vendors. His friends back home will be grateful for the

An unusual angle shot through an opening in the Elevated structure

"something different" quality in the pictures he sends them and he himself will have a collection of pictures that will forever after recall impressions that might possibly be lost if not recorded on the spot by means of a camera pointed at an angle.

New Low-Priced Exposure Meter

SOMETHING of a mild sensation in photographic circles has attended the recent introduction of a precision exposure meter selling for less than two dollars. Called the Leudi, it is of the visual or "extinction" type, but it differs from other meters in its class by the fact that it is not held close to the eye but about 10 inches away. It is extremely small in size—1½ by ½ by ⅜″—and is very light in weight. While its insignificant appearance would seem to militate against it, comparative tests with the highest-priced instruments now on the market have shown it to be remarkably efficient, particularly under artificial light conditions. Its inconspicuousness, dependability, simplicity of operation and extreme portability, occupying a space no bigger than that required for a few coins, have already been recognized by many who have never owned a meter because they could not afford the price.

When the instrument is pointed at the subject to be photographed, a series of numbers from 1 to 8 may be seen. The lowest number that can be seen without straining the eye is the key for calculating the correct exposure, which is done by consulting a scale on the outside of the meter, the guides being five differentiated squares indicating light conditions from the brightest outdoor scenes to interiors lighted by artificial light. After the least visible number is placed on one of these squares the exposure time for any opening is read off automatically. The meter may be used for both still and motion picture photography.

Super-X Film

FIFTY percent faster than supersensitive, Eastman Super-X film for 35-millimeter film users is the latest contribution of the film makers to the cause of more efficient "candid" camera work and other types of photography under adverse light conditions. The manufacturers call it "the film that makes your fast lens twice as fast." This statement should prove heartening to owners of $f/4.5$ and $f/3.5$ lenses, who may have had poor success when attempting indoor, night, and theater shots with the fastest emulsions hitherto obtainable.

Incidentally, the advantage and money-saving involved in the use of bulk film should be given greater consideration by advanced amateurs who do their own processing. Not only is the price of film material reduced by about two thirds, but the film may be cut to any length desired, so that if the worker knows in advance that he will take only about a dozen shots, he may cut his film accordingly and thus obviate the delay and annoyance of having to wait until the entire roll of three dozen is exposed before he develops the roll. This feature may often prove of incalculable advantage, as when prints are needed in a hurry, or when exposures are made for testing purposes. The saving involved is a very considerable factor, since at the low price the worker can afford to take many shots of a single much-desired subject without ever considering the cost. Well-known users of miniature cameras, such as William Mortensen and William Rittasse, have said that when they are working on some particular subject which they want to be sure to get they may expose as many as a hundred or more shots before they leave it.

Film Reversal

SIXTEEN-MILLIMETER motion picture film is the only film at present on the market that may be chemically reversed; that is, in which the developed result of the exposed film is a positive instead of a negative, the procedure being direct. However, any film may be "reversed" by developing it in the usual way and then printing on positive film, the latter being used for projection or as a transparency. The professional 35-mm motion picture film is "reversed" for projection in this manner. As to projection, machines are at present limited to 35 and 16-mm film sizes, in addition to the lantern slide projector which takes glass slides 2¼ by 3¼ inches. Sizes other than these they may be used as transparencies.

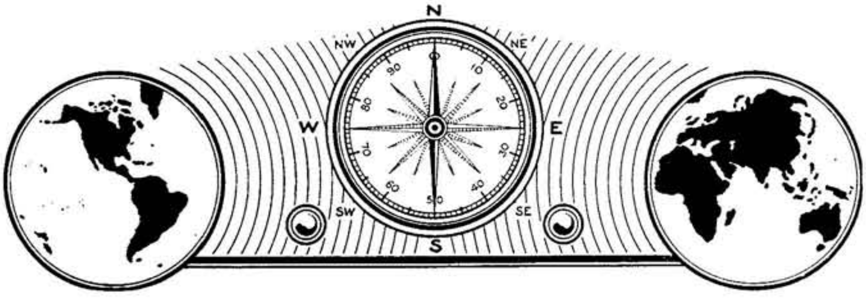
The formula for developing reversible film is D-16, which follows:

Water	10 gallons
Elon	180 grains
Sodium Sulphite	3 pounds, 5 ounces
Hydroquinone	8 ounces
Sodium Carbonate	1 pound, 9 ounces
Potassium Bromide	1 ounce, 63 grains
Citric Acid	400 grains
Potassium Metabisulphite	2 ounces

Develop 7 to 15 minutes at 65 degrees, Fahrenheit.

Photoflood Reflector

A NEW 10-inch Photoflood reflector and stand is made of heavy gage aluminum, highly polished on the outside while the inside is frosted to furnish a soft diffused light. It holds two lamps. Attached to a collapsible stand by a swivel joint, it can be extended to 7½ feet and folded down to 26 inches. When opened, the legs of the stand clamp automatically.



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

The 1936 All-Wave Receivers

The new Fall lines of all-wave receivers are in the hands of the dealer The formal introduction of these sets to the public takes place in New York at the Electrical and Radio Exposition, Grand Central Palace, September 18th to 28th, inclusive.

Many new features have been included in all-wave receivers for the coming year. Practically every manufacturer in the field has created a complete line of sets employing the new metal tubes. Some producers will continue with a line of glass tube receivers as a complement. A few manufacturers have introduced sets in which either the glass- or metal-type tubes may be used, at the option of the purchaser.

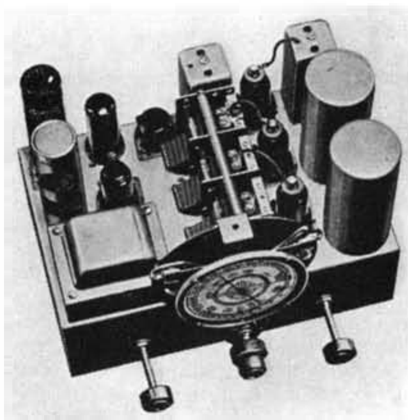
Manufacturers are placing great emphasis on precision and simplicity of design in their advertising. The receivers back up the claims, too. RCA Victor continues pushing the "Magic Brain" unit, to which, incidentally, has been added a "Magic Eye." This "eye" is a miniature cathode-ray tube with a fluorescent screen flush with the front panel. On this screen one may "view the signal" as it passes through the receiver, and by the width of the light band on the screen, determine immediately if the receiver is correctly tuned. The larger RCA Victor sets also have dynamic loud speakers with dual voice coils, one for reproducing bass notes and the other for reproducing treble.

General Electric receivers blossom out with the "Sentry Box" unit, a compact metal case containing all circuits that are manually tuned. The delicate, sensitive circuits are thereby isolated from the remainder of the receiver and, in consequence, are less subject to disturbances or changes in constants. The console receivers have a new type of dial, similar in some respects to a type of scale recently introduced in Germany and Austria, but with improvements. The G. E. dial is in the form of a drum. The pointer travels laterally across the surface of the drum on which the frequency divisions are marked, while the drum itself revolves with a change in the setting of the band-selector switch, thus bringing in line with the pointer another frequency scale. With this arrangement, only one scale is visible at a time, resulting in less confusion.

United American Bosch are playing up their "CentrOmatic" units. All the delicately adjusted, manually tuned equipment is in a single case located in the heart of the receiver. This unit is interesting as contrasted to other systems in that it contains no wiring. Each coil is locked to its terminal posts and switch contacts. Wiring and soldering are thus dispensed with. Theoretically, the absence of wire leads and soldered connections in this unit should boost sensitivity materially.

The emphasis on precision and simplicity of design is of paramount importance. Without real precision adjustment of circuits, a highly sensitive and selective all-wave receiver is out of the question. If it is to be highly sensitive to weak signals, and capable of selecting one signal from another no more than a hair's breadth apart on the dial, extreme precision in manufacture is required. In order to obtain high degrees of precision, simplicity of design is necessary.

In connection with these points, it is worth noting that a large number of the 1936 all-wave receivers include many components impregnated with compounds to keep out moisture, for even a comparatively low degree of humidity can throw off the



Courtesy International Radio Corp.

Either metal or glass tubes may be used in this new receiver chassis

circuit adjustments in a radio receiver if the moisture is permitted to enter the insulation of coils and condensers.

Heat is another disturbing influence in cases where precision adjustments must be maintained, for heat expands metals, and if the copper wire in short-wave coils is permitted to expand and contract, and the metal plates of small trimming and padding condensers are permitted to alter their positions by the same cause, the receiver cannot be kept in tune with signals; in the modern, highly selective receiver, this results in a terrific drop in sensitivity.

Heat in a radio receiver is produced by

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

the tubes, the power transformer, the field coil of the dynamic loud speaker, and by power resistors. In many of the 1936 all-wave receivers the delicate components, such as coils, condensers and resistors of high value, are protected from heat by mounting them in protective cases, or by placing them well away from heat-producing sources. In either case these components are maintained at a fairly constant temperature and this assures constant circuit adjustments.

Amateur "Phone" Transmitters

AMERICAN amateurs are permitted to operate radiophone transmitters in the following frequency bands: 1800 to 2000 kc.; 3900 to 4000 kc.; 14,150 to 14,250 kc.; 28,000 to 28,500 kc.; and 56,000 to 60,000 kc. The last two frequency bands are not covered by the average all-wave receiver, a special set being required to listen to them.

Only amateurs holding Class A licenses are permitted to use the 14,150 to 14,250-kc. band. This is the famous "20-meter band" and is the most interesting of the lot. It is distinctly a long-distance band and is practically valueless as a medium for short-distance transmissions. [See page 232, May 1935, SCIENTIFIC AMERICAN, for an explanation of this phenomenon.—*Editor.*]

The 20-meter band goes dead shortly after sundown, the exact time depending upon the season and upon atmospheric conditions. An amateur using this band may be able to carry on long-distance communication as late as ten or eleven o'clock in the evening. When the band dies, he switches the frequency of his transmitter to 4000 kc (around 80 meters) or 2000 kc (around 160 meters). These are both excellent "night-time frequencies" but are not quite so satisfactory for long-distance communication. Moreover, since these bands are not restricted, there is more crowding of stations than is found in the 20-meter band.

Though the American amateur is restricted to the frequencies between 14,150 and 14,250 in the 20-meter band, foreign amateurs may operate outside of these limits. Most of the foreign amateurs operate just beyond the limits of the high-frequency end of the American band; that is, slightly above 14,250 kc. Since this frequency area is free from local interference, it is not at all difficult for the American listener to hear amateur phone stations in Canada, England, Holland, Belgium, Africa, South America, and other distant countries. However, many of the Canadian, Central American, and Mexican amateur stations operate within the frequency limits of the American amateur band.

In any event, when listening in on the 20-meter band, do not fail to search a bit above 14,250 kc. Early Saturday or Sunday morning is the best time for picking up the Europeans. Very few are heard after 9 A.M.

Not Chinese . . .

SHOULD you pick up the voice of an individual presumably talking in a tinny-sounding Chinese, do not make the mistake of logging "China" on your list of stations received; it is nothing more than scrambled

"Scrambled" speech is used in commercial radio channels to prevent eavesdropping. Transpacific calls go through this switchboard

or inverted speech being transmitted over one of the many world commercial radiophone channels.

Scrambling is resorted to so that you may not be a willing or unwilling eavesdropper. The voice of the person on the phone is inverted prior to transmission by radio, and reassembled in its proper order at the radio receiver before being placed on the telephone land lines.

Commercial "Code" Stations

COMMERCIAL radio telegraph transmitters do not employ steady carrier waves, as do radio broadcast transmitters. The wave is transmitted only when the telegraph key is closed in the formation of code characters.

Some code stations modulate the transmitted wave with an audible frequency, but the majority of stations use a pure wave, with no modulation whatsoever. The modulated code signals are heard in an all-wave receiver just as readily as a broadcast program. The unmodulated signals cannot be heard, except as interrupted clicks or hissing sounds when the signals are of sufficient intensity. Therefore, the user of an all-wave receiver must not infer that these sounds are created by local electrical appliances. Electrical interference of this last mentioned nature cannot be tuned out; consequently, if the noises you hear may be eliminated by a slight movement of the dial pointer, you may rest assured it is a code station.

If, on the other hand, the noise cannot be tuned out, and, yet, from the sound and character of the signal, you are moderately sure it is a commercial radio telegraph station, the interference is being created by a code station operating at the same frequency as the intermediate frequency of the amplifier in your superheterodyne receiver; in other words, the signal is from a long-wave code station, not a short-wave station.

This condition may be cured by installing a "wave-trap" in the antenna lead to the receiver. The trap is tuned to the same frequency as the amplifier in the receiver. This prevents the long-wave code signal from breaking through.

Books SELECTED BY THE EDITORS

WALTER FRANKLIN PRINCE —A Memorial

READERS of SCIENTIFIC AMERICAN are familiar with some of the works of the late Dr. Walter Franklin Prince, who contributed largely to these pages during the last ten years or so of his life. On matters pertaining to psychic phenomena, telepathy, and allied subjects, Dr. Prince was considered as the final authority, the last court of appeal. His vast knowledge of these obscure corners, to which few are willing to grant the title of science, was matched only by his keen analytical sense and his open-minded attitude during the investigation of any disputed subject. As Research Officer of the Boston Society for Psychic Research, he rendered services in the search for truth that have never been equalled before, and probably never again will be equalled by any one worker.

After the death of Dr. Prince, the Boston Society set about to gather material for a memorial volume, and the present book is the result. In no sense of the word is it a eulogy. Rather, it presents a clear-cut picture of a man among men—a sincere worker in a field where trickery and deception runs rampant, yet in which he pressed forward unceasingly, taking the bitter with the sweet and searching ever for the elusive truth. To the student of psychic matters or to the layman who is casually interested in the subject, the book will give a well-balanced conception of the value of Dr. Prince's work. Also, the bibliographies published in it will prove to be a valuable guide to reference works, many of which would be difficult to locate otherwise.—$2.15 postpaid.—*A. P. P.*

A HISTORY OF SCIENCE, TECHNOLOGY AND PHILOSOPHY IN THE 16TH AND 17TH CENTURIES

By A. Wolf, Professor and Head of Department of History of Science, Univ. of London

IN the 16th and 17th Centuries the foundations of the modern Age of Science were laid—Copernicus, Galilei, Tycho Brahe, Kepler, Newton, and other great lights—and no one can hope to understand our present science intelligently without the knowledge of its background conferred by the history of science. This monumental, 675-page illustrated history covers the most important period. It traces the growth of astronomy, mathematics, physics, meteorology, geology, biology, medicine, and the various technologies, and is written in a clear, readable style. It is such a book as would appeal, say, to a manufacturer or a well-read business man rather than a greasy closet student. An educated man is one who can see things as a whole; others see only the particular. Nothing gives this perspective like history and, in science, the history of science.—$7.25 postpaid.—*A. G. I.*

WAR AND WAGES

By Maj. Robert E. Adams, U.S.M.C., retired

THE need for an adequate national defense to prevent war has been shown by Major Adams in this outstanding book. It is a history of the wars in which this country has engaged, showing how these wars were effected by the policies of other countries, and how they could have been prevented if only we had possessed adequate means of national defense. It is such an essentially honest book that it is bound to stir vehement criticism among those "disarmament by example" fanatics who won't relish the idea of being blamed, even indirectly, for the excessive losses in men and money attributed to the unwillingness of their fellows to permit the development of an adequate national defense system prior to our wars. On their shoulders, however, lies the blame, as this volume demonstrates. We recommend it to those who, in this day of world peril, wish to face facts squarely, who are open-minded and willing to learn; and to those who are already in the thick of the fight for national defense.—$3.20 postpaid.—*F. D. M.*

SALES AND ADVERTISING (In Two Volumes.)

By Chester A. Gauss, E.E., M.E., and Lucius I. Wightman, E.E., M.E. Revised by Harry A. Bates

THE twin problems of sales and advertising are so closely linked with almost every business and industry of the present day, and the problems involved are often so involved in solution that there is a wide-spread need for a comprehensive guide. The two volumes of the present work will go far to fill this need, and can be read with profit by anyone connected with business or industry in any capacity from clerical work to that of an active executive.

The book is described by the publisher as: "A practical treatise covering the psychology of selling and advertising, analysis of sales, advertising and its relation to selling, copywriting, typography, mechanics of advertising, advertising department systems, and the control of advertising and sales expense." Although the two volumes comprise 555 pages of text matter, including many illustrations, the authors appear to have been hard put at times to cover adequately the many involved phases of their subject. As a result, some of the subjects are "high-spotted," but still retain enough meat to satisfy anyone who wants only a background of knowledge, rather than a comprehensive education in some one particular part of the business of sales and advertising. The text is presented in an easy-to-read manner that makes for rapid assimilation of the content.—$6.20 postpaid for both volumes.—*A. P. P.*

ANCIENT EGYPTIAN MATERIALS AND INDUSTRIES

By A. Lucas, O.B.E., F.I.C., F.S.A.

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By A. Frederick Collins

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By John F. Rider

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There is no doubt that the cathode-ray oscillograph will be used more and more widely as time goes on, not only in industrial, but in educational fields. It is a new and important tool and because of this, "The Cathode-ray Tube at Work" fills a real need and should prove to be an asset to the man who is working with or can apply this device in any field whatsoever. Only by understanding the functioning of every part of the oscillograph can it be made to operate properly and efficiently and the present book provides the information that will give this needed understanding.—$2.65 postpaid.—*A. P. P.*

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