LIFE AND DEATH: Enzymes May Open the Door

# SCIENTIFIC AMERICAN

March · 1938

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# SCIENTIFIC AMERICAN

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


## CONTENTS • MARCH • 1938



**FROM potatoes to petunias, from soy beans to snapdragons, the work of the professional plant breeder runs the whole gamut of agricultural crops and garden flowers. By such efforts, as told in the article starting on page 133, many of our common vegetables and flowers have been bred into forms far different from the originals. The plant breeder shown on our front cover is working with snapdragons. Note the individual flower spikes that have been bagged to insure self-pollination.** ***(Courtesy Bodger Seeds, Ltd.)***


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# 50 YEARS AGO IN . . .

## SCIENTIFIC AMERICAN

***(Condensed From Issues of March, 1888)***

FORTS—"Now that Italy inclines to German alliances, the French are seeking new means of strengthening their eastern or Alpine frontier, and the French military press is urging more haste in the construction of the cordon of forts which the general staff is organizing along the giant hills that separate the republic from the kingdom of Italy."

BLIZZARD—"The recent great storm will not have been without some good results if it energizes the efforts of those seeking to introduce some hitherto obviously needed public improvements. . . . Among such improvements that have long been urgently called for, one is that of putting underground at least a portion of the telegraph and electric light wires in all large cities, and burying some of the telegraph lines connecting the most important commercial centers. It would be ludicrous, were it not too serious a matter, to think of telegraphic messages being sent between Boston and New York *via* London, 6,000 miles under the ocean, as was necessary on March 12 and 13. While passenger and freight trains were stalled in snow drifts all the way from Boston to Baltimore, the telegraph service of the country was suddenly paralyzed."

CHIMNEYS—"A well proportioned chimney, of neat design, from 200 to 300 feet high, is always an imposing structure and an ornament to a large manufacturing establishment, but it may well be questioned if it is ever worth while to build them over 150 feet high. Where cost is no consideration there is no objection to building them as high as one pleases; but for the purely utilitarian purpose of steam making, we have yet to find a case where it was necessary to build a chimney more than 150 feet high."

NAPHTHA—"One of the largest naphtha fountains yet known has lately broken out near Baku, which threatens to inundate all Balakhani. The naphtha, owing to the pressure of the gases which accompany it, rises to a height of from 280 to 420 feet, and is carried away by the wind to a great distance, falling like fine rain at the more distant parts of the district, but near the fountain coming down in torrents that form rivers and streamlets."

BOOMERANGS—"According to a German manufacturer, who has made some 11,000 toy boomerangs, the mystery of the movement lies in the shape, the boomerang having a sharp curvature in the middle, with unequal length of the two arms, which must be made of equal weight by unequal thickness. The peculiarity of motion is said to be due to the difference in the length of the arms, which diverges the curve of rotation from the circular."

FROZEN SAND—"A recent number of the *Annales Industrielles* states that a mine shaft is being successfully sunk by M. Alexandre, of the Houssu Company, in Belgium, through a stratum of moist sand 12 m. thick, met with at 70 m. depth, by the Poetsch method, which consists in freezing the sand, then excavating it like rock."

SPIDER—"The habits of the running spider of southern Europe, *Tarantula narbonensis*, Latr., studied by Herr Beck, are curious. It makes a vertical round hole in the ground about ten inches deep, and this . . . is lined with web. A little way down is a small lateral hole, into which the spider shrinks when an animal falls into the tube; when the animal has reached the bottom, the spider pounces on it."

SHIP RAILWAYS—"The air is full of ship railway projects for all parts of the globe. The ship railway over the Chignecto Isthmus is already under contract. A ship railway has also been surveyed across the Florida peninsula to save the 600 miles of distance around and through the straits. . . . The great work in all this programme, both as to the magnitude of its construction and its results, is the Tehuantepec ship railway. . . . Perhaps it is too much as yet to say that the age of ship canals is giving way to that of ship railways, but M. De Lesseps can hardly be expected to feel quite at his ease in the presence of this new and vigorous movement."

WITH CHAMPAGNE—"The illustration shows a method of performing a neat dessert experiment. When a grape or raisin is allowed to fall to the bottom of a glass of champagne, bubbles of gas are observed to attach themselves to it. This causes the grape or raisin to rise to the surface, where the bubbles burst. Then it sinks, and afterward begins its ascent again. The bubbles of carbonic acid gas perform the rôle of minute balloons ascending in the liquid and carrying the object with them."

PASTEUR TREATMENT—"The municipal authorities of Barcelona, as we announced last year, have established a municipal microbiological laboratory, mainly with the view of enabling persons bitten by rabid animals to obtain the advantages of Pasteur's method of treatment. . . . Altogether eighty-five persons have been subjected to the treatment. Of these, twenty-five had been bitten by animals that were certainly rabid, fifteen by those which had been pronounced rabid by medical men or veterinary surgeons, and thirty-seven by animals which were believed to be rabid, but whose condition could not be verified by professional men. The remaining eight persons had not been bitten at all, but submitted to the process in order to prove its harmlessness. . . . Not a single case, either of those who had been bitten or of those who had not, proved fatal."

FALLS—"According to a recent calculation, the highest waterfalls in the world are the three Krimbs Falls in the Upper Prinzgau; these falls have a total height of 1,148 ft. The three falls next in height are found in Scandinavia—the Verme Foss, in Romsdal, 984 ft.; the Vettis Foss, on the Sogne Fjord, 853 ft.; the Rjuken Foss, in Thelemarken, 804 ft."

DUST EXPLOSIONS—"The *Milling World* reminds millers of the oft-proved fact that flour dust is a dangerously explosive material. Beware, says the editor, of lights thrust or carried into bins or rooms filled with dust-laden air."

**AND NOW FOR THE FUTURE**

**¶Industrial plant lighting and its effects on production and personnel, by A. K. Gaetjens.**

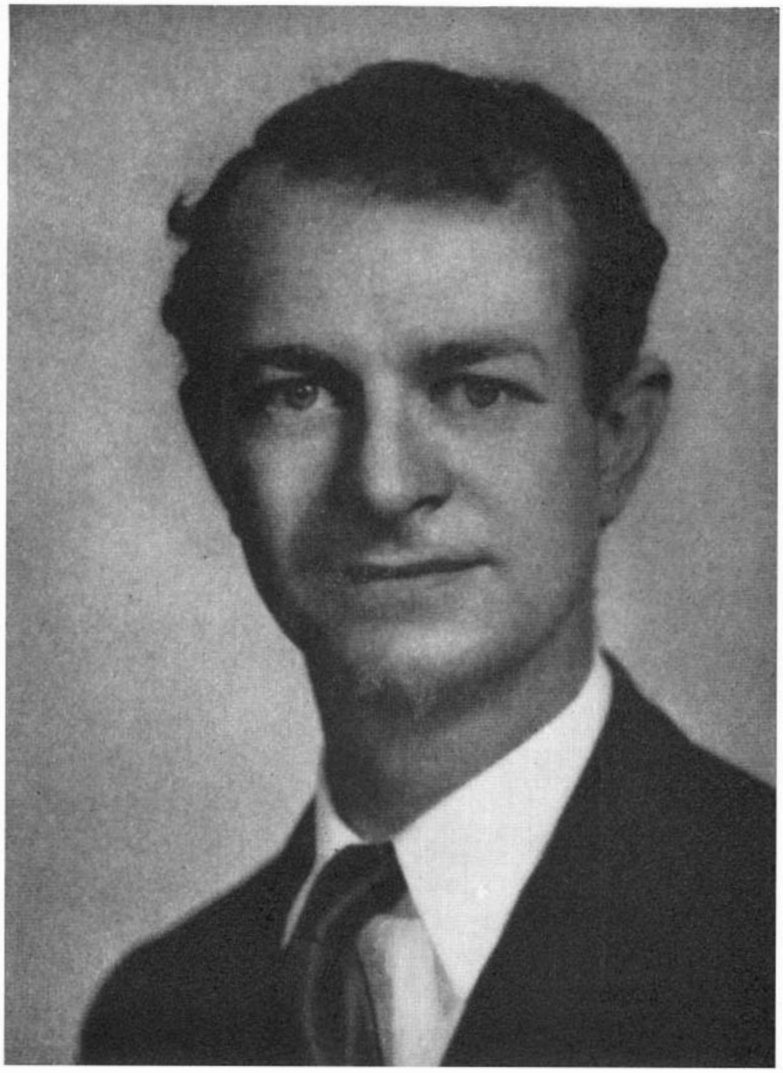
**¶Construction of a streamlined train from strip steel to finish.**

**¶Why some metals are soft and yielding, others hard and brittle, by Sidney J. French, Ph.D.**

**¶What is definitely known of the phenomenon of the Northern Lights, by Prof. A. S. Eve, F.R.S.**

**¶New light on the Sumerians, the problem child of Oriental archeology, by E. A. Speiser.**

# *Personalities in Science*



**DR. LINUS PAULING**

PRONOUNCED six years ago to be the most promising young American chemist in 1931 (Scientific American, November 1931, page 293), Dr. Linus Pauling, then aged but 30, has now emerged a mature and definite "personality in science." His recent appointment to succeed the late Dr. Arthur A. Noyes as Director of the Gates-Crellin Chemical Laboratories and Chairman of the Division of Chemistry and Chemical Engineering at the California Institute of Technology, substantiates the brilliant predictions made for him in 1931 when he received the Langmuir Award in Pure Chemistry. Dr. Pauling was the first to receive this annual chemistry prize which has since been captured by some of his abler students.

To be given a departmental directorship at the age of 36 bears witness to the confidence and respect of his colleagues and fellow scientists. Dr. Pauling has served a thorough apprenticeship as student, friend, and admirer of Dr. Noyes, who was one of the most outstanding physical chemists of the last generation.

Professor Pauling's interest in chemistry dates from early boyhood, and it was while a student in chemical engineering at Oregon State Agricultural College that he chose it as a life work. G. N. Lewis' work on the electron bond, which came to his attention as a sophomore, was, he tells us, a profound factor in affecting his decision. Following graduation from college in 1922, he went to the California Institute of Technology for advanced study. While working there for his doctorate, obtained in 1925, he carried out his famous early research on crystal and molecular structure under the direction of Dr. Roscoe G. Dickinson. One of the most formative opportunities of his career then came to him as a Guggenheim Fellowship which took him abroad for 19 months. He studied under Bohr at Copenhagen, Sommerfeld at Munich, and Schrödinger at Zürich. Schrödinger was at that time just publishing his first papers on wave mechanics, so the young chemist was present on the very frontier of the new theory of quantum mechanics. In 1927, he was appointed Assistant Professor of Theoretical Chemistry at the California Institute of Technology, in Pasadena, and in 1931 he was given a full professorship.

Professor Pauling's research field is diverse and varied. His most important recent work deals with the determination of the structure of gas molecules by diffraction of electron waves. But he is not limited to one specialty. His range includes as well the applications of quantum mechanics to chemistry, rotation of molecules in crystals, theory of stability of complex crystals, sizes of ions, the chemical bond, line spectra, and the structure of hemoglobin and other natural substances. For the past few years, a grant from the Rockefeller Fund has been at his disposal for carrying on these researches with a group of 12 or more men under him. His program correlates these problems into an interrelated system in which about half of the time is devoted to experimental and half to theoretical methods, thereby rendering the system more powerful. European scholars come from many points to work under Dr. Pauling. He and his associates have contributed many papers in these fields, and he has published two books, "Structure of Line Spectra" (Pauling and Goudsmit), 1930, and "Introduction to Quantum Mechanics" (Pauling and Wilson), 1935. He is a member of the National Academy of Sciences and the American Chemical Society, and serves as an associate editor for the American Chemical Society Journal. As a lecturer in chemistry, he has been associated with the Massachusetts Institute of Technology and the University of California.

Professor Pauling gave the George Fisher Baker Lectures in Chemistry at Cornell University during the autumn semester of 1937-38. While there, he gave some 30 lectures on the nature of the chemical bond.

Personally, this scientist is not the formal being his achievements might presuppose. He and his beautiful young wife are in popular demand on the campus. Equally hospitable to struggling student or visiting professor, their home, enlivened with four bright children, reflects intellectual charm and true *joie de vivre.—Susan Hartley*

Photo by R. Schudel

## A FORTRESS OF SCIENCE ON A MOUNTAIN PEAK

RECENTLY dedicated was the new Meteorological Observatory Jungfraujoch, on the peak of the Sphinx, 11,716 feet above sea level in the Swiss Alps. Reached by way of the Sphinx tunnel of the Jungfrau railway, a connecting tunnel, and a 364-foot elevator, the observatory has been built not only for making routine meteorological records, but also to afford scientists an opportunity for research work in astronomy, physics, cosmic rays, aerodynamics, and so on. A glass-enclosed veranda in the observatory building and terraces on the east and west sides are open to sightseers.

**Stock-seed plots on a California flower seed farm. As seed from these plots is to be used for seed-production purposes the following year, every effort is made to eliminate during the blooming season all plants but those with desired characteristics**

# STREAMLINED PLANTS

## Professional Plant Breeding . . . Benefits the Farmer, the Housewife, Many Others . . . Finer Fruits, More Beautiful Flowers, Tastier Vegetables

By KEITH C. BARRONS

THE work of the professional plant breeder is not designed to aid the farmer alone. Everyone who produces, processes, or consumes plants and plant products is benefited in no small way by the breeder's efforts to mold superior heritage in agricultural crops. This includes everyone from the grower, whose yields are increased and income made more certain by improved varieties, to the housewife who finds better fruits and vegetables at her local market, made possible by the breeding of superior new strains. Between these two are the canners, the millers, the bakers, and the shippers, all of whom have had varieties bred to meet their specific requirements. As in the case of other lines of agricultural progress, John Public reaps the real harvest in the form of better living and lower costs.

"Streamlining" of cars may not have suggested the streamlined potato, yet such a variety is one of the chief goals of potato specialists everywhere. This streamlining is the elimination of deep eyes that cause such waste during peeling. Besides being more economical, the newer shallow-eyed varieties may be peeled with greater speed. Like the streamlining of cars, the elimination of deep eyes in potatoes is a gradual process. Our latest varieties are improvements, but still shallower eyes may be expected in later models.

Carrots used to be short chubby roots, far less attractive than the long slim beauties seen on many markets today. By careful breeding, a deeper orange color has been developed and the core has been made more tender or practically eliminated. The modern carrot, if well grown, has as little in common with the carrot of former years as a modern streamlined car with a pre-war gas buggy.

The shape of many vegetables has been altered for the sake of beauty or to fit modern needs. A new cucumber which is uniformly eight inches long, if properly grown, is ideal for the shipper. Small Hubbard squash to fit the modern kitchen have made their appearance on some markets. Appropriately enough, the variety is called Kitchenette. It is predicted that smaller varieties of watermelons better suited to the modern refrigerator will gain favor with the housewife as a logical successor to the 30-pound monsters so common in the past.

Nature decreed that certain plants should have barbs or spines either for purposes of protection or seed dissemination. Often those individuals with the sharpest weapons of defense were the

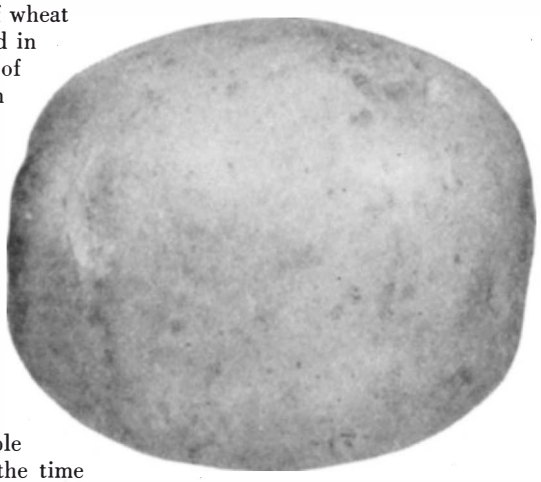
**In soil badly infested with the fungus causing the yellows disease, the center row was planted to a variety of ordinary cabbage, the others to yellows-resistant types**

ones best able to reproduce their kind; so, through natural selection, many species developed special means of protection prior to being cultivated by man. Just as Nature preserved individuals with the largest and sharpest weapons, man has, through many centuries of breeding, directed the process of evolution in the other direction. Wild plums and apples have thorns, yet our cultivated varieties of these fruits are entirely thornless. By selection through a number of generations, Luther Burbank once developed thornless cacti to be used as food for cattle. More recently another Californian has introduced a thornless dewberry—surely a boon to the berry picker. This streamlining for comfort has been extended to ornamentals. Many a gardener will rejoice to know that the plant breeder has taken the "barb" out of barberry, for a new "thornless" barberry was recently granted a United States Plant Patent.

OF the many plant improvements that add to the comfort of the grower perhaps none has had as enthusiastic acceptance as smooth-awned barley. In ordinary barley the awns, or beards as they are often called, are covered with tiny barbs. These slant backward from the tip of the awn like so many tiny fishhook barbs, and indeed their action is not unlike that of fishhooks as anyone who has threshed barley will tell you. Animals, too, suffer from eating these beards, for in many places barley is grown for hay. Many of our modern barley varieties are smooth-awned; that is, their beards, although still present, do not possess barbs. In wheat, the beards are not armed with such weapons, but the breeder has gone one step further by removing them altogether. Many of the best wheat varieties grown today are of the beardless type.

While working as a student assistant at a mid-western agricultural experiment station I was once assigned the task of cross-pollinating a number of wheat varieties. One day while engaged in making these crosses, a group of farmers on a tour of inspection happened to walk by the plot where I was bending over young heads of wheat which had just emerged from the sheath of leaves that protects them during their early development. The farm-crop specialist who was showing the group about stopped to tell them that I was making crosses and that the station hoped to breed a beardless wheat which also possessed certain other desirable characteristics. I was busy at the time cutting off the young beards with a pair of scissors prior to removing the pollen sacs and pollinating with a beardless variety. In making these crosses the beards are often removed merely because they are in the way. One old farmer remarked, "So that's the way you make 'em beardless." Unfortunately, it is not quite that simple, yet from the first beardless wheat discovered many years ago, breeders have, by cross-pollination methods, produced beardless varieties possessing other desirable characteristics such as high yield, disease resistance, and good milling quality.

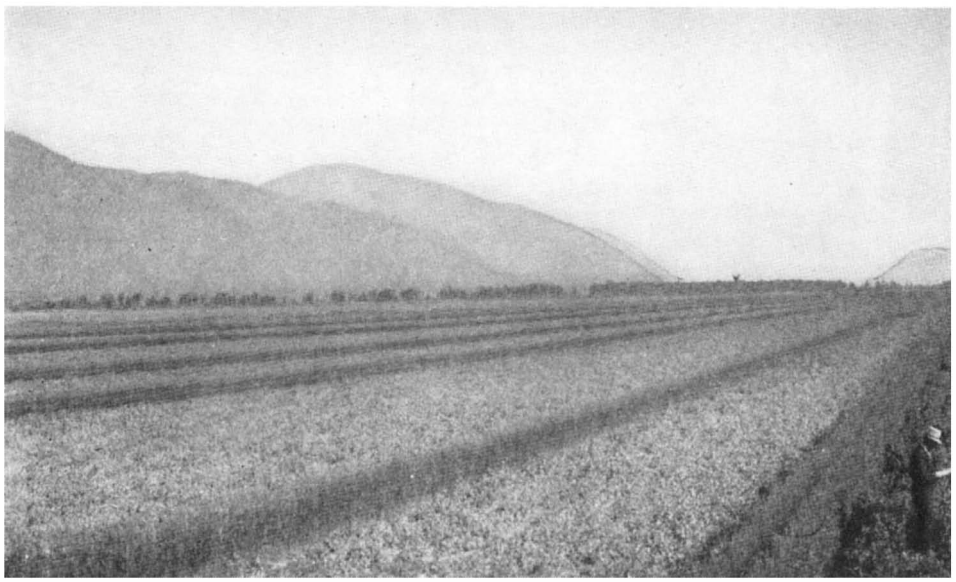
The breeding of varieties of farm and garden plants that resist diseases has been one of the outstanding agricultural achievements of the 20th Century. Among the first serious plant diseases conquered in this way was the wilt of flax. At the turn of the century, flax growing in the north central states was becoming highly unprofitable due to the ravages of a soil fungus called *Fusarium lini*. All through the flax belt, "flax-sick" soil was being turned over to more profitable crops. The outlook for the domestic linseed-oil industry was anything but bright. Then a pioneer breeder, H. L. Bolley of the North Dakota Agricultural Experiment Station, saved



**The new "streamlined" Chippewa potato. Absence of deep eyes reduces waste in peeling and also speeds up the job for the housewife**

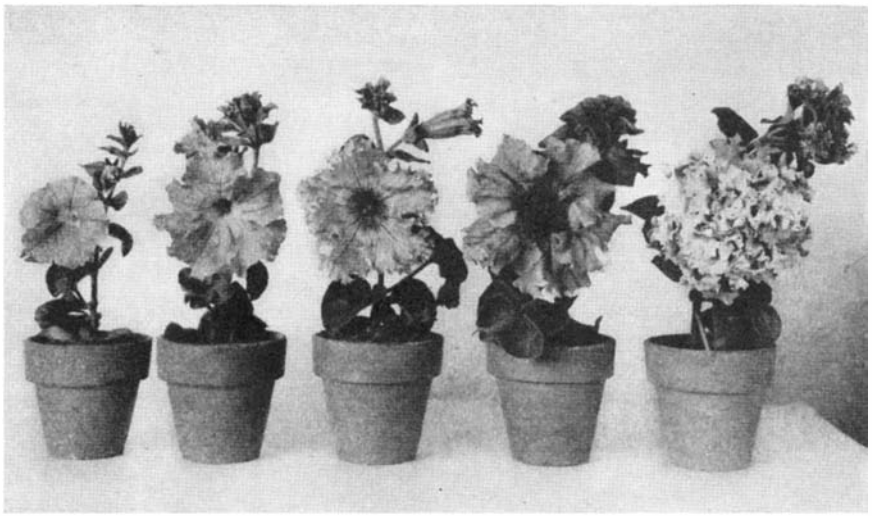
●

***Below:*** **Stock seed blocks of peas growing in Idaho. Each strip is a different variety. Seed from them will go to large production fields where commercial seed is grown in quantity**

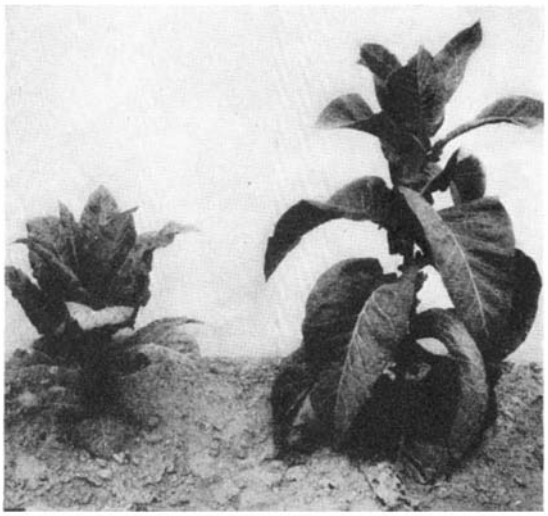


the day for both growers and processors by developing a variety that was highly resistant to the wilt organism. Bolley is ranked as a pioneer because he was probably the first man in the history of plant breeding to subject a crop to an artificial epidemic of a specific disease in order to determine which individuals possess hereditary resistance. This method, which is based on the principle of the survival of the fittest, is used by breeders everywhere today in their effort to control pests by superior heritage. Nor are they unaided in their efforts, for the plant pathologists work hand in hand with them, studying the disease organisms and learning how to induce epidemics at will.

There is scarcely a major crop that has not been saved from becoming unprofitable in some section of the United States by the breeding of disease-resistant varieties. Wheat rust, cotton wilt, and sugar-cane mosaic are a few of the most serious diseases conquered in this way. Recently sugar-beet specialists in the west have developed a strain of that crop which is resistant to the dreaded curly-top disease. Such streamlined, resistant varieties are now found in most every garden. Tomatoes and asters that escape their respective wilt diseases, and snap-dragons resistant to rust, are but a few of those listed in current seed catalogs.



**Evolution of petunias in the hands of the plant breeder. The one on the left is similar in size to the wild petunias. Note crinkly, attractive flowers of others**



**A striking result of plant breeding. At the left is shown a tobacco plant of the mosaic susceptible variety. At the right is another into which has been bred a resistance to this destructive disease of tobacco fields**

John Public's dividend from disease-resistant varieties is probably greater than from any other plant-breeding accomplishment. Such varieties are perhaps doing more to stabilize agricultural production than all man's combined efforts along other lines. Stabilized production without crop failures means lower retail prices on farm products as well as a more prosperous agriculture. In a few cases, plants have been developed that resist certain insect pests. Great possibilities exist for further lowering of production costs and reducing the hazards of farming by the breeding of disease- and insect-resistant varieties.

I ONCE visited a cabbage grower who had a 10-acre field planted to an excellent strain of the Copenhagen Market variety. A large percentage of the heads in this field were ready to cut on the first harvest. Because they were so uniform in size and shape he sold the crop at a premium. Across the road was another large field of the same variety of cabbage planted by a man who was not so fortunate in securing a uniform strain from his seedsman. More than likely he saved a dollar or two on his seed, but what a loss this small saving caused! While his neighbor's crop was ready for harvesting within a period of 10 days, his harvesting dragged out for a month. True, his total yield was as great but the extra work involved in harvesting a dab at a time, together with the lower price paid for cabbage that varied considerably in size and shape of head, meant the difference between a good and a poor profit. The first grower was benefited by the work of a trained plant breeder in developing and maintaining a uniform strain of the Copenhagen Market variety.

Uniformity is one of the more important objectives of all plant breeders. A few wild-type peas in a canning variety may cause the grade and, likewise, the price of a whole pack to be lowered. That is one reason why canners and seedsmen employ breeding experts to maintain their varieties at a high level of purity. Uniformity is so important to the millers that grain shipments containing mixtures of certain types are sold at a substantially lower price. Some cotton mills are willing to pay a premium

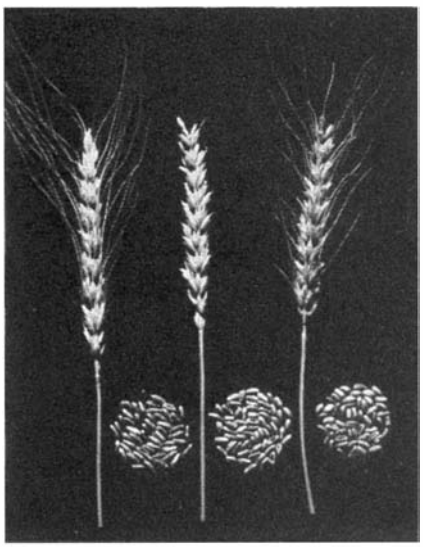
for staple of uniform length and quality. To supply this demand, certain areas have been set up as one-variety communities where only one specific variety may be grown and ginned. The reason for this is that cotton is naturally cross-pollinated and a uniform variety would be difficult to maintain were several varieties grown in neighboring fields as they ordinarily are. Breeders have developed high-quality, uniform strains of most agricultural crops but their job is never finished, because uniformity must be maintained by careful selection and seed-growing methods. Here, too, the breeders' efforts have resulted in better living for everyone through standardized and uniform quality in fruits and vegetables and other agricultural products.

IN 1857 Wendelin Grimm, a German farmer, moved with his family to Carver County in Central Minnesota. He brought with him a considerable quantity of alfalfa seed and the following year planted it on his new farm. Alfalfa had been grown in the east and, to some extent, on the west coast prior to that date, but it was not hardy enough to stand the long cold winters of the north. Grimm's first plantings suffered from winter injury but always a few plants survived; the persistent German immigrant determined to grow this valuable forage crop in his new home, and saved seed year after year. It is improbable Grimm thought of himself as a plant breeder, yet by growing the progeny of these super-hardy plants singled out by natural selection he founded a strain which was destined to extend the alfalfa-growing region hundreds of miles northward. It is fitting that this strain is known today as Grimm alfalfa.

Greater winter-hardiness has been one of the important contributions of breeders to agriculture in northern climates. Using natural selection as their most useful tool they have developed hardier varieties of wheat and rye that have extended the winter grain belt northward, making it possible for more farmers to take advantage of the desirable practice of fall planting. Plums, apples, and other fruits now enrich the farm life in areas formerly considered far too cold for successful cultivation of these valuable species.

Soon after the development of the quick-freezing method of preserving fruits and vegetables it was found that certain varieties were far better adapted to this process than others. For example, a pea variety to be well adapted to freezing preservation must develop a brilliant green color during the process of blanching and freezing, and this color must remain during the period of storage. At the same time it must not develop undesirable flavors. A tendency to split eliminates it entirely from the list of useful varieties for quick freezing. Not all otherwise good pea varieties come up to these standards. Today, with frozen fruits and vegetables growing more popular by leaps and bounds, breeders are paying more and more attention to the adaptability of varieties to this new and expanding method of food preservation.

Oil-producing plants such as flax and



**A spike of beardless wheat, in center, with two of the bearded variety**

soybeans have been bred not only for high oil content but for a quick-drying type of oil more useful to the paint manufacturer. These hereditary changes in the drying properties of plant oils are but one example among many in which the chemical nature of plant products has been altered by the breeder. High nicotine content in tobacco grown for nicotine extraction, pyrethrum flowers that will give a high yield of the extract used so extensively in insecticides, poppy varieties that produce large quantities of opium; such are the achievements of the breeder in increasing the efficiency of drug-producing plants.

New early- and late-maturing varieties have extended the season through which many fruits and vegetables may be had at reasonable prices. Other early varieties have enabled growers in northern climates to utilize certain crops which were formerly grown only in areas with longer seasons. Varieties with erect habits of growth for machine harvesting, grains with stiff stems that resist damage from beating rains, and corn that will yield fairly well in spite of dry weather are recent plant-breeding accomplishments that make farming more profitable.

Nowhere is the work of the plant breeder more conspicuous than in the flower garden. Without the closest observation, who would recognize the kinship between many of our lovely garden flowers and the relatively unattractive wild species from which they arose? Not only in showy beauty but also in scent have many garden plants been glorified. One of the most recent contributions to the home garden is a marigold whose leaves lack the usual pungent odor so distasteful to many who would otherwise number this species among their most favored flowers. Several varieties of marigolds with this desirable characteristic are now available from many seedsmen.

High yield and quality are desirable characteristics in any variety. These two factors must be considered in determining the value of new strains, in addition to their other desirable attributes. With crops grown for some purposes such as feed for livestock, yield is the most important factor; but in fruits and vegetables, higher and higher quality is the progressive goal of those who breed these plants. To be sure, any variety must yield reasonably well to be accepted by the grower, but without quality to satisfy some specific demand, the highest yielding horticultural crop would be of little value.

THE ability to yield is a complex attribute dependent on the inherent vigor of the plant, adaptability to specific environmental conditions, resistance to disease, and many other factors, but quality is perhaps even more complex. Every accepted variety considered of good quality has dozens of specific and interrelated characteristics that raise it above the hereditary level of certain other varieties within the species. Quality in plants and plant products is as impossible to define as intelligence or beauty in animals.

Color, flavor, odor, and keeping ability are but a few of the quality factors considered in selecting superior individual plants or varieties in horticultural crops. Cooking tests, canning tests, and tests for vitamin content are examples of the special techniques that must be employed by many breeders. In addition to a knowledge of breeding methods and the related sciences every breeder must know the plants with which he is working. An understanding of marketing methods and demands, of canning and preserving processes, and of the desires and whims of the housewife is absolutely essential if one is to develop new plants that will fit into the highly complex agricultural picture of a streamlined age.

The job of the plant breeder is unending. As ways of living change and new methods of processing plant products develop, demands for new varieties continually arise. Changes in soil fertility, changes in diseases and insect pests, and changes in farming practice require a plant-breeding profession ever ready to mold the plastic plant material, with which Nature endowed us, to fit existing and future needs.

# OUR POINT OF VIEW

## Better Naval Defense

NO one except Navy officials, a few Congressmen, and the White House knows, as this is being written, just what naval construction and expansion will be planned and authorized during this session of Congress. That there will be a definite, rather sizable expansion is conceded to be not only desirable but urgent. The belligerency of certain other nations is responsible.

The *Panay* incident, senseless and idiotic as it was for the attackers, and tragic as it was for the attacked, holds the promise of being of vast benefit to the world. It has awakened the American public out of its complacency and shown us that unless we expect to throw up an insurmountable wall around our borders we must be prepared to demand complete protection for our citizens throughout the world. It has proved that, as many people have long contended, we do not really want to maintain this sort of indifference, that we want a return to the traditional principle that our flag must be respected wherever flown. It has ranged on the side of the democracies and weaker nations—more definitely than for a long time—the voice of America which can and will be strong once more. But while it is not likely that we will enter into any foreign commitments—officially—the temper of the nation is such that the war makers will charily watch every defense move we make. Our moral support can be a powerful factor in the preservation of peace.

At present, strengthening of our "first line of defense," the Navy, seems assured. After years of abortive attempts to achieve a real naval limitations agreement among the nations, we have been slow to accept the inevitable. Not content to let our early "disarmament by example" betoken our sincerity, we still adhered to the letter of our various naval treaties after their expiration and even entered into a further one with Britain and France. The "escape clause" in this last one, however, gives us the necessary opportunity to call the bluff of a belligerent world. Present indications are that our naval-building program, soon to be inaugurated, will be larger than at any time since the days immediately succeeding the World War.

Unless forced to do so, however, we will launch no very extravagant program of ship-building. In no case will we make unjust demands of any nation, nor will we use our Navy in any aggression. But the naval construction which is detailed in the Digest of this issue will certainly be expanded. If necessity arises that expansion will be great.

Out of the *Panay* incident comes strong assurance from another quarter that Americans are about the same as they always have been. They are no more pacifistic, nor more war-like than they were before the World War, nor will they take insults with any better humor. This journal predicted editorially in 1934, when students all over the land were signing the pledge never to fight for their country, that they were simply allowing emotion—adolescent hysteria—to rule them; and, further, that as they matured or emergencies arose, they would be among the first to renounce pacifism. It has happened! A group representing a student organization in a convention at Vassar last Christmas vociferously renounced their "I won't fight" pledges.

That editorial was based upon a first-hand knowledge of the fundamental character of the American people. We would advise the trouble-makers of the world to get a whale of a lot of such knowledge before they try our temper too much.

## New Methods, New Puzzles

THE history of science and industry includes many examples of the fact that very often one problem cannot be tackled until another has been quite solved. One such example is the fact that the Panama Canal could not be dug until medical science had learned about the mosquito as the source of yellow fever. Similarly, until yesterday, the geologists, though possessing fairly detailed knowledge of the strata and topography of the land surfaces of the globe, still could not satisfactorily deal with the ocean bed, a full three fourths of the earth's surface, because the relatively few and scattered soundings taken over its vast expanse gave only a generalized picture of the hidden shapes beneath the waters. It was sometimes suspected, however, that if the oceans could only be unwatered to permit a full view, a surprising variety of shapes would be revealed.

Relatively recently, with the perfection of the sonic depth finder installed in ships' bottoms, this surprise has taken place. In a few regions the United States Coast and Geodetic Survey ships have now attempted and successfully made detailed submarine maps by this method, and have developed the technique until it is comparably accurate with land topographic surveying. To geologists and all scientific persons there is the same thrill in this happy accomplishment as there is in falling heir to a small fortune which one never hoped to see.

One of the by-products of this method has been the precise mapping of submarine canyons off the coasts, notably the one that lies some 100 miles off the harbor of New York and which is comparable in depth with the Grand Canyon. The slopes of this vast chasm have been mapped in accurate and fine detail and from these submarine contour maps we see the various shapes of the subseascape just as we see that of our familiar high-and-dry landscapes on looking at maps of the same kind. An area similarly mapped near the Alaska Peninsula reveals in detail the topography of familiar landscapes.

The solution of the great puzzle—what excavated the canyons?—is likely to keep geologists intrigued for years to come. What agency could excavate a canyon a mile deep in the seabed, under water? Perhaps, however, the canyons were excavated when the seabed was above water. Have the ocean beds been lifted above water, deeply eroded by streams and then let sink again? Or did the great ice caps of the Pleistocene glacial epoch withdraw enough water from the ocean basins to permit erosion on the land thus made naked? If so, much more water was locked up in the polar ice than glaciologists have previously believed. Could submarine currents have excavated these canyons in solid rock? Among geologists, several other hypotheses, some of them rather abstruse, have been offered and studied, but the answer has not yet been revealed.

In other ways geologists are becoming intimate with the hitherto standoffish seabottoms. C. H. Piggot has developed a technique for taking more satisfactory samples of them than any we have had. He lowers a kind of gun into contact with the bottom and then fires it, shooting a tubular sampler some distance into the silt and bringing up tale-telling sections representing very long periods of slow deposition. A new way to measure the thickness of strata below the waters by means of artificial explosions—a special application of the seismographical prospecting now well-known because of its use in the search for oil on land—is also coming into use.

In short, the forbidden, mysterious ocean beds are now surrendering some of their mysteries. Ways to accomplish the impossible are being found. Once more the impossible is becoming possible; soon may become commonplace.

# ENZYMES: KEYS TO

## At the Forefront of the Scientific Stage Today Are These Important Controlling Substances on Which Highly Significant Researches Are Being Conducted

UNTIL 1895, a mystic "vital force" was thought to be the secret behind many a stimulating and regulating activity of protoplasm, the substance of life. Thus, this vital force was considered to be the cause of yeast's power to change or ferment sugar into alcohol and carbon dioxide. The vital force, scientists guessed, vanished when the yeast died. But in 1895, Büchner ground yeast with sand—of course killing the organisms—and then proved that the non-living extract which he obtained could still cause fermentation, even though no ghost was haunting the reaction.

En-zyme—Greek for "in yeast"—was the name given the ferment, or active part of the yeast's juice, and is the name applied today to scores of similiarly active substances which cause, accelerate, and control biochemical reactions, no matter what the species of animal or plant.

Life's darkest, most fascinating secrets are hidden in the mysteries of enzymes—now known to be huge and intricate molecules, somehow able to dominate the uncountable chemical activities within living flesh.

Only because of the play of enzymes can we digest our foods, or find chemical value in our very breath. And the use of food and oxygen in the multivaried events of growth, movement, reproduction, and even sensation and our thoughts—all is unlocked by these really miraculous keys.

THE genes which control inheritance are seemingly no more and no less than enzymes. Germs of tuberculosis, leprosy, plague—of all infections—can attack and injure us only because they pour out enzymes having deadly effect upon the chemistry of our life substance. The virus—a germ minute beyond the powers of the microscope, and the cause of infantile paralysis, influenza, and smallpox—may be simply pure enzyme, and nothing else besides: a sort of parasitic molecule.

Cancer—not a germ-disease—is the guilt of the body's own distraught dictators, which have become over-stimulating to the multiplication of useless cells, at the horrible expense of other tissues. Phages, odd ultra-microscopic bits of matter which devour bacteria, must also be varieties of enzymes—perhaps produced by unhealthy bacteria themselves.

And now substances, inductors or organizers, have been discovered by Hans Spemann, of the University of Freiburg, Germany. Inductors, found in very young animals or embryos, guide the formation of organs out of simple, formless masses of cells and thus induce eye, kidney, brain and every organ to take shape. These organ-inducing substances, though not yet extracted pure and still little known, are also widely believed to be kinds of enzymes.

Finally, since enzymes control all the chemical reactions which together mean life, they are responsible for those lethal developments in every higher creature: the phenomena of aging that end in natural death. Hence, full knowledge of enzymes means knowledge of the most important problems of bio-science and experimental medicine.

Photo Science Service

**Prof. Hans Spemann, discoverer of inductors — organ traffic police**

In all, surely there are myriads of enzymes, since no activity of protoplasm is conceivable in their absence. Oxidases are enzymes effecting the oxidation or burning of fuel foods for energy's sake. They may be seen in action when an apple or a potato is cut. In the presence of air or oxygen, they oxidize colorless compounds of the exposed tissue to dark-colored ones.

Pepsin, of the stomach's gastric juice, splits unwieldy proteins into simpler molecules, which other enzymes continue to digest or crack until fragments useful to the tissues are reached. Trypsin of pancreatic juice helps in this protein-bursting labor. Fats are exploded by lipases, and starches by amylases, such as saliva's ptyalin, which makes sugar out of starch.

Thrombin aids blood to clot. It is lacking in hemophiles—bleeders. Negroes are dark because of the enzyme tyrosinase. Tyrosin is a colorless substance present in most skin. When tyrosin is oxidized by tyrosinase, it turns black. An albino lacks the enzyme: hence cannot become pigmented.

Thus enzyme actions are chemical actions. Enzymes produce chemical changes, altering one molecule into another. Most of such alterations, all essential to animate existence, would not occur without enzymes. Other alterations in molecules, unless influenced by the stimulating presence of enzymes, would take place at too slow a pace for life's needs. Still other molecular changes would not be possible at life's moderate temperatures—or in life's tiniest laboratories, the cells—or with life's required efficiency. In his scientific laboratories, man discovers it impossible to duplicate these enzyme-caused chemical activities without powerful and poisonous reagents, life-destroying heat, complicated and bulky apparatus, and high inefficiency. Man's respect for the enzyme is therefore great. Man would learn from the enzyme many a means to cheap manufacture of invaluable products.

THE firefly and deep-sea monsters can boast of practical use of "cold light," thanks to the enzyme luciferase. This molecule acts upon a mysterious substance, luciferin, present in luminous organs, and the result is light almost without heat. Here, as indeed in every instance of enzyme marvels, the enigma of the biologist becomes the enigma of the chemist and the physicist too. What is the basic nature of enzyme activity? What is the fundamental mechanism by which enzymes are able to regulate—to dictate—the work of other molecules? As to the theory of enzyme machinery, there is as yet only one point of agreement: Many stupendous scientific problems are concerned—biological, chemical, and physical. Exceeding bafflement is as yet the sole reward of those who have spent and those who are spending their careers in the attempt to elucidate the movements and the chemical changes of an enzyme molecule as it busies itself with a life task. When will man have cold light in his dwellings? This will

# LIFE AND DEATH

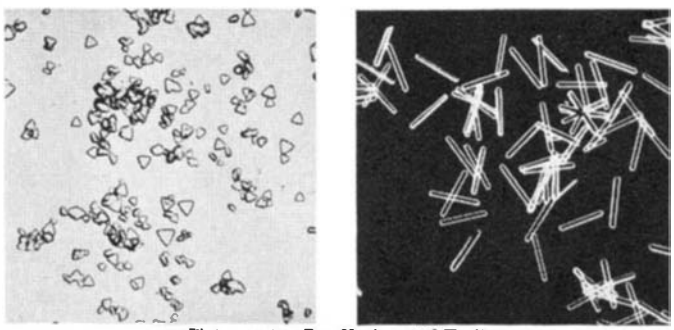
By BARCLAY MOON NEWMAN

be when research has described something of the comings and goings of certain remarkable little things—such as luciferase's secretive linkage of atoms.

So all scientists are today intensely interested in these activators of vital processes. The chemist sees that they are vast collections of atoms, often thousands of atoms, united into molecules of really unique size, weight, and complexity.

Chemical analysis shows that the atoms involved are the typical life-givers: carbon, hydrogen, oxygen, nitrogen, sulfur, phosphorus, and several metals, including at times iron and magnesium.

Such great aggregations of atoms belong to the mighty class of compounds, the proteins, discoverable only in living things or their products. Their intricacy promises long to be the despair of the constructor of formulas. Laboratory synthesis of any protein, any enzyme, will transcend human skill for many years, perhaps many decades—some pessimists say forever. Meanwhile, enzyme-synthesis remains the first step in creating life in the test tube.



Photos courtesy Drs. Northrop and Kunitz

***Left:*** **Trypsin crystals. Each crystal is made up of many molecules of trypsin, a digestive ferment (enzyme) which breaks down proteins into simpler molecules. Trypsin is produced by the pancreas, whence it travels into the small intestine, there to carry on its activity. It was first obtained in its pure, crystalline form by Drs. John H. Northrop and M. Kunitz.** ***Right:*** **Trypsinogen, from which trypsin is formed, isolated by Drs. J. H. Northrop and M. Kunitz, Rockefeller Institute**

THESE gigantic gangs of atoms are exceedingly delicate. They are readily affected by the slightest chemical or physical influence. Boiling destroys them, often coagulating them just as it does the protein *albumin,* main constituent of egg-white, making them insoluble and precipitating their particles like snow to the bottom of the solution. Probably all laboratory reagents alter them somewhat, usually transforming them into wholly different compounds, as by bursting them into their component parts. Therefore it was for a long time impossible to isolate any of them unchanged and in pure form from living tissue. It was averred by numerous experts that no enzyme would ever be obtained in crystalline, that is, chemically pure, state. And as long as pure enzymes were unavailable, little could be learned of their structure and of the machinery of their action on biochemical compounds either in protoplasm or in laboratory ware.

At last, in 1926, Dr. James B. Sumner won the honor of being the first to secure an enzyme, urease, as crystals of an uncontaminated compound, and one precisely like that naturally occurring in the protoplasm used as a source. More recently, Dr. John H. Northrop, of the Rockefeller Institute, has achieved the crystallization not only of pure pepsin, from the cow's gastric juice, but also pure trypsin, from pancreatic juice of the cow too—both enzymes being protein-splitters, and Dr. Henry C. Sherman, of Columbia University, has forced amylase, a starch-digester, into the symmetry of the pure state. Quite definitely, Americans are far in the van of this special scientific endeavor: indeed, so far in the lead that a number of European investigators are still blind to the fact that Sumner, Northrop, and Sherman have indubitably secured true, uncontaminated enzyme-molecules. Such doubts are, however, perhaps natural in view of the incomparable intricacy of enzymes and of the mechanism of their action.

Nevertheless, doubts are now being rapidly dissipated and our knowledge of these amazing molecules and their kin is accumulating apace—mainly because of the invention of the ultra-centrifuge, new marvel of the biologists and chemists who are mindful of physical chemistry, as all good scientists must be today. This instrument [Scientific American, June 1936, page 329—*Ed.*], though merely a high development of the principle of the cream-separator, is literally whirling out profound secrets of creation's biggest molecules, proteins.

Thé Svedberg, renowned Swedish scientist and Nobel-prize recipient, who has had preëminent success in applying the technique of physical chemistry to the study of complex bio-chemical compounds, pioneered in research with the ultra-centrifuge. About 13 years ago, he invented the first high-speed centrifuge, an oil-driven machine.

The solution holding the substance to be analyzed is put into tiny quartz tubes fixed horizontally within a rotor of special alloy and special shape. The rotor is spun by means of a high-pressure oil-jet striking the blades of a turbine. In order that friction and heating may be reduced, the rotor spins within a partial vacuum containing hydrogen instead of air. The apparatus must be cooled by streaming oil, since the rotor is made to yield speeds as high as 75,000 revolutions per minute: of course with the production of considerable heat. Higher velocities are possible, but the tremendous centrifugal force developed—more than 500,000 times the force of gravity—is likely to explode the rotor.

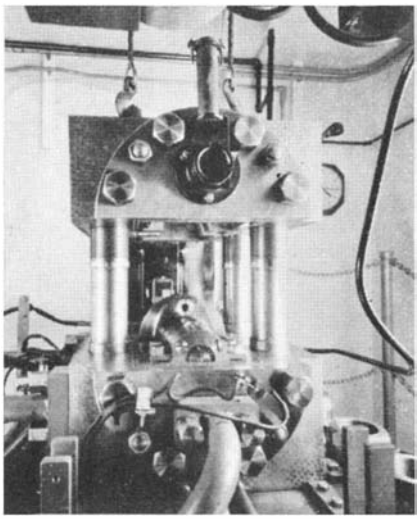
THE specimen is observed even while being whirled around at 1000 times, and more, per second. Svedberg accomplishes this feat by passing a beam of ultra-violet light through the transparent tubes containing the specimen. The beam undergoes a certain amount of absorption and scattering, depending upon the size of the molecules and upon the degree of clumping of these particles as they are urged toward the outer ends of the tubes by the mighty centrifugal force. The changes in the ultra-violet beam are caught and recorded by means of a photo-electric cell.

In the ultra-centrifuge, as in any centrifugal separator, the heavier the particles, the greater is the rate at which they are flung outward. Therefore the weight of the protein or other bits in the specimen solution can readily be determined from the rate at which they are flung outward, or sedimented, within the tubes.

Never before had any one been able to measure proteins in so direct a way. And until Svedberg's investigations, great uncertainty beclouded the best estimates of protein molecular weights, sizes, and shapes—even though accuracy here is the prime essential to any real understanding of the chemical and

physical nature of these meaningful compounds. With his invention, Svedberg made a remarkable series of highly precise measurements upon many proteins. Besides, since he used physical methods, his determinations applied to pure and unchanged proteins—whose extreme delicacy chemical methods so swiftly and sadly disrupt.

Svedberg's researches have proved



**The Svedberg ultra-centrifuge at the duPont Experimental Station. Upper part is removed, revealing rotor and cell for the solution**

that the weights of protein molecules gradually scale up from 34,500, the weight of hemoglobin, the pigment and oxygen-carrier of human blood, to 5,000,000, the weight of hemocyanin, the pigment of the blood of the snail, *Helix pomatia*. The giantism of such collections of atoms may be emphasized by comparing their molecular weights with that of hydrogen gas: merely 2. Other molecular weights for comparison are: water, 18; sodium chloride or table salt, 59; and cane sugar, 342. The actually stupefying intricacy of protein molecules is indicated by the fact that, as familiar and fairly well understood molecules go, cane sugar is generally regarded as complex—and for scores of years chemists were not even able to write its formula. Further, cane sugar is a cluster of a mere 45 atoms; certain proteins are clusters of *several thousand* atoms to the molecule.

DEVELOPMENT of the air-driven centrifuge in the United States—the one just described being oil-driven—especially by Beams of the University of Virginia and McBain, of Stanford University, is leading to still more significant findings. The air-driven machine has two important advantages. It is inexpensive (no one but Svedberg could afford the oil-driven device, requiring the most expensive of parts and, too, a whole corps of highly trained mechanicians to nurse it along) and large volumes of liquids can be centrifuged in the air-driven 'fuge, instead of only a few drops, as in Svedberg's invention. Also, its velocity is limited only by the strength of the rotor: one rotor made of the alloy duralumin exploded when spun just above 2200 revolutions per second (132,000 per minute).

Dr. Ralph Wyckoff, of the Rockefeller Institute, has been using the air-driven ultra-centrifuge to swirl out knowledge of viruses. He has determined that the typical virus of the mosaic disease of tobacco has a molecular weight of about 17,000,000—more than three times the weight of Svedberg's largest specimen. Moreover, his work with this and other viruses of both animals and plants seems to be establishing a most interesting point: While other proteins are wondrously big and heavy, viruses are the biggest and heaviest of all—no other molecules remotely approach the size of the virus architecture. Hence, he is now asking the question: "Can molecules the size of virus proteins occur naturally in plants and animals without producing disease?"

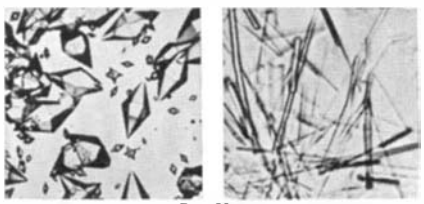
INDEED, it is becoming more and more evident that when we get enzymes as big as viruses, and when these get into living protoplasm, they astonishingly take over the whole economy of the victim and govern it to their own morbid advantage. For instance, a trace of virus enters the tobacco plant, oddly is able to assume control of the life processes, and actually transforms the major part of the host's vital substance into hordes of virus molecules. This phenomenon is among the most remarkable ever brought to light in the entire history of science. Is it possible, besides, that the virus-germs of the great virus plagues of ancient and modern history—smallpox, influenza, encephalitis, and the common cold, greatest of all plagues in total economic loss, arose not outside man but, astonishingly enough, within man himself—just as the phages are supposed to leap from malfunctioning enzymes within bacteria and then destroy that which gave them birth?

The mechanism of how a single, presumably non-living molecule turns living stuff totally unlike itself into many million copies of itself cannot yet be even imagined. Nevertheless, though on a much grander scale, this mechanism can be fundamentally no different from the activity of lesser enzymes. A gene, probably an enzyme of molecular weight 50,000 (merely), creates a duplicate of itself out of the surrounding life-fluid every time a cell divides in two—that is, reproduces. By this means these determiners of heredity—parent-derived regulators of hair-color, size of body, shape of face—are able to be a portion of every cell in the body, and so help to mold the young tissues into the inherited adult form and adult behavior.

Enzymes can perform in other ways almost equally strange. Pepsinogen is the parent-molecule, as it were, of pepsin. It is similar to pepsin in chemical structure, but cannot digest proteins. In the presence of hydrochloric acid, supplied by gastric juice, pepsinogen transmutes itself into pepsin, "more alive" and able to split proteins into their components. Here is an enzyme producing itself—practically spontaneously—out of unlike material.

Enzymes also attack and digest other enzymes. Pepsin solution cannot be kept long exposed to the air. Bacteria fall from the air into the solution and exude their own enzymes, which break down the pepsin into fragments which the bacteria absorb for food.

Wyckoff has recently called attention to other and highly practical aspects of enzyme and virus activity. Just as pepsinogen, only an atom or two different from pepsin, is inactive, and "harmless" to proteins, so displacements of a mere atom or two within a virus mean the difference between a diabolically efficient destroyer of animal flesh and a helpful stimulant to the body's resistance—to an attack of the active, unchanged virus. Everyone today benefits from this phenomenon—smallpox vaccine is human smallpox virus, only very, very slightly altered chemically, though greatly weakened biologically and medically, by its culture in the cow. It has been transmuted, by its sojourn in the



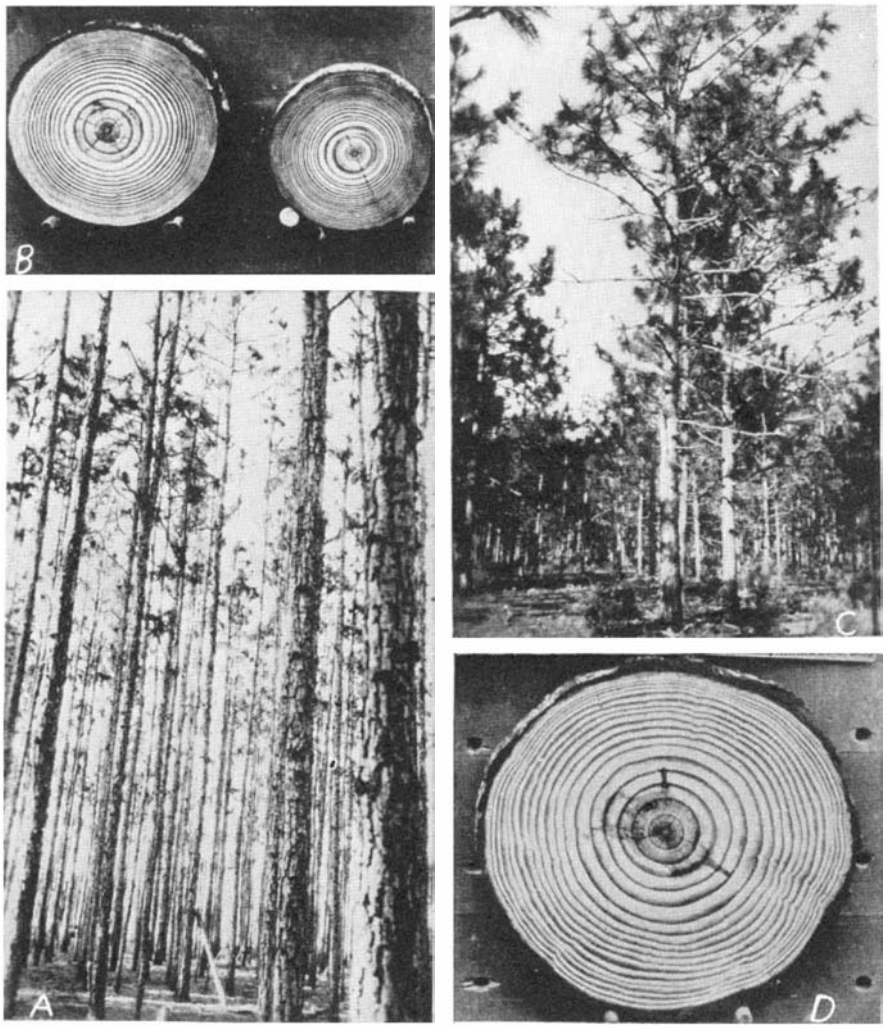
Photos courtesy Drs. Northrop and Herriot

***Left:* Crystals of pepsin found in gastric juice of the stomach and first isolated by Northrop. *Right:* Pepsinogen, forerunner of pepsin**

cow's chemical system, from "human pox" into "cowpox." And the human body finds this slightly changed virus a most valuable stimulus to smallpox immunity. So immunity follows vaccination with cowpox.

The centrifuge is being made still more helpful—here helpful in inducing such slight changes in viruses. Here we have molecules larger by far than Svedberg's earlier interests—and far more fragile, hence far more susceptible to breakage upon being whirled by the swift-cycling 'fuge. Thus, Wyckoff and his associates are already noting differences in viruses' virulence, or infecting power, according to the amount of jarring provided in the centrifuging. We are definitely on a new road, perhaps even a royal road, to conquest of man's evilest afflictions and life's mystery.

# Wood Grown to Order




**Longleaf pine stand A will produce dense wood (cross-section at B); stand C, of broad crowned trees, will produce relatively low density wood, as shown at D**

By MARY BRANDEL HOPKINS

MEANS of controlling the strength or weakness, hardness or softness, of wood which forest trees will produce in the next 50 or 60 years has recently been achieved. No longer is the future of all American woods placed in the lap of Nature with a fervent hope that she will produce the type of wood which man's more exacting uses require. From now on, a check rein may be held on Nature's caprices—and caprices they are, when she produces, in the same species of tree, wood of widely varying qualities.

Until recently, however, there has been no difficulty in securing in this country, whenever needed, wood having the properties desired for a special use. But now that the virgin forests are disappearing, the nation's troubles are about to begin as it becomes necessary to depend more and more upon the younger, second-growth stands with their smaller trees containing a lesser relative amount of high quality lumber. Consequently, to learn how growth conditions affect or control the quality of wood has become of such major importance that for the past 14 years the United States Forest Products Laboratory, Madison, Wisconsin, has been investigating the subject. To Benson H. Paul, laboratory silviculturist, fell a large share of the responsibility.

ONE phase of the many-sided study has been the application of silviculture in controlling the specific gravity of wood, which previous studies proved is a fair basis for judging its strength, hardness, and other physical properties.

It has been shown beyond a doubt that severe crowding in the broad-leaved species studied causes a decrease in the specific gravity, and therefore in the strength, of the wood produced. By relieving the crowded conditions in which the trees grow, specific gravity will be increased and the wood will be stronger. It is also apparent that wood having the most uniform strength and fewest defects is produced, in the hardwoods, when the young trees are grown sufficiently close together to cause dying and removal of side branches by exclusion of sunlight, and are thinned later to provide for faster growth in diameter. If fairly rapid growth is sustained by keeping the trees properly thinned, crops such as ash and hickory will mature in the comparatively short period of 50 to 60 years, instead of the usual 100 to 150 years.

In the cone-bearing southern pines and redwood, control of specific gravity through the influence of growing space calls for somewhat different treatment.

In these species, strength depends principally on the relative proportions of the weaker springwood and the heavier summerwood in the annual growth rings. In second growth forests, spacing of trees has a distinct influence, the springwood portion being much narrower in the small-crowned trees of crowded stands, the amount of summerwood proportionately greater, and the wood accordingly heavier. But the crowded trees grew slower than those in more open stands. Thus in coniferous species the production of timber of very high strength requires a longer time than that having lower strength.

On the other hand, relatively wide spacing of second-growth southern pines and redwood throughout the entire period of growth will give the trees larger crowns, more knots, and a higher percentage of light wood. But offsetting this disadvantage is the possibility of growing a tree of specified diameter in much shorter time than would otherwise be required.

Because quantity and quality production are evidently combined on the more fertile forest sites, prevention of forest fires, the basis of soil improvement, will go a long way toward improving the quality of the wood grown. If no forest fires occur, the organic content of the soil will increase; decomposition will furnish it with nitrogen; moisture will be retained. The result will be to increase the production of strong summerwood.

# NEW ASTRONOMICAL ADVANCES

## A Résumé of Some of the Researches Described at the Most Recent Semi-Annual Meeting of the 400 Astronomers of the North American Continent

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 meetings of the American Astronomical Society are always enjoyable affairs, for the astronomers of this country are friendly folks, and not too numerous to be included in a single circle of acquaintance, nor to overstrain the accommodations available in a small town. This makes it possible to meet usually at some college or university, and be together not merely during the formal sessions, but for the whole time—to great mutual advantage.

The recent gathering in the western university town where these lines are written has been a fine example of the success of this policy—with a cordial welcome, an exceptionally attractive place of meeting, and a long program of good papers. The only fear which might have been felt in advance was that there might not be time for presentation of them all; but this was dispelled by a general spirit of co-operation, assisted by a dark-room "interval timer," which could be set to the exact time alloted to the paper on the program, and which rang a perfectly audible signal at its conclusion!

The 50 papers which were presented to the Society covered a wide range, from gravitational theory to the details of instrumental construction, and from the moon to remote regions of the galaxy.

Beginning with theory, we may note the work of K. P. Williams of Indiana on the transits of Mercury. It has long been known that the observed times of these, like the observations of the moon, indicate that something is wrong with the earth's rotation as a time-keeper. The records of ancient eclipses of the moon and sun show that the earth is very gradually slowing down, doubtless due to the cumulative effects of the friction of the tides; and the observations of the last two centuries exhibit irregular fluctuations after the effects of all known forces which act on the moon, including the tidal friction, have been allowed for, which it is now generally recognized must be due to irregular, and so far unpredictable, changes in the earth's rotation.

Williams, applying the corrections for the latter changes deduced by Spencer Jones, finds that they greatly improve the agreement between calculation and observation, but leave outstanding a slow, steady change. Mercury is gradually running ahead of the calculations, just as would happen if the days, which we assume to be of equal length, were slowly getting longer. The rate of this change appears at first sight to be about 2½ times as great as is found from observations of the moon. But it is well known that tidal friction reacts on the moon, forcing it farther from the earth and lengthening its period. When allowance is made for this, the observations of Mercury and of the moon are found to be in entire agreement. The irregular fluctuations (which during the last century have at one time made the earth 15 seconds slow, compared with a perfect clock, and at another 15 seconds fast) affect Mercury and the moon in just the same way, showing that they must arise from some cause in the earth alone, without reaction on the moon. Brown's explanation by minute changes in our planet's diameter, due to some internal forces, is thus confirmed.

WHAT care is taken with the observations of the moon is well illustrated by a communication from Watts, Whittaker, and Adams of the Naval Observatory. They have corrected the meridian observations of the time at which the moon's limb crosses the wires of the transit circle to allow for the fact that the observed point on the moon's edge is sometimes on the top of a mountain-mass, and at others in a low-lying place, and they find that the agreement of the observations is decidedly improved. For several years past, the earth's rotation appears to have been quite uniform—that is, there have been no internal changes affecting its diameter by more than an inch or two.

An interesting paper upon the planets came from E. C. Slipher of the Lowell Observatory, who sent on some fine slides of photographs of Mars, Jupiter, and Saturn, taken with light of many different wavelengths, from the violet to the near infra-red. Jupiter's atmosphere, above his cloudy surface, was remarkably transparent—sharp details being visible right up to the limb. For Mars, the well-known permanent markings, though easily photographed with red or yellow light, cannot be observed at all in the blue. It has often been suggested that this arises simply from their color—the reddish surface of the planet reflecting much more red light than the gray or greenish markings, but almost the same percentage of the blue rays. But, last May, a series of photographs taken with blue light showed the Syrtis Major—one of the most prominent of the permanent markings—distinctly, for several days. A few weeks earlier and later, only the general nondescript appearance was found on the "blue" pictures, while those with the red screen showed that the markings had been there all the time.

This shows beyond a doubt that the Martian atmosphere is usually filled with a blue haze so dense as to obscure the surface (so long as only blue light is used), while for a few days last May the haze cleared off over millions of square miles and for once revealed what lay below.

What causes this peculiar haze no one yet knows; it presents a tempting problem to the investigator. But we know more of the earth's atmosphere than we did before two other observers from Flagstaff, Adel and Lampland, reported (at the American Association meeting at Indianapolis) the discovery of nitrogen pentoxide ($N_2O_5$). This was decisively identified by an absorption band far out in the infra-red, where observations can be made only with a bolometer. This highly reactive compound is produced, like ozone, by photo-chemical reactions, high up above the stratosphere, and is not found near the earth's surface.

Whipple at Harvard reported on meteor trails picked up during the "sky patrol" work at Cambridge and Oak Ridge. These plates are taken every clear night to keep track of the stars in general, and afford a permanent record of what goes on in the heavens. Once in about a hundred hours of exposure time a meteor bright enough to leave a photographic record flashes across the field. (Only those which appear brighter than

Jupiter do so.) By arranging that the same regions of the sky shall be photographed simultaneously at the two stations, 25 miles apart, it is possible to get many of these trails in duplicate, and to work out the height and actual position of the meteor track. Moreover, a shutter with narrow arms something like an electric fan is placed in front of the cameras, so that the meteor trail is broken by interruptions made 20 times per second. This makes it possible in favorable cases to find the velocity accurately, and to compute the orbit in which the meteor was moving before it hit the earth. The majority of these so far studied have had orbits of pretty short period, closely resembling those of the recently discovered asteroids like "Reinmuth's object" which passed close to the earth. The main difference is that these asteroids are something like a mile in diameter, and the meteors probably an inch or so. A decade of such observations should tell us what proportion of these bright meteors move in orbits of long period, like the comets and some well-known meteor swarms, and whether any of them have entered the solar system from outside.

Courtesy Extension Division, Indiana University

**The unique 24-inch Schwarzschild reflector with its builder, Prof. W. A. Cogshall of Indiana University, who has been quietly working on it for several years**

BURNS, of Allegheny, reported some important spectroscopic observations, clearing up several doubtful questions of identification of elements in the sun. Caesium, whose strongest lines lie in the infra-red, has been detected by the presence of these lines in sun-spots. Tantalum, whose presence was doubtful, appears to be confirmed. Tin, which presented an unusually perplexing problem, is at last definitely identified. Only one out of three or four good lines is free from interference by blends with other elements, but this line has been recorded as due to iron. It has long been suspected that it was really due to tin, and appeared in the laboratory spectrum of iron because it is very hard to separate tin completely from iron by chemical methods. Working with samples of exceptionally pure iron prepared by various processes, Burns has obtained spectra which show no trace of the debatable line—thus freeing it from suspicion.

Rudnick and Elvey, at the McDonald Observatory in Texas, reported on an excellent photo-electric light-curve of the eclipsing variable $\mu_1$ *Scorpii*. This pair—long known to be double from spectroscopic observations—has a period of about a day and a half and consists of two stars of about equal size and somewhat unequal brightness, very close to one another. The observations with the photometer and spectroscope make it possible to determine the actual diameters of the stars: a preliminary study indicates that they are five or six times as big as the sun. This is no novelty; but the distance of this star is reliably known —since it is a member of Kapteyn's great moving cluster—and hence its actual brightness can be found. Knowing its size, the amount of light emitted per square mile can be calculated and compared with the sun, and from this the surface temperature can be found. These results have not yet been worked out, but they soon will be, and when they are we shall have a much more trustworthy determination of the temperature of a star of Class B than any which is at present available.

From the Yerkes Observatory, Struve and van Biesbroeck described a remarkably ingenious spectrograph for studying the spectra of faint nebulae. Greenstein and Henyey, with this instrument, have found that the nebulae near Gamma Cygni show the bright forbidden line $\lambda 3727$ of oxygen. The star, whose light undoubtedly stimulates the nebula to shine, is a relatively cool one (Class F8) and a typical super-giant. To stir up oxygen atoms in the nebula to shine as they do requires ultra-violet light of much shorter wavelength than it had previously been supposed such a star could emit, but there seems to be no escape from the conclusion that it does. There is a good deal of other evidence that the cooler stars, and notably the sun, send out more short-wave radiation than had been supposed, and it is now up to theoretical investigators to find out why and how they do.

On the instrumental side a report was presented by our host, Professor Cogshall, of the first observation with a reflecting telescope of unique type. Long ago, before the Great War, Schwarzschild had shown by difficult mathematical analysis that it was possible to make a reflecting telescope which would have a wide field of good definition, instead of the very limited one provided by the ordinary paraboloidal mirror. But the difficulties of construction of the mirrors were so great as to deter the most courageous. The curves defining these forms were of the fourth degree, and it was a hard job to figure the glass to the proper shape, and test it to be sure that this had been attained. Cogshall, working alone, and with limited financial resources behind him, computed the curves for a 24-inch reflector, and ground and polished the mirrors himself. The mounting shown in our illustration was constructed, and a modest new observatory erected to house it. Last week, its designer had the pleasure of showing to the Society some of the first photographs taken with this instrument—which, to this day, is the only example of this theoretically very important and promising type. The adjustments of such an instrument are unusually intricate and delicate, and the finishing touches have not yet been made; but, even so, the plates show that a wide field of good definition has been attained, far surpassing that of any reflector of the ordinary type. This form of reflecting telescope, with a concave secondary mirror half the diameter of the primary, gives good star images over a field four degrees in diameter. The plate holder may be seen, about half way between the mirrors.

LAST, but not least, must be recorded the award of the Annie J. Cannon Prize to Mrs. Sitterly—formerly Miss Charlotte Moore. This prize—established by Miss Cannon from a considerable prize which she had herself been awarded—is given every three years by the Council of the American Astronomical Society to some woman, without regard to nationality, who has done distinguished work in astronomy. Mrs. Sitterly's work in spectroscopy, especially on the sun-spot spectrum and the identification of solar lines, has placed her in the front rank of workers of this field; and the award has met with unanimous approval —as did that to Mrs. Gaposchkin three years ago.—*Bloomington, Indiana, January 3, 1938.*

# China and Modern Science

## Though the Times Were Ripe in Ancient China's Civilization, Pure (Hence Practical) Science did Not Develop There Because China was too Practical!

By RUFUS SUTER
Library of Congress

CHINA invented printing from type; China invented gun powder; China probably invented the mariner's compass.

For centuries the culture of this so-called "backward" nation was the equal of, and in some respects superior to, that of western nations. In number of first-class intellects, wealth of dominions, political organization, literature, art, flood control, and soil conservation, her record was enviable. As late as the end of the 18th Century even the state of public sanitation was probably not much different from that of Great Britain. Why, then, did not China instead of Europe give birth to modern science? If we knew the reason we should know why the Celestial Empire today is relatively helpless, whereas countries which were still semi-barbarous while she was enjoying the fruits of a refined civilization have become world powers.

One reason why China did not give birth to modern science was her civil service examination system. Suppose that in the first century of the Christian era the papacy in Rome had started a 2000-year career not only as religious head of Europe but also as temporal master with a strong army to back up her will. Imagine then that she had established the history of Herodotus, the "Odyssey" of Homer, the moral and political writings of Aristotle, and some work on sooth-saying, as an authoritative canon to furnish the sole subject-matter for education and for the examinations which were to be the "open sesame" to public office. This metaphor is not too accurate but it gives an idea of what was the actual situation in China for approximately 2000 years before the decline of the last imperial dynasty. The emperors, who were the vice-gerents of heaven as well as the rulers of men, inculcated through the centuries in the minds of their subjects the notion that the Classics were ultimately authoritative. The civil service examinations became almost exclusively the road to officialdom in the imperial capital and in the provinces, and indeed were the road to any form of social prestige. Dynasties changed but this basic policy remained. Thus one may readily have a suspicion of why capable and ambitious men in the Middle Kingdom were content to confine themselves to the study of "The Book of History," "The Book of Odes," "The Book of Changes," and the other Confucian Classics. There was no economic occasion, nor any other sort of practical occasion, for investigating natural phenomena for their own sake.

Wider and deeper consideration suggests another reason why modern science did not emerge natively in China. The peculiar set of circumstances which occurred in the west before the advent of science in the 16th Century did not have any counterpart in the Celestial Empire. We may assume, in other words, that when science sprang forth fully developed in the west, with the new attitude towards nature of Vesalius, Kepler, Galileo, Harvey, and the others of that unrivalled galaxy of geniuses, this growth required just the background which historically it had.

The scientific awakening in Europe began as one aspect of a general reaction against the unempirical cast of thinking of the Middle Ages. Its claims were less ambitious than those of the schoolmen. It did not seek to fathom the attributes of God and the human soul, or the divine purpose in creating. It only sought to ferret out by careful watching, as the skilful mechanic does, how things work: the rate of acceleration, for example, of a ball rolling down an inclined plane.

THIS increased stress on the importance for knowledge of observed fact, however, was not the whole of the secret of the scientific awakening. If science was a reaction against the omniscient deductive structure of the Middle Ages it was also the heir of the Middle Ages. They bequeathed to it the idea that nature is orderly, a conviction without which science is impossible because in its absence observation and experiment yield only a miscellany of disjointed bits of curious information about things, which is what native Chinese natural knowledge was. We should not underestimate the number of such items of information acquired by the ancient Chinese. They developed methods of extending the life period of the soil, knew the medicinal value of herbs, foretold eclipses, measured the length of the year with extraordinary accuracy, devised a primitive seismoscope. Indeed, their discoveries and inventions were well nigh numberless. But Chinese natural knowledge always remained piecemeal. It never had the capacity to develop into an organized whole where one discovery would point to others beyond itself and so would eventually permit a really farsighted, effective control of nature on a vast scale.

That we inherited the conviction of the orderliness of nature from our mediæval ancestors is seldom realized. We think of our forebears as living in an orgy of supernaturalism, seeing miraculous, arbitrary interventions of the hand of a divine Despot everywhere. But, while this may have been true of the masses, it certainly does not reflect the thought of the learned. That the schoolmen reasoned syllogistically alone disproves it, for people who reasoned syllogistically must have believed that the world was arranged according to a pattern to which the syllogism would apply. The world for our ancestors was a network of premises and conclusions. Or, to describe the picture in another way, the universe was a lawyer's brief. Whatever may have been the defects of this conception it did not err in the direction of disregarding the orderliness of nature, for orderliness belongs as essentially to a lawyer's brief as to a machine (the pattern after which the fathers of modern science conceived of the universe), or as to a set of mathematical equations (the picture some of our 20th Century scholars entertain of their environment).

The schoolmen did not originate this rigorous legalistic conception of the world. They inherited it. For centuries, however, they mulled over it, devised precise ways of expressing its details in technical language, analyzed and synthesized it, wrangled about it, and split hairs to a degree of nicety which to us of today seems ridiculous. The result was, nevertheless, that the conviction of the orderliness of nature was indelibly imprinted on the cultivated western mind. It became instinctive. When the 16th Century arrived the stage was set.

The fathers of modern science had merely to appreciate that the powerful and efficient, indeed the sole effective, way of finding the lines of orderliness was to observe and experiment. They took for granted that the laws were *there*. Every event happened according to *some* law. The puzzle was to discover *which* laws, and this could be done by watching. Then, when the laws were unravelled, there was no end to the previously unknown facts and additional laws which would be suggested, to the predictions which could be made, to the information about the past, the invisible, the unobservably small, and the unobservable large, which could be gleaned, to the practical applications which could be maneuvered, and to the development of means of harnessing the forces of nature for human use.

One has no grounds for supposing that the Chinese, if they had enjoyed the long western training in seeing the world as orderly, would not likewise have given birth to science. As it was, unfortunately, they were not aware that beneath the helter-skelter of natural phenomena are fixed grooves in which all happenings fall if the puzzle is pondered sufficiently. Hence their observations and experiments led nowhere.

WE now come to a possible third reason why science did not develop indigenously in the Middle Kingdom. One hesitates to mention it because it belongs in the realm of the speculative more obviously than did the other two reasons, and it may have no basis in fact. If we consider it we should do so with reservation. It is associated with a cast of mind which in the past was widespread among the Chinese intelligentsia. This cast of mind may have been a result of the civil service examination system, or it may have been a natural character of the Chinese mentality (if such an expression means anything, which is doubtful since the best psychological opinion of today is that no innate distinguishing national or racial mental traits exist). At any rate, the scholarly class among the Chinese in the past, and to a remarkable extent in the present, was and is marked by a practicalness of interest which has not characterized the corresponding class in western lands since the days of classical Greece and Rome. The Chinese scholar was a practical, common sense, dignified man. He would have been ashamed to roll balls down inclined planes merely to measure their acceleration accurately, as did Galileo. Such an occupation would have been childish and not worthy of a fully matured human being who had better be concerned with the serious problems of statecraft, economic organization, moral training, and history; or, if he had an impractical moment, he might study an ode.

Photo Alinari, Florence

**Galileo Galilei was not "ashamed" to perform experiments with little balls and inclined planes, and then to fight for his findings until they took root and modern science grew from them and from him. Giuseppe Bezzuoli's painting in the Museum of Physics and Natural History, Florence, Italy, depicts him at the age of about 26 (1590) making his famous experiment at Pisa before the illuminati. Two men at the left are "settling" the question by looking it up in Aristotle, whose authority was universally regarded as final, whether his *a priori* reasoning agreed with actual experiment or not. Like the Chinese, the Greeks would not experiment; only slaves used their hands. This delayed science over 2000 years**

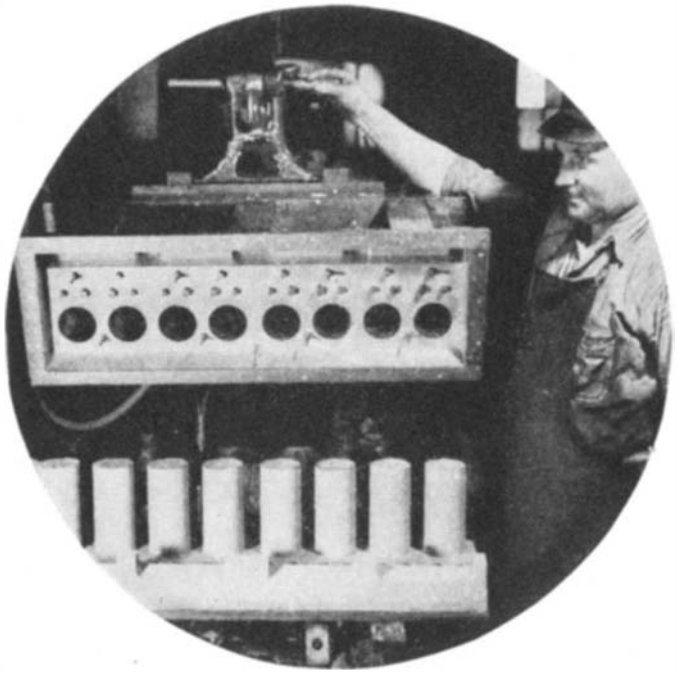
One would imagine that this practical bent would have been good soil for the development of science in China. Here, however, we come face to face with one of the paradoxes in the story of man's struggle to master his environment. While modern science in the west has effected an intensely practical revolution in every aspect of life it was not at its inception a consciously practical venture, nor has it been since in the hands of the men who have done most to push its frontiers into new territory. When Galileo performed his experiments with the balls and the inclined planes he was not consciously and deliberately creating the science of dynamics which was destined to play a rôle in the transformation of an agricultural society into our modern industrial civilization with its amazing feats of engineering. The same may be said of Faraday and Maxwell. The innumerable practical applications of our knowledge of electricity and magnetism were made possible partly by their investigations, but they were pure scientists interested in electrical and magnetic phenomena for their own sake. As striking an example of this paradox was Roentgen's discovery of the X ray. He was a typical German professor isolated from the world and as concentrated on exclusively theoretical questions as is Einstein. His discovery, nevertheless, has been of as great humanitarian value as that of anesthetics.

There is nothing mysterious in this circumstance that theoretical inquiries have commonly preceded practical applications. It is simply that first principles are more readily accessible to minds not distracted by concern with the question of use. It is, curiously, a *practical* disadvantage to the development of a science, particularly at the initial stage, for the explorers to remain at the utilitarian level. Once the theoretical principles are laid bare practical applications will naturally follow without any pressure in that direction by the pioneers. To cite an illustration which at first glance will seem farfetched: the obvious utilitarian value of observing the stars must have been in the beginning to predict future happenings in the body-politic. It was a bold man, absurdly impractical and oblivious to public opinion, who at some date in our western history made the leap from astrology to astronomy, first plotted the movements of the heavenly bodies just to learn how they move and not to discover whether some monarch's reign was to be successful.

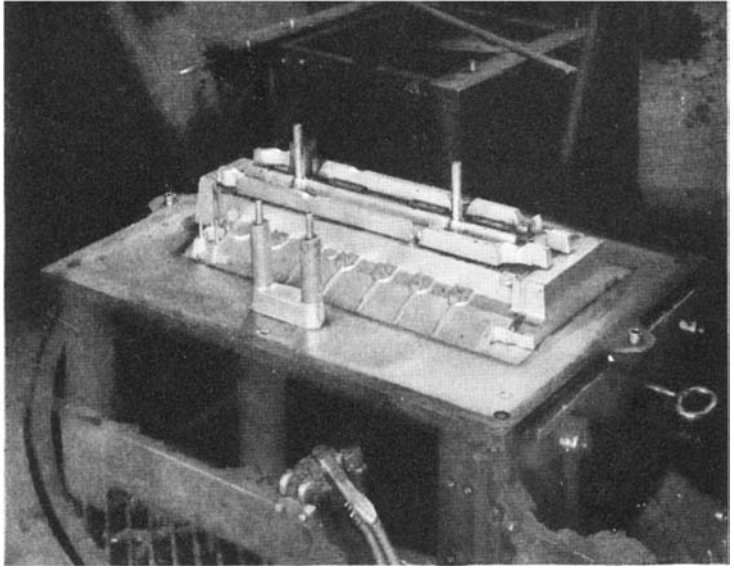
THIS degree of impracticalness never occurred among the Chinese intelligentsia, or if it did it was swiftly suppressed by the authorities. There was a long line of eminent men in the Middle Kingdom who were official court astrologers and who made accurate observations with excellent instruments of precision. They all, however, labored under the delusion that the affairs of this world are determined by, and to be read in, the heavenly bodies. They were too practical (or perhaps it was their superiors who were too practical) to free themselves of the ideal of political or social utility and to assume a point of view which could have permitted the evolution of a pure science of astronomy capable of begetting practically utilisable information.

An analogous situation frustrated the growth of native Chinese mathematics, geology, zoology, anatomy, and medicine, all of which by the richness of their beginnings gave promise of marvelous development, but in the end did not liberate themselves from the pseudo-science—practical, often beneficent in its motivation—of sooth-saying.

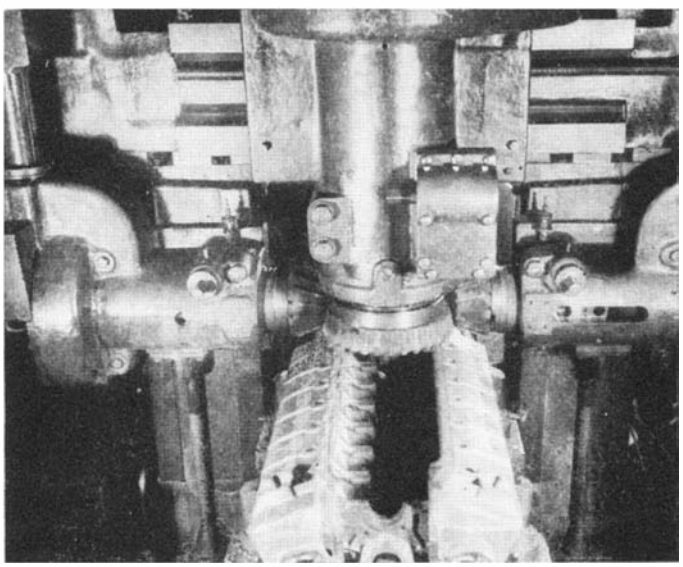
# A MOTOR-CAR



**1** All motor-car engines have their beginnings in sand. In one phase of the foundry procedure oil-treated sand is compressed in core boxes and the resultant mold is baked to produce the core. The core shown above will be used to shape the inner cylinder walls of one of the two eight-cylinder banks of a Cadillac Sixteen engine. The other photos on this page show the same engine taking form



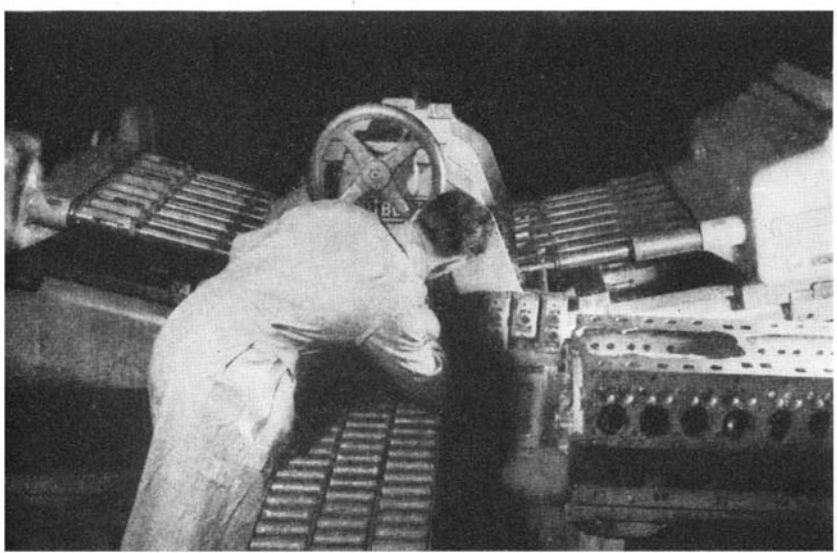
**2** An aluminum pattern of the bottom of the engine block. A mixture of sand, clay, and graphite is packed over this, held in place by a metal box called a flask. The flask is inverted, the pattern removed, the cores are assembled in the cavity, and molten iron is poured into the spaces



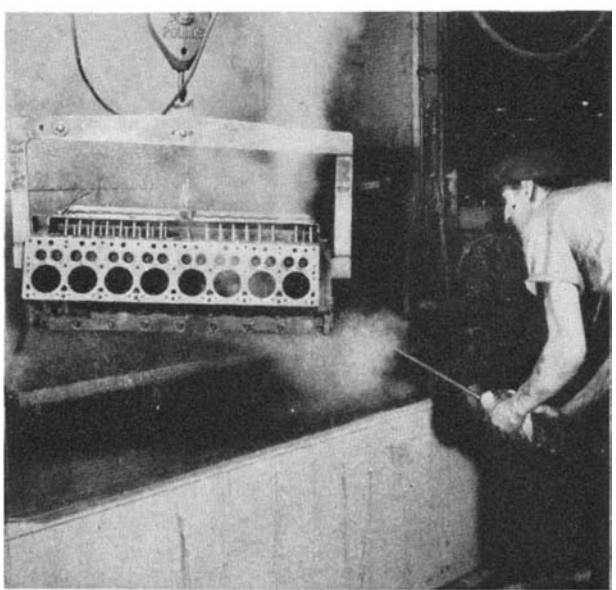
**3** *Left:* The block, scoured free of sand, receives the first touch of the milling machine. One cutter smooths the oil-pan face while two side cutters take care of the engine support brackets. Here, and in subsequent operations to final assembly, the block is placed upside down

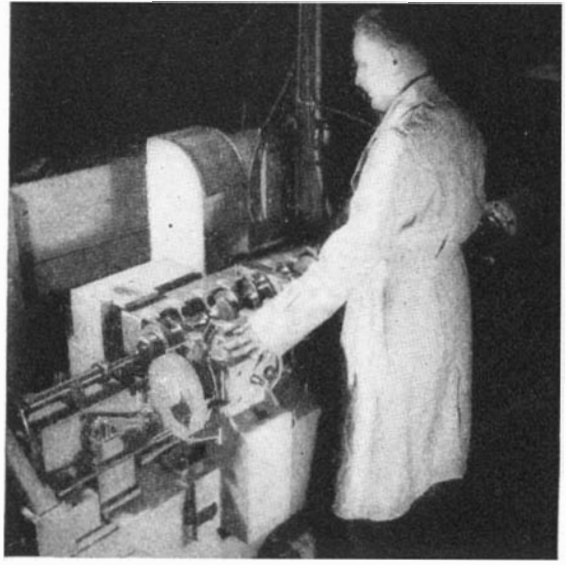
**4** While the block is in process of manufacture, other motor parts are being made and machined. A delicate scale (*right*) weighs sets of pistons, rings, pins, and the small end only of connecting rods, to produce matched sets for smooth operation

**5** Ten multiple-drill machines, marking ten steps in manufacture, drill 301 holes in the block for accessories, oil passages, and assembly. Blocks are drilled for one function on one side, reversed, and the process repeated. In the machine below, holes for valve-lifter and valve-guide bearings are being drilled simultaneously

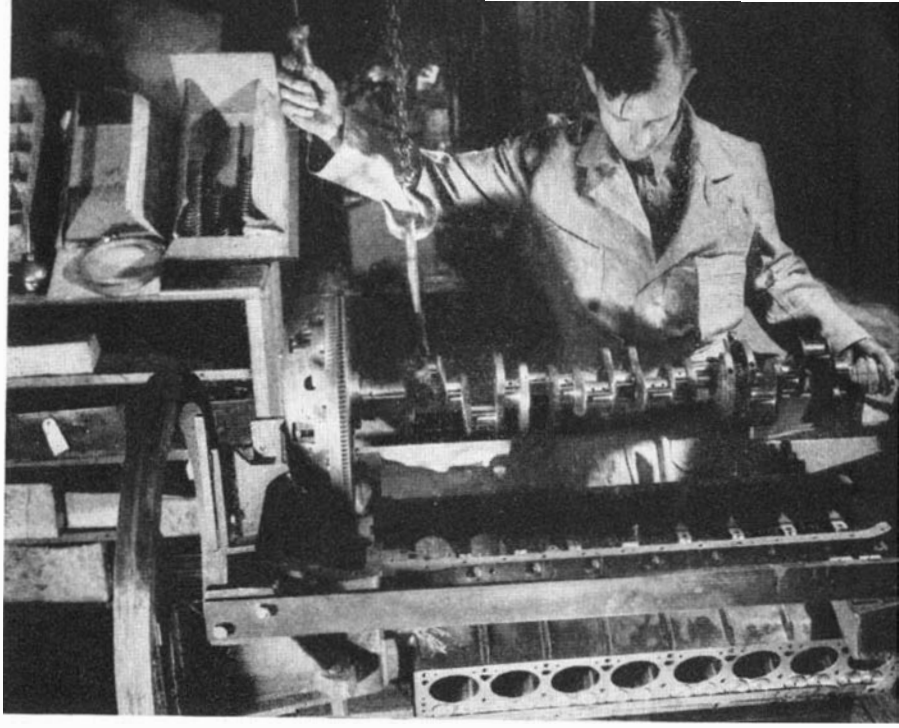


**6** Fragments of metal or grime, once enclosed in the engine, would ruin the fine piece of machinery. In one of the final series of washings, shown below, a cleaning solution of boiling kerosene and water is forced under high pressure through all of the oil lines





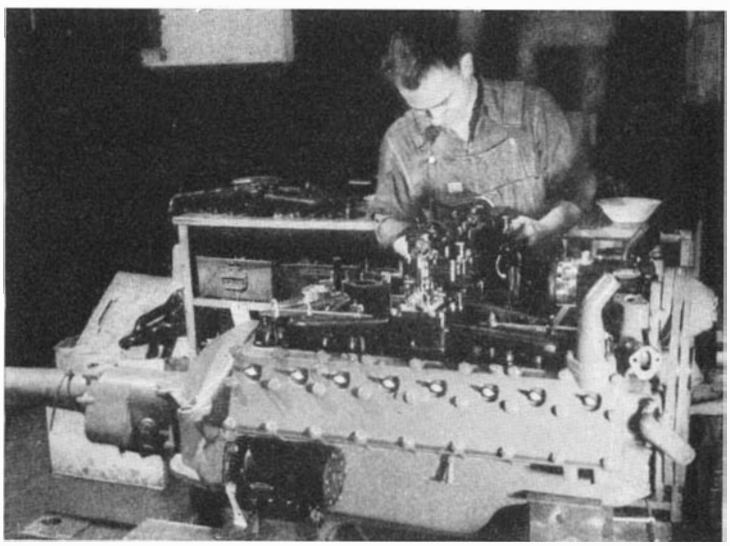
**7** The engine crankshaft, one of the most intricate masses in the unit, must be perfectly balanced. Set up as shown above and revolved at high speed, balance within 0.5 inch-ounce is indicated on the oscillograph



**8** With the block still upside down, the crankshaft is lowered into position. At the left end of the shaft is the clutch and flywheel assembly. After the crankshaft is placed, the pistons and rods are inserted from below and the motor pan is attached. Compactness of the new Sixteen is evident here. The crankshaft is much shorter than those designed for use in previous models of the same general engine type

# Engine Takes Form

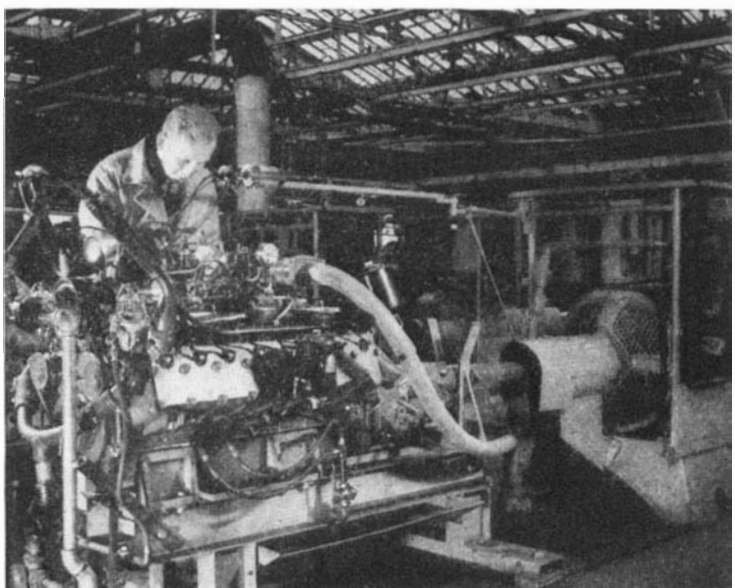
By A. P. PECK

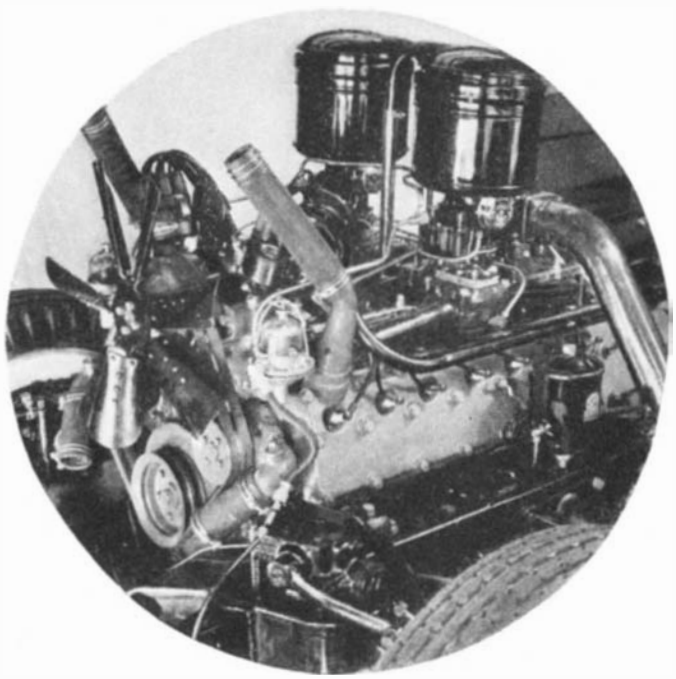


**9** *Right:* The transmission has been fitted and the engine has been placed right-side up. The workman is fitting into place the various accessories. Counting generators, carbureters, and so on, as one part each, the new Sixteen has 1627 parts; last year's Sixteen model had 3273 parts

**10** *Below:* The completed motor is tested on the dynamometer. At full throttle, the dials will register 185 horsepower. Essentially, the dynamometer consists of a specially designed electric generator coupled to the shaft of the engine and acting as a load or brake to absorb the power developed. Power output of the motor-car engine is then indicated on electric meters

**11** *Lower right:* Ready for the radiator, the completely assembled engine rests low in the chassis, the 135-degree design of the two cylinder banks making for a low center of gravity. Duplicate sets of engine accessories, for easier servicing, will be noted in this photograph





# Camera Engraving

## Photo-Engraving Conquering a New, Difficult Field . . . Makes Printing Rolls for Textiles, Wall Paper . . . Certain Advantages over Older Methods

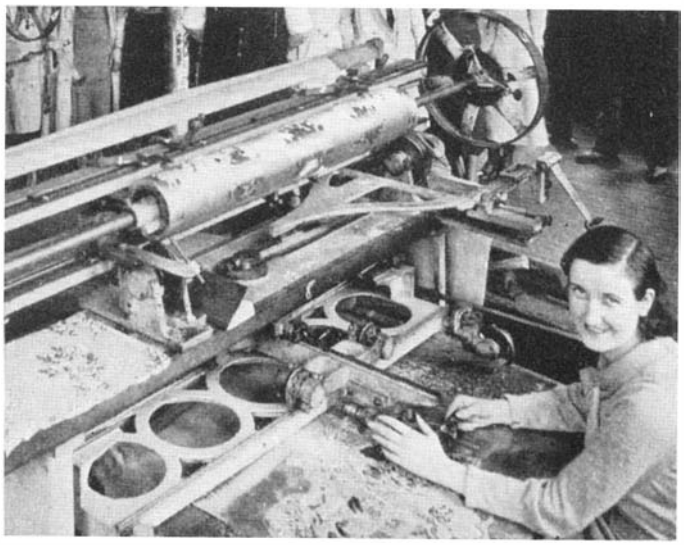
By PHILIP H. SMITH

UNREMITTING research is responsible for putting within the reach of the average person's pocketbook oil-cloth, textile and wall paper products which were non-existent a few years ago.

You can now purchase oil-cloth sporting highly complex, multi-color designs which reproduce the artists' conceptions with absolute fidelity; you can get textiles printed to give the appearance of furs, and wall papers which have the surface look of grained woods or coarse weave textiles, all perfect as to detail.

The means for obtaining this hitherto impossible in designs has been photo-engraving. All of these products are printed from engraved copper rolls and it is the substitution of the camera for the hand in the application of the pattern to the roll that has permitted the reproduction of intricate detail to achieve many phenomenal effects.

The triumph of photo-engraving in these three fields is more than an extension of the long successful color-process printing of paper. Each field has presented a different combination of problems requiring specific solutions. Much has had to be forgotten as well as learned to make the process work successfully, and even now its rôle is limited and supplementary to existing processes. Broadly speaking, photo-engraving is being used in these new fields chiefly where the older processes cannot be used because the length of time required to reproduce intricate detail on the roll by older methods would make costs prohibitive, or because the human hand is unable to execute detail faithfully.



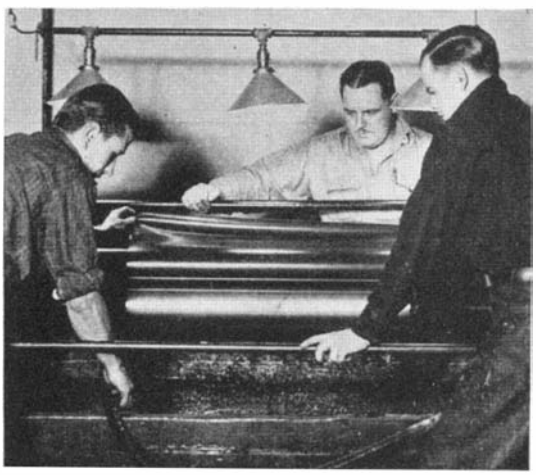
**In the pantograph method of engraving rolls, the operator traces the design, diamond points scratch the varnished roll**

WHEN mechanization comes to an industry, it is expected to replace hand work. It usually does. But photo-engraving applied to the production processes of these three products has been unable to abolish all hand skill. We have, therefore, a situation that is unique. We start with the camera which is known to register detail with extreme accuracy. We apply it in competition with the human hand and eye, known for their fallibility as well as great skill, and expect to see it triumph quickly. After many years of trial and error, it fails to conquer completely. This must be explained.

So we have here a progress report—the story of beginnings and accomplishments; when we have surveyed the record we may be able to determine how much farther photo-engraving is likely to go. Will it ultimately sweep the field? What will it mean to the reduction of production costs? Those who are devoting all their energies to perfecting the process declare that wider application is only a matter of time and closer co-operation between the parties who might benefit. But we cannot agree or disagree until we examine the various processes and the problems to be faced.

There are four methods of engraving printing rolls—hand, mill and die, pantograph, and photographic. In the first method, an outline of the pattern to be reproduced is cut on the copper roll. The hand engraver then punches or cuts very small points, or pins, on the ground surface of the roll, which, in turn, carry the color. Heavy tones are obtained by cutting large pins and vice versa. Multi-color work calls for a separate roll for each color. However, by allowing the pins carrying one color to fall over the pins carrying another color, a mixture of the two colors can be obtained to create new shades. This is the most laborious process and usually the most expensive.

Mill and die engraving is much faster. The first step is to turn a piece of steel, especially prepared, into the required diameter, and to cut into it a single repeat of the pattern to be engraved. After cutting the design, the steel is hardened by heat. It is then placed in a machine and the design transferred to a steel roll of the proper diameter by applying extreme pressure, thereby raising what is called a mill. The mill presents just the reverse of the die. Then the roll is placed in an engraving machine and the design is transferred, once more under pressure, this time to a copper roll.



**In photo-engraving, sensitized carbon tissue transfers design to roller ready for etching**

Pantograph engraving is the fastest and least expensive process, but its application is limited to a particular type of design. Here the design is etched or hand cut on a zinc plate on a scale several times larger than the original. This plate is put into a pantograph together with a copper roll which has been treated with an acid-resisting varnish. The operator then traces the design as it appears on the zinc plate and the diamond points of the machine cut through the varnish simultaneously in the desired number of places, thus exposing the copper for later etching.

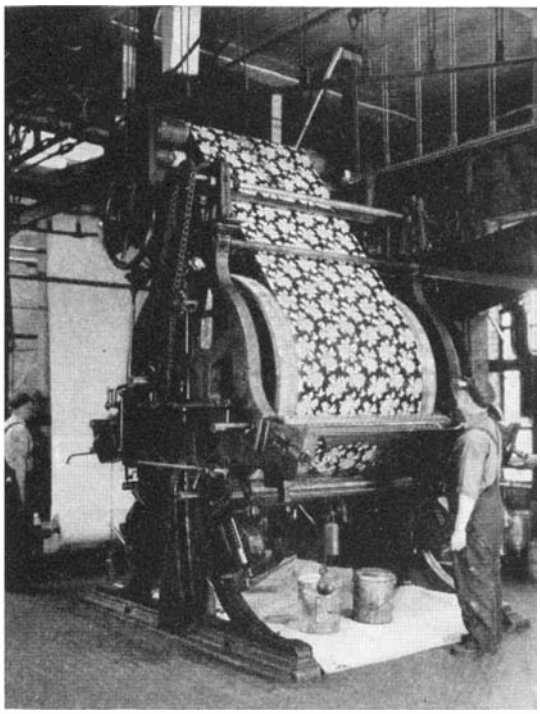
The photographic process is the newest. It comprises two methods—the gravure and the intaglio reverse half-tone. The former follows the rotogravure process used to print Sunday paper supplements. The design is photographed, then the negative is used to print onto a sensitized carbon tissue which is later transferred to the copper roll. The tissue must be thoroughly developed and then painted to block out any spots not to be etched. Finally the roll is placed in a bath of acid and the design is etched in the various tones appearing in the pattern.

THE intaglio process is similar to rotogravure as far as the photography is involved, but instead of the amount of color being controlled by the depth of the etch, it is governed by the size of color-carrying points. These points, or pins as they are technically termed, are obtained by photographing the design through a screen (as are the half-tone cuts used in this magazine), so that the screen effect is etched into the surface of the roll to achieve, in effect, countless raised points. Pin size is controlled by screen size.

Both processes feature photographic separation of color. Thus a separate roll is produced for each of the primary colors. Then, in the printing process, when the colors are applied in their correct order, intricate patterns in soft shades can be produced on the material.

The photographic processes in the textile industry involve much secrecy. Each engraver has developed particular skills through long experience. Most of these jealously guarded secrets have to do with transfer of the design to the roll and cannot be revealed here.

Oil-cloth has been mentioned first among the industries using the photographically produced roll because adoption is most widespread and perhaps most successful. Commercial, economic, and technical conditions combine to make it most practical and it is here that the intaglio half-tone process is being used. The surface of the material and the cellulose acetate lacquers with which it is printed can be handled excellently. Hitherto, large designs with intricate detail and shading were too costly to produce, and the manufacturer had to be content with simple geometric patterns. Even now, the latter type of design can be produced more cheaply with the pantograph method if there is no color gradation.

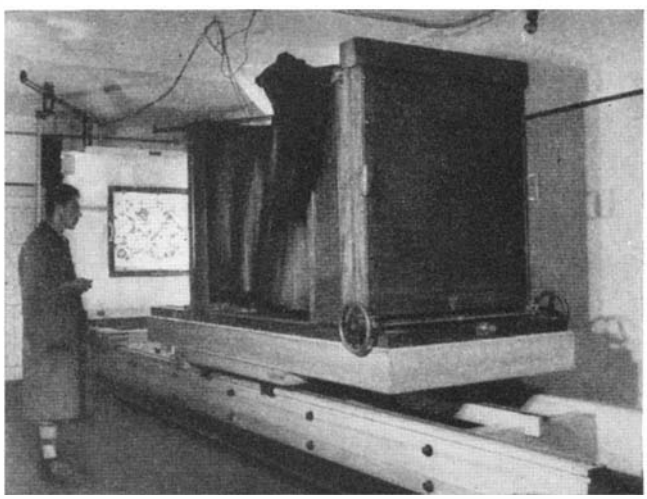


**Four rolls print four colors, in register, on oil cloth as it turns around this revolving drum**

The photo-engraver who works in the textile field has a wholly different set of conditions to meet. The material upon which the printing is done, the colors, the machinery, and the designs, are quite unlike those found in oil-cloth manufacture. Here, application of photo-engraving began with silks which had a smooth surface and a selling price high enough to justify the cost of experimentation. From silks, the next step was to cotton and today more and more cotton-printing rolls are being produced by the photographic method.

The camera is used only when designs are complex and involve a great deal of shading. If the pantograph can be used for simpler work, it wins on a price basis. But there are instances where only the photographic process produces the desired results. If you have seen fabrics which give the effect of furs, you have seen the best possible example. No human hand could ever engrave the intricate detail of fur texture.

Multi-color work is done with the new process quite successfully, but the best results are obtained when the design bases on the three primary colors. When rolls are made with definite color use in mind, the colors cannot be switched satisfactorily and for that reason hand-engraved rolls are often preferred, simply because more rolls are



**A large camera, used in photo-engraving, moves on a heavy frame during focusing: A design being photographed**

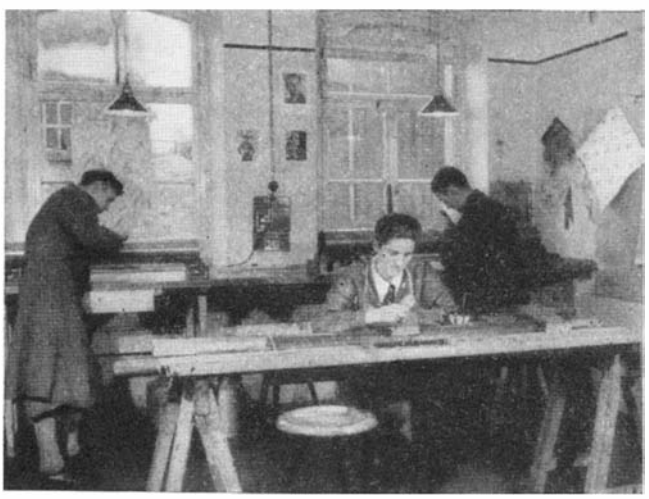
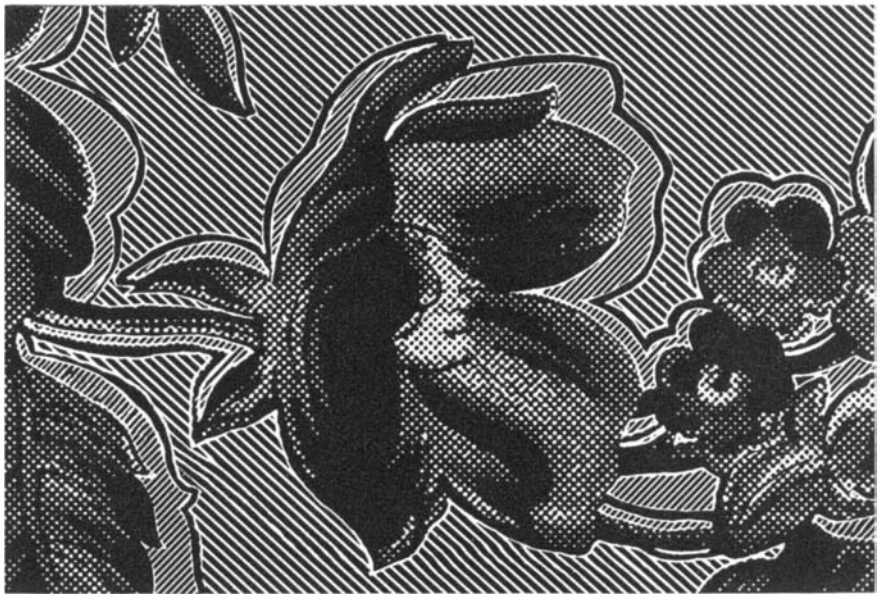


**Photo-engraved rolls are inspected in foreground and "tooled" near windows to clean up and to correct errors**



**Part of design for a roll, reproduced at twice the original size to show versatility of photo-engraving. Gradations of tone are obtained by dots and a variety of lines**

used. In other words, the photo-engraver tries to achieve, with few rolls, the same effects that heretofore have been created with many hand-made rolls.

The engraver who works in the textile field, unlike the man who produces for oil cloth, has a material into which the colors must strike fairly deeply. The colors, too, vary in that chemicals are used which, in the printing, develop into color only after passage through chemical solutions.

IN the third field, that of wall paper, photo-engraving has made least progress and for several good reasons which do not necessarily cast any reflections on the process. Only about 10 percent of wall papers are engraved. This means that the volume of business is not sufficient to warrant the cost of extensive experimental work. Nor is the demand for wall papers such that designs of the character best produced by photography have any great field. Wall paper has one very fundamental difference from either oil-cloth or textiles in that it appears before the eye always in measured strips which must be identical. The camera, which reproduces with fidelity, catches all defects as well as effects. The slightest discrepancy in the process of transferring the design to the roll will stand revealed when strips are laid side by side to match the design. Likewise, if the etching process is not uniform over the entire surface, the paper will be streaked.

Intricacy of design and the extent of shading is again the deciding point in the type of process to be used, with the exception that there are certain designs which can be reproduced only by photography. We find these to be wood grains and textiles where the amount of detail would swamp the hand engraver.

At this point we can begin to draw some conclusions regarding the photographic process in general and as it applies in the different fields.

The first and perhaps most obvious conclusion is that photo-engraving is by no means a completely mechanized process. Individual skill and artistry has not been abolished by the camera; what has happened is that the skill of the hand engraver has been simply transferred to the photo-engraver. In unskilled hands, no worthwhile results can be achieved. The photo-engraver must have the skill of the artist at his finger tips and have intimate knowledge of design and process.

Since the engraver is not the designer nor the printer, a high degree of co-operation must exist between these three principal factors; where that has been brought about the greatest progress has been achieved. Designing for the photographic process is now a definite art with very few skilled practitioners; the handling of color and the actual printing process have been altered to meet the exigencies.

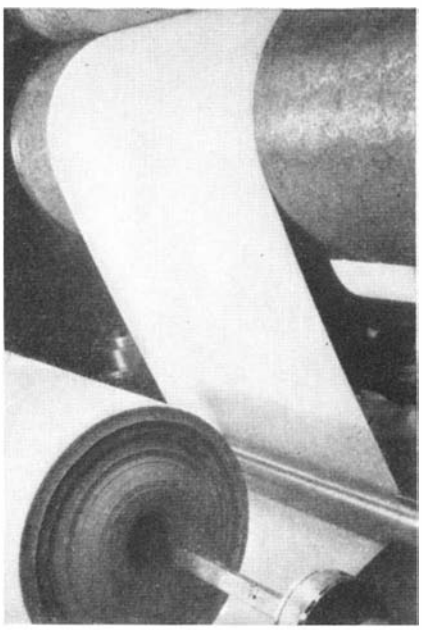
Probably the greatest conquest by the photographic process will be made in the oil-cloth field where results already point the way. Yet 100 percent use is not anticipated. Even photo-engravers admit that very often costs can be held down by limiting the use to backgrounds and combining with hand-engraving for full design effect. On the other hand, they are quick to point to great savings when applied to certain designs. If, as it happens, hand operations will take three months to achieve the same result that can be had in three weeks with photography, the latter will win even though the roll cost might be higher.

Illustrations courtesy of Chambers-Storck Co.; Fabrikoid Division, E. I. duPont de Nemours & Co. Inc.; Nu-Process Roller Corp.; U. S. Finishing Co.; Wadsworth & Woodman Co.

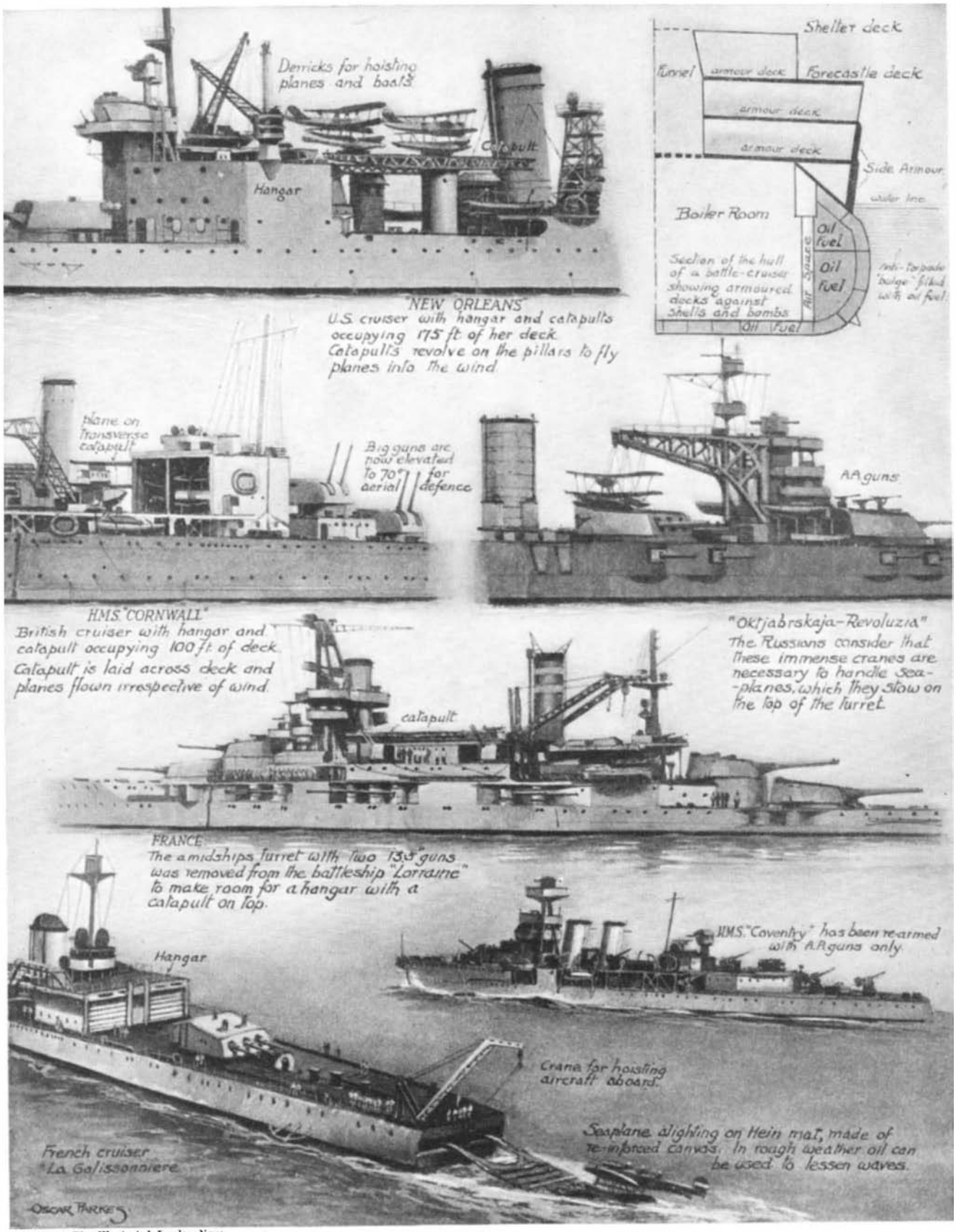
In the textile field, we find style operating as a major factor. If fashion decrees the use of solid color fabrics, development of photo-engraving slows; but in the main it keeps moving steadily ahead. Early attempts at introduction were costly and unsatisfactory and gave the process a black-eye from which it has not yet fully recovered. Many photo-engravers sprang up who could not deliver the goods, but did last long enough to create a host of skeptics. Now the ill effects are wearing off and more developmental work is in progress, looking to more accurate and inexpensive multi-color work.

Still another set of conditions govern the wall-paper field. Here it is a decorative effect that is sought rather than detail and it is detail that the camera offers. Manufacturers see no over-all advantage to be gained from pushing the photographic process as long as costs exceed that of hand work. They admit, however, that much might be achieved if designer, engraver, and printer worked together, but they must first see possibilities of increased commercial demand.

CRITICISM is rampant in every branch of photo-engraving activity. Each party looks to the other to make the successful contribution when joint enterprise is perhaps the only way to reach the goal. But it all sums up to this: mistakes and failures are always obvious and invariably aired during the trying period of experimentation. It is just another way of saying that progress is being made and that the last word has yet to be uttered. Photo-engraving is being adopted just as quickly as it does a better job, or an equally good job at lower cost, and it already has made a permanent place for itself.



**Large printing or embossing rolls present many operating problems**




Courtesy *The Illustrated London News*

# Aircraft Have Influenced Warship Design

INCREASING use of airplanes by navies has forced modifications of warship design for more effective use of, and protection against, them. In the drawing by the naval authority, Dr. Oscar Parkes, are shown some of the developments already made. It will be noted that deck space is conserved by British practice, shown on H. M. S. *Cornwall*, of installing a transverse catapult, whereas on the U. S. S. *New Orleans* the catapult must swing in all directions to face the wind. Other innovations are the full elevation of the main armament guns, and the addition of much armor for deck protection.

# THE SCIENCE OF

*(In Two Parts—Part Two)*

By SIDNEY J. FRENCH
Assistant Professor of Chemistry,
Colgate University, Hamilton, N. Y.

IN Part I of this series the three important factors which govern the formation of alloys were considered. They had to do with the particular pattern of crystal lattice formed by a metal, with the number of outpost electrons belonging to the atom of a given metal, and with the relative sizes of the atoms. While these are by no means the only factors that influence the formation of alloys, they are decidedly the most important.

But, before considering alloys themselves, we may well consider the factors which distinguish metals rather sharply from other substances, the factors which permit metals to be flattened into thin sheets, bent, or drawn into fine wires without crumbling. What property possessed by the atom accounts for these unusual phenomena? A simple analogy will help in answering the question. Imagine a flexible box filled with marbles all of the same size. Now put pressure on one edge of the box. The whole pattern is distorted or warped out of shape as the marbles slide and roll over one another to take up new positions. The serried lines of the original formation are skewed into a new alinement; but still, each marble maintains its contacts with its original fellows (Figure 10).

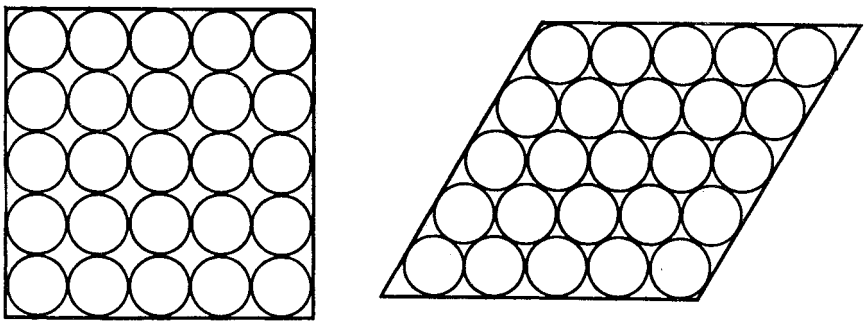


*Figure 10:* **Illustrating the slipping of metal atoms past one another when pressure is put on the metal: the left-hand arrangement changes to the other**

In a similar manner metal atoms slide and slip past one another when pressure is put on the metal. By further stretching, the metal can be drawn into a wire. But the marble analogy falls down in one important respect—marbles are held together only by the force of gravity while atoms have electrons to hold them together in a more powerful bond. However, if the electrons per atom are few in number, the bond, though firm, is not rigid, and atoms may slip and slide into new positions to distort the crystal structure without parting from their neighbors. And, if the atoms are relatively large, the skewing process is more easily accomplished. We find, then, that metals having large atoms and few outer electrons per atom are the most malleable and ductile, the most easily bent or worked, and the softest of the metals. And, in addition, they are the best conductors of heat and electricity. In this class come three of our most important metals—gold, silver, and copper—followed closely by the useful lead, tin, pure iron, and aluminum.

The slipping of atoms past one another will take place most readily where the distances between atoms are the greatest, for it is there that the forces holding the atoms in position are the smallest. Just as the distances between corn plants in a symmetrically planted corn field depend upon the particular angle of view—on the particular row under observation—so, too, the distances between atoms in a metal crystal lattice will vary. (See Figures 2 and 3 of Part I.) On the bias, where distances are greatest and binding forces weakest, skewing will be at a maximum. Here lie the so-called slip planes; here it is that the first "give" takes place when pressure is put on the metal.

Many of the metals have modified crystal lattices in which the atoms are closer together in one dimension than in another. Such metals have very definite slip planes or planes of weakness which confer great ductility, malleability, and softness on the metal (Figure 11).

Perhaps the best example of a substance exhibiting marked slip planes is to be found, not among the metals, but in graphite, a peculiarly crystalline type of carbon. Here the tiny unit crystal is a hexagon composed of six carbon atoms. Within the hexagon are powerful electronic forces binding the atoms together to give a hard, rigid structure. But between adjacent hexagons distances are greater and forces weaker. Hence, these tiny hexagons slip past one another with ease to give the smooth greasy touch and apparent softness so familiar in graphite (Figure 12). So smoothly do these tiny crystals slip past one another that graphite finds important uses as a lubricant. But graphite is unlike the metals in that it lacks the clinging power of the metal atoms, the force which still ties atoms together even though they be warped far out of position.

TO return again to our marble analogy, let us imagine that the marbles are now set in glue, so that each marble is rigidly attached to its neighbors. Pressure on one edge of the box results not in the even slipping and sliding of marbles but in irregular breaks between various clumps of marbles. Gone now is the former flexibility; in its place we have rigidity and brittleness. We have a good representation of the brittle metals such as chromium, bismuth, or antimony which shatter into fragments at the blow of a hammer, which break instead of bend, which are poor conductors of heat and electricity and which cannot be machined. These are the metals in which the atoms are tied rigidly together by

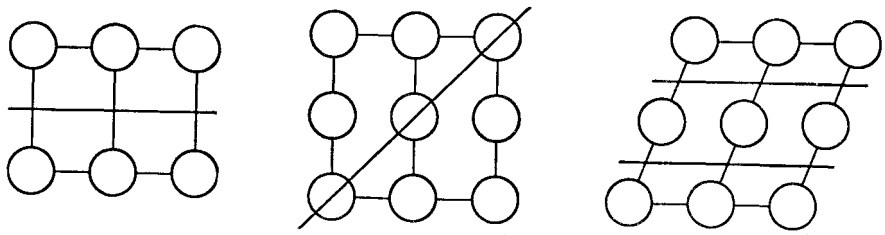


*Figure 11:* **Illustrating slip planes, or lines of weakness in crystal lattices where the atoms of some metals are farthest apart. These confer ductility and softness**

# Alloy Building

## Why Metals Can be Worked . . . Why Graphite is a Lubricant . . . Why Some Metals are Brittle and Why Diamonds are Hard . . . Why Carbon Hardens Steel

the large number of electrons present per atom. There is little chance for distortion of the crystal lattice; there are few slip planes and little "give." If there are pronounced lines of weakness in the crystal structure, the metal, like bismuth, will fracture into shiny smooth-surfaced angular bits.

As graphite represents the extreme of softness, so the diamond, another form of crystalline carbon, represents the extreme of hardness. The carbon atoms, small in size and each with four outpost electrons, are held close together with powerful and rigid electronic forces to produce the hardest crystal known to man.

AS the superstructure of a ship may be thrown into place quickly, once the keel has been laid and the ribs put in place, so we can finally fit the discussion of alloys over the somewhat extensive groundwork of fundamental principles.

We may well consider the simplest example, to start with—the case of two ideal metals whose atoms are as nearly alike as possible, having similar sizes, possessing the same number of outpost electrons and crystallizing on the same pattern. Of course, there is no such ideal case in existence but, like Plato, we can visualize Utopia. In essence, we have merely painted some white marbles red and the change in color does not prevent the marbles from fitting in their former holes. We may mix the red and white marbles in any proportions at will and they slip into their proper places without fuss or delay. So with our two ideal metals; the atoms of one may be substituted for those of the other in the crystal lattice without upsetting the pattern and without materially altering the mean properties of the alloy (Figure 13). As the average color of the box of marbles will depend on the proportion of reds and whites, so the average properties of the ideal alloy will depend alone on the proportion of each metal present and it approaches those of the metal whose atoms are present in largest number. We have, so to speak, a sliding scale the limits of which on either end are the two metals making up the alloy. Such alloys are often termed solid solutions. Alloys of gold with silver approach this ideal state, as do those of gold with copper and silver with copper.

Having considered cases where there is a maximum of similarity between atoms, we can turn to cases where there is a maximum dissimilarity. Consider two metals in which the atoms are far apart in size and crystallize in totally different patterns. We no longer have the analogy of red and white marbles; we are dealing with footballs and golf balls. Shake these together in a barrel and the golf balls soon find their way to the bottom, leaving the footballs above. So it is with such unlike metals; they may not mix even when both are melted, the lighter one forming a layer over the heavier. But, even if they do mix in the liquid state, there can be no mixing when the alloy solidifies, for a football cannot take its place in the golf-ball lattice nor can a golf ball match up with a football. Each metal crystallizes separately on its own lattice pattern with its own atoms making up the lattice (Figure 14). But if the atoms are thoroughly mixed in the liquid state, only a few of one variety will be close enough together to form a crystal. Hence, the crystals of one metal will not be continuous but tiny and intermingled with tiny crystals of the other metal.

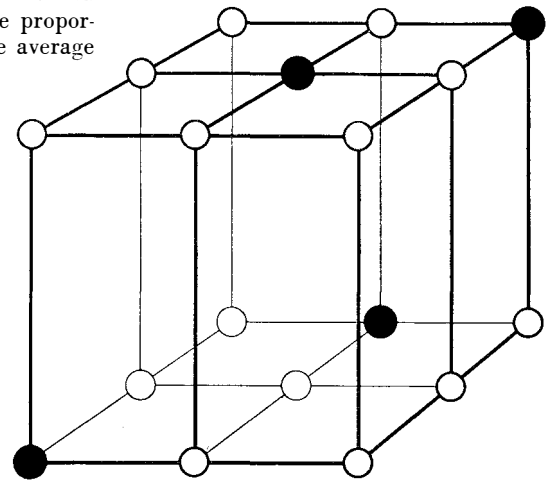


*Figure 13:* **The substitution of an atom of one metal for that of another in a crystal lattice causes little distortion, provided the atoms are similar (substituted atoms are shown in black)**

These crystals are so tiny and so interwoven that to the eye the alloy appears to be the same throughout. But polishing and etching with acid to dissolve out the boundaries between crystals throws the tiny units into a relief which becomes clearly evident under the microscope (Figure 15).

Such alloys, composed of mixed crystals of the two metals, are known as eutectic alloys when the mixture has the right proportions. In general, they are quite brittle, breaking easily at the crystal boundaries. They cannot be worked into sheets or wires because the separate crystals do not cling together but the interweaving of crystal units gives hardness and rigidity. There can be no continuous slip planes, for these are broken at the crystal boundary.

If an excess proportion of one metal is used in the preparation of such alloys,

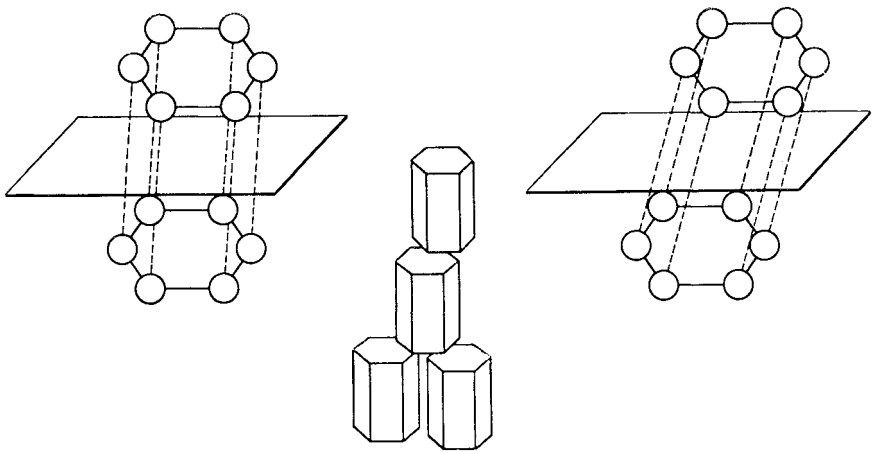


*Figure 12:* **Showing why a "lead" (graphite) pencil writes so smoothly: As the end crystals are caught by the paper, crystals higher up slide quite easily apart**

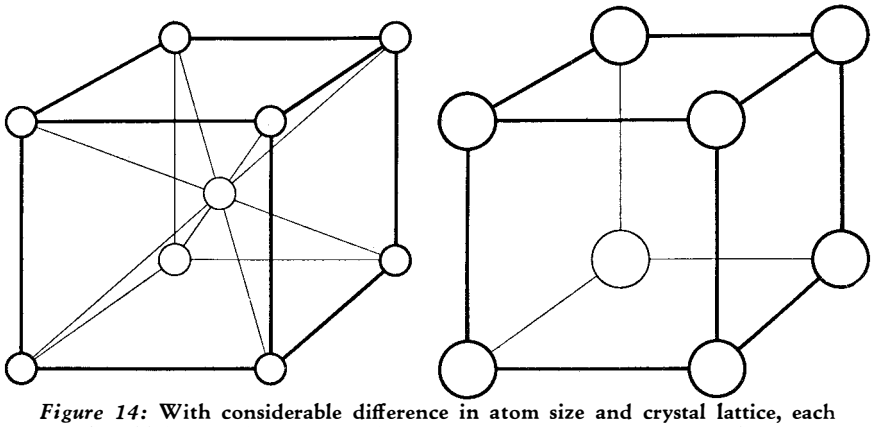


*Figure 14:* **With considerable difference in atom size and crystal lattice, each metal snobbily crystallizes separately and a eutectic type of alloy is thereby formed**

the eutectic alloy will be imbedded in and surrounded by the excess metal, thus providing a soft matrix for tiny crystals of harder alloy. As hard stones may be imbedded in asphalt to give a yielding yet durable surface to wear, so such alloys find valuable uses as bearing metals, the soft matrix metal supplying the necessary elasticity and the embedded alloy the durable contact points.

EUTECTIC alloys have another interesting property, that of melting or freezing at low temperature. Tin has the lowest freezing point of all the common metals, yet the eutectic alloy of tin with lead freezes considerably below the freezing point of tin itself. To explain this peculiarity, in part at least, we may use one more analogy. A football team in practise and without opponents can line up in formation quickly, but place an opposing team on the field and tangled masses of opposing players greatly retard the lining-up process. Some bewildered player may even find himself temporarily in the wrong line-up, but he is soon ejected. So, in a mixture of molten lead and tin, with each atom trying to find a place in its own line-up as the temperature falls toward the freezing point, there is great confusion and retardation of crystal formation. The temperature falls considerably below the normal freezing point before the atoms can untangle themselves and line up in crystal formation. Then, too, lead atoms have some attraction for tin atoms, even though the two cannot occupy the same crystal, and this attraction must be broken before either metal can crystallize. At lower temperatures, the tendency to fall into crystal formation overcomes the attraction between lead and tin atoms.

Eutectic alloys, and in fact, all alloys, are not necessarily limited to two metals; there may be three, four, or even a half dozen metals in the alloy. This, of course, leads to very complicated structures. As the number of metals making up a eutectic alloy is increased, the freezing point of the alloy is further decreased. Tin, freezing at 456 degrees, Fahrenheit, forms with lead, bismuth, and cadmium, all freezing at higher temperatures, a eutectic alloy freezing at 158 degrees. Such an alloy melts in hot water and is often used in fire sprinkling systems. If a fifth metal, indium, is added to the other four, an alloy melting at 116 degrees or in luke-warm water, is obtained.

There is one type of alloy which does not fit well into the framework we have set up, and we cannot pass it by without mention. It is the type of alloy known as an intermetallic compound. Just as hydrogen atoms may unite with oxygen atoms to form molecules of the compound, water, so atoms of some metals may unite chemically with those of other metals to form intermetallic compounds. It is in these alloys that the number of electrons present per atom plays the important rôle. Metals in which the atoms have but one or two outpost electrons unite most readily with those in which the atoms have five or six of these electrons. This type of union tends to destroy, in a large measure, the metallic properties and such alloys are hard and brittle, and conduct heat and electricity poorly.

Closely related to such alloys though not usually classed as alloys are the compounds formed between certain metals and sulfur. Many of these, such as iron sulfide (fool's gold) and lead sulfide (galena), have a decided metallic luster. But further consideration of this vast and lightly explored field would carry us far beyond this brief survey of alloys.

We have considered two extremes: those in which the atoms are most similar, the solid solutions, and those in which the atoms are most dissimilar, the eutectic alloys. Between these extremes lie the interesting intermediate alloys. Suppose we consider two metals whose atoms differ somewhat in size but crystallize on the same pattern and are in other respects quite similar. We are now, in effect, trying to slip a larger atom into a hole in a crystal lattice designed for a smaller atom, or vice versa. The fit may not be perfect, but it may work within limits. We may put a few ostrich eggs into an egg crate designed for hen's eggs without destroying the total symmetry of the egg containers, but there will be awkward bulges in the partitions and if the process is continued for long we might better reverse the method and place hen's eggs in containers designed for ostrich eggs. Only within limits can these unlike objects be interchanged.

SO, too, in crystal lattices of metals, larger or smaller atoms may be substituted in the lattice within limits. But the substitution distorts or strains the crystal. It loses its softness, its malleability and ductility (Figure 16). When the distortion has proceeded to the limits of strain, there will come an abrupt change in the lattice; it may become

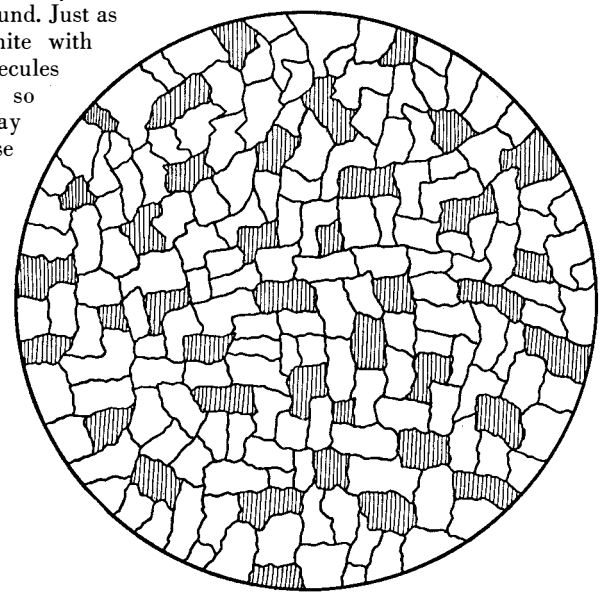


*Figure 15:* **How the structure of a eutectic alloy appears when seen under the microscope. Etching reveals the tiny crystals of the separate metals in it**

that of the other metal. With this abrupt shift in the lattice comes an equally abrupt shift in the properties of the alloy, thus accounting for the sudden changes in the properties of alloys when the proportions of the two metals are but slightly altered. We are in effect changing suddenly from putting ostrich eggs into a hen's egg crate to putting hen's eggs into an ostrich's egg crate.

It is not always the case, however, that the crystal structure changes abruptly from that of the smaller atom to that of the larger or vice versa. There may be an intermediate structure which will best

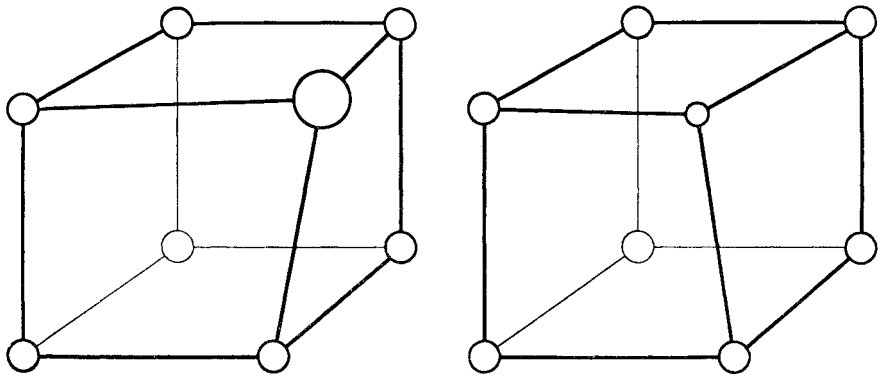


*Figure 16:* **Illustrating the kind of distortion caused in crystal lattices when larger (left) or smaller (right) atoms of another metal are substituted in them**

accommodate the two sizes of atoms. Or there may even be several intermediate structures but the change from one to the other is an abrupt one. As we add more of one metal to another there may first occur a warping or distortion of the original lattice followed by an abrupt shift to an intermediate structure and ending finally in the distorted lattice of the added metal. One or more intermetallic compounds may even be formed in the process. These are the complicated alloys which still have the modern metallurgist scratching his head and wondering if he really knows what makes alloys behave as they do. Nevertheless, daylight is slowly but surely beginning to send its diffused rays into dark places to reveal nature's principles in the formation of alloys.

IN cases where one metal crystallizes on one pattern and the second metal on another, even though the atoms are similar in size and other characteristics, the story is much the same as that just related. The crystal structure is warped by the addition of the foreign atoms, then changes abruptly to an intermediate structure or to that of the second metal (Figure 17). Again an abrupt change in properties accompanies the change in structure. Alloys of nickel with chromium show such an abrupt change from the nickel lattice to the chromium lattice or vice versa. The nickel lattice can accommodate, without too great distortion, large numbers of copper atoms, hence the nickel-like appearance of copper-nickel alloys.

Since the substitution of any foreign metal atom in the lattice of a given metal invariably results in some distortion, some strain of structure, and some reduction of symmetry and slip planes, alloys of a given metal are invariably harder and less ductile than the pure metal. Pure silver is far too soft for coinage purposes; it is therefore hardened by alloying with copper.

The hardening effect of a trace of carbon on iron in steel making is noteworthy. Less than 1 percent of carbon present in iron increases the hardness and tensile strength many times over. This striking effect is thought to be due to the very small size of the carbon atom, which can fit itself into the iron crystal lattice without disturbing the iron atom formation. Instead of substituting for an iron atom, it merely slips in between iron atoms giving a so-called interstitial lattice formation (Figure 18). In effect, the addition of the carbon atom has stretched the lattice slightly, thus providing hardness without warping, and serves as an extra brace to the crystal, thus providing greater tensile strength.

It would be interesting to know, were the evidence available, just how much difference there can be in the sizes of atoms before substitution in a lattice becomes impossible. With such information at hand we should be able to predict whether a certain alloy should be of the solid solution or eutectic type. Dr. Hume-Rothery has recently studied this problem in a long series of experiments. His conclusions are that there must be less than 14 percent difference in the radii of the metal atoms for substitution to take place. If the difference is greater, there is no substitution in the lattice and the eutectic type of alloys can be expected. Obviously, the rule would hold only where other factors, such as number of electrons per atom and type of crystal lattice, do not interfere seriously. But the study is significant, in that it provides some quantitative means of predetermining the character of an alloy.

The principles upon which the formation of alloys depend have been touched upon but lightly; the details are too complex to consider here, and many problems remain to be solved. Few metals are ever 100 percent pure, and a trace of impurity may greatly alter the nature of the metal. Furthermore, most commercial alloys today contain not two but three, four, or more metals. Before we can have a complete understanding of these complex systems, we shall have to go much farther along the road of purposeful experiment. But the fact that we are beginning to understand even the simplest alloys—those composed of only two metals—is in itself heartening.

THE day will undoubtedly come when alloys can be built to order; when specifications can be met by first considering the principles involved, then building the alloy to meet its particular requirements. When that day arrives, countless new alloys will take their places in the industrial world, the home, the automobile, the airplane, and the train. The business of alloy building will have passed from the dark mysteries of trial and error technic to the bright stage of a true science. The alloy age of today is but a feeble ancestor to the alloy world to come, and our children will smile as they look back on a period called by enthusiasts, "the age of alloys."

(*The End*)

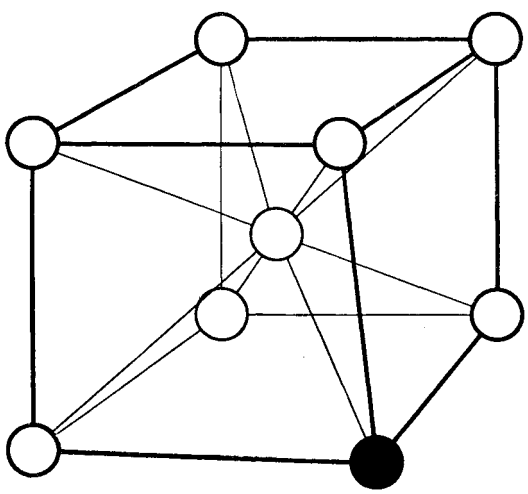


*Figure 17:* **Distortion of a body-centred lattice by introduction of atom tending to crystallize in some different lattice structure**

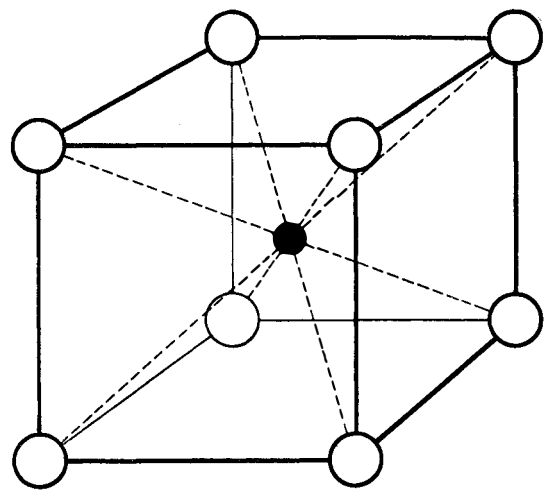


*Figure 18:* **Interstitial lattice in which a small atom may enter the lattice of larger atoms without replacing one of the latter or materially disturbing the larger lattice**

# ELECTRICITY PAINTS A PICTURE

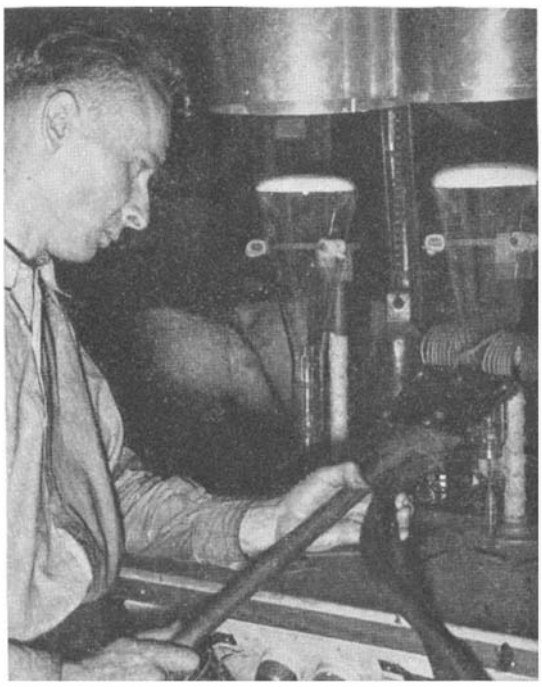
## . . . And the Picture Tells a Significant Story to Research Workers in Many Fields . . . Cathode-Ray Tube Development Has Made this Possible

By ALLEN B. DUMONT

WITH an electronic beam for its brush and a fluorescent screen for its canvas, electricity can paint images of its own minutest variations, its lightning-fast changes, and its most complex moods. Devoid of the moving parts and inherent inertia of even the most delicate meter, the cathode-ray tube has become a new and startling tool in the hands of scientists, engineers, industrialists, and even radio servicemen, for applications and possibilities limited only by their own ingenuity.

Strangely enough, the cathode-ray tube is at once a very old idea and a very new application. Its origin dates back several decades. Various workers in the early electrical art, including Edison and Crookes, were aware of strange discharges of then unknown character in vacuum. But the commercialization of the cathode-ray tube really began with the experiments of J. J. Thompson in 1897 when he first discovered the true nature of the electron, and with the helpful work of Braun in the same year.

The usual cathode-ray tube is a funnel-shaped glass tube, highly evacuated. Indeed, the vacuum is so perfect that the larger tubes are subjected to such elevated atmospheric-pressure strains that it becomes necessary to resort to glass walls as much as ¼ of an inch thick, and rounded rather than sharp corners. The narrow neck portion of the conventional cathode-ray tube contains the electronic gun and its controls, while the chemical coating for the fluorescent screen is placed on the inside surface of the flared end.



**Cathode-ray tubes in the making. Minus bases, the tubes here are undergoing bombardment and final exhaust pumping before sealing off**

The electronic gun contains a heated cathode which emits a copious flow of electrons, a modulating electrode surrounding the cathode for controlling the beam current, a focusing electrode for concentrating the beam, and an accelerating electrode which causes the electrons to be drawn out of the electronic gun at such tremendous velocity that they traverse the entire length of the tube and strike the fluorescent screen at the far end. The crystals of the fluorescent screen become agitated and throw off a bright glow at the point of impact. Thus there is, in effect, a veritable gun shooting a stream of invisible bullets which, upon striking a screen, cause a glow. Just a bright dot appears on the screen. Varying the voltage on the modulating electrode causes that spot to be brighter or dimmer; varying the voltage on the focusing electrode causes the spot to become smaller or larger. But as in the case of any gun, it is necessary to be able to aim the electronic gun —to swing it from left to right, and from top to bottom. This may be done by means of electromagnetic coils placed over the neck, on the outside of the tube. Or, what is the more common and popular method of deflection, deflector plates may be placed inside the neck of the tube, very close to the cathode beam as it passes between such plates from cathode to screen. Two sets of plates are required for vertical and horizontal displacement. The plates are, of course, at right angles to each other.

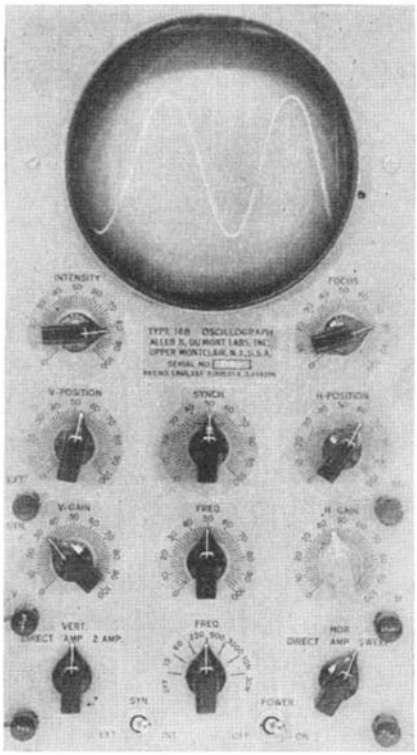
Now the beauty of the cathode-ray tube is the absence of moving parts or mechanical operation. Everything is done electrically, with the help of fluorescent chemicals. There is no weight or mass or inertia to contend with. The cathode-ray beam is as light as a light beam; it is weightless. It is capable of gyrating with lightning-like speed and of responding to the slightest variations in the electrostatic charges placed on its deflecting plates. The relative response of the cathode-ray tube and the usual indicating meter would be on the same scale as the acceleration of today's 12-cylinder automobile compared with the "one-lunger" horseless carriage at the turn of the century.

THE fluorescent screen plays a most important part. It is to the cathode-ray tube what a sketching tablet or canvas is to the artist. No amount of swinging of that practically invisible cathode-ray beam could create an image unless those fluorescent crystals were ready to glow on impact and, what is equally important to the case, to continue glowing for a longer or shorter interval, depending on the use of the tube, thereby producing the effect of a complete image or pattern rather than just a dot of light. The user today has the choice of fast or slow fade-out of the fluorescent image, or so-called "decay" rate. For photographic purposes, a relatively high decay rate is used, while for television's images, a slower decay rate to reduce flicker is more desirable.

A plurality of panel controls have to do with the operation of the cathode-ray oscillograph. The controls on the left side may affect vertical motion of the cathode beam, those on the right affecting horizontal motion. If the left positioning control is moved slowly, the cathode-ray spot moves up and down as a dot. If the positioning control is wiggled rapidly, the dot becomes a continuous line. By turning the right positioning control, the spot can be shifted horizontally, while a wiggle results in a horizontal line. Wiggling the two positioning controls produces diagonal lines and even circles.

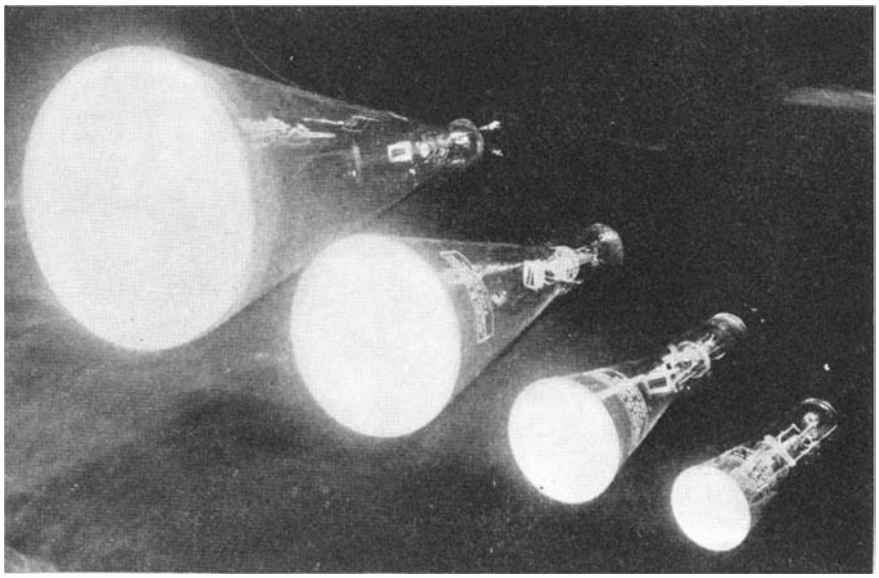
The most general use of the cathode-ray oscillograph employs displacement along the horizontal in proportion to time. A device for producing such displacement is termed a linear sweep circuit, and the rate of this sweep can be adjusted quite critically to simplify the observations being made.

Reduced to simple terms, and essential for a real understanding of the cathode-ray oscillograph, the operation is as follows: An electrical input voltage proportional to the quantity to be measured, either mechanical or electrical, is applied at the vertical input terminals. Suppose a low-voltage, 60-cycle signal is connected to the vertical posts. With the "sweep" turned off and only the vertical amplifier turned on, the input signal gives a convenient length vertical line.




**Wave-form of an alternating current is painted electrically on the round screen of a cathode-ray tube**

Note that using just one set of deflector plates gives just an up and down or straight-line image. If now the sweep circuit is turned on, the straight line instantly wiggles into a series of waves. These may be quite narrow, steep, crowded together. A further adjustment of the sweep circuit stretches them out, broader, but not so many showing within the circle of the screen. The sweep circuit may be adjusted so that the waves glide slowly by, to the left or the right, or even stand absolutely still. Even a portion of a single wave may be obtained, greatly magnified, for critical study. With electricity painting its own picture, anything which can be translated into electrical terms can be critically studied with the oscillograph.



**Typical cathode-ray tubes, from nine-inch to two-inch screen diameter**

Until a half-dozen years ago, the cathode-ray tube was a comparative rarity. Today tens of thousands of cathode-ray tubes, ranging in diameter from two inches to nine inches, are in daily use. Quickly surveying the radio field it is found that even the radio serviceman with a slim purse now boasts a cathode-ray tube oscillograph to aid him in tracking down the most persistent radio troubles. Radio factory workers use cathode-ray tubes for testing and adjusting sets and components.

IN the more refined cathode-ray tube, already available, is the basis for practical television reception. With satisfactory associated equipment, the cathode-ray beam reproduces the necessary pattern of glowing lines to match the pick-up scanner at the remote transmitting studio. A modulating electrode in the tube serves to vary the intensity of the spot, and this variable intensity, plus the sweeping of the dot line-by-line for a total of 441 lines representing our present scanning standard in America, weaves a picture on the screen.

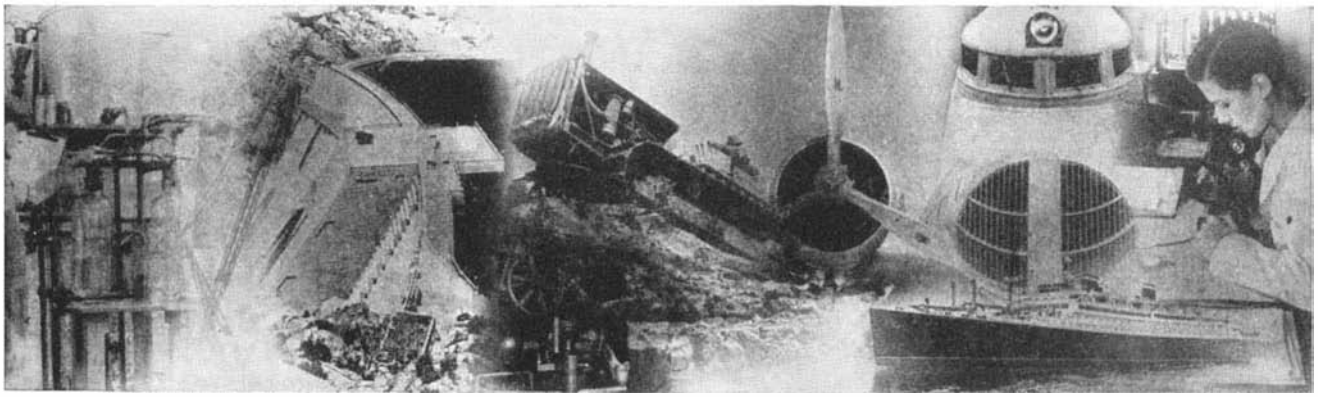
But the cathode-ray tube does not stop with radio and even with early television. Every day, so it seems, new and unexpected applications turn up. In the field of music, for instance, the resonoscope is a development which is producing an entirely new pitch consciousness. Here is an instrument which provides for the first time a definite standard of musical pitch and then tells you how near you can approach that pitch with your voice or musical instrument. [The resonoscope was described on page 105, February 1938 Scientific American.—Editor.]

Other human queries are answered by the cathode-ray tube. For example, it can be used as a highly sensitive electrocardiograph, or heart tester. The slightest tremors can be greatly amplified and magnified on the screen, studied and photographed. The results of nervous disorders and reflexes may be sketched on the screen. The electro-encephalograph provides five simultaneous indications of five brain, nerve, or reflex conditions of a patient on five different cathode-ray tubes. It is entirely probable that the veracity of witnesses in the future will be decided by the wiggles on the cathode-ray screen of a lie detector.

Because the cathode-ray tube is lightning-fast in its response to the slightest electrical variation, it finds no end of uses in studying either recurrent or transient phenomena. It is used in studying what is happening in all kinds of electrical circuits. Wave forms are traced in simple or intricate patterns on the greenish fluorescent screen, which keep on reproducing themselves so long as the electrical phenomena take place.

In the case of transient phenomena, a slow-decay fluorescent screen is used, producing a bluish image. A single impulse of the desired transient phenomenon is fed to the oscillograph. The corresponding pattern is instantly traced on the screen and remains "frozen" in place for a full minute or more, slowly fading away. Several transient phenomena can be flashed on the same screen, and comparisons made because of the slow decay rate. This ability to hold patterns is of tremendous importance in studying such lightning-like phenomena as the operation of circuit breakers, the breakdown of electrical condensers, the action of automobile distributors, and so on.

The cathode-ray tube, in the final analysis, is a sort of finger-print expert. Everything in this world has characteristics peculiar unto itself. If those characteristics can be reduced to electrical terms, then those electrical terms become the veritable finger prints which the cathode-ray tube reproduces for critical visual study. Hence its industrial applications are practically unlimited.



# THE SCIENTIFIC AMERICAN DIGEST


**Conducted by F. D. McHUGH**

Contributing Editors

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

D. H. KILLEFFER
Chemical Engineer


## 6000 YEARS HENCE

IN our photograph, C. M. Broome, Jr., representative of The American Rolling Mill Company (left), presents Dr. Thornwell Jacobs, president of Oglethorpe University, Atlanta, with a stainless steel plaque for the door of the crypt in which comprehensive records of present civilization will be preserved in stainless steel containers.

**Presentation of the metal plaque that will seal for 6000 years the crypt containing civilization's full record**

The crypt, to be sealed next year, will not be opened until 8113. Dr. Jacobs first announced this plan in detail in the November, 1936, issue of Scientific American.

The plaque, bearing the names of President Roosevelt, former Governor Talmadge of Georgia, and Dr. Jacobs, reads:

"This crypt contains memorials of the civilization which existed in the United States and in the world at large during the first half of the twentieth century. In receptacles of stainless steel, in which the air has been replaced by inert gases, are encyclopedias, histories, scientific works, special editions of newspapers, travelogues, travel talks, cinema reels, models, phonograph records and similar materials from which an adequate idea of the state and nature of the civilization of 1900 to 1950 can be ascertained. No jewels or precious metals are included.

"We depend upon the laws of the County of DeKalb, the State of Georgia and the Government of the United States, and of their heirs, assigns and successors, and upon the sense of sportsmanship of posterity for the continued preservation of this vault until the year 8113 at which time we direct that it shall be opened by authorities representing the above governmental agencies and the administration of Oglethorpe University. Until that time, we beg of all persons that this sealed door and the contents of the crypt within may remain inviolate."

### CANE

**A TON of sugar cane will yield approximately 100 pounds of raw sugar and three gallons of rum.** ***—Industrial and Engineering Chemistry.***

## REPELLING RODENTS

TO reduce the loss of fall-planted bulbs commonly experienced by gardeners through the ravages of rats and other rodents, a new compound with a slight odor has been developed. Its odor is not unpleasant to human beings but drives rodents away so that they do not eat parts of bulbs treated with it. It is non-toxic and is applied to the bulbs before planting in the fall.—*D. H. K.*

## EXPLOSIMETER

THE M. S. A. Explosimeter, a pocket-sized instrument for quickly and easily determining the presence of combustible gas hazards, has been placed on the market by Mine Safety Appliance Co.

This instrument is designed to meet the demand for an instrument that can be carried about on the job and operated by any workman. It shows whether gas concentrations are within or above the explosive range. In size and weight, the Explosimeter compares with a small folding camera, and can be carried either in a pocket or on a shoulder strap.

By operating a small piston-type pump, a sample of the atmosphere to be tested is drawn through a length of hose into the Explosimeter. Sampling line of practically any length may be used, with no lag in the indicator reading except the time required to draw the sample through the line.

The gas sample flows over a hot platinum wire which forms a part of a balanced electrical circuit, current for which is provided by a small two-cell dry battery. This detector unit is balanced against the filament of a small electric light bulb burning in an inert atmosphere. Combustion of gases on the surface of the detector filament creates an increase in the temperature of the wire and consequently an increase in its resistance, thus causing the electrical circuit to be unbalanced. This unbalancing of the circuit causes a deflection of the pointer of the electrical meter, proportional to the concentration of gas in the atmosphere being tested. The concentration of gas may be read directly on the meter, which is graduated in percent of the lower explosive limit.

Adjustment of a single knob is all that is necessary to prepare the Explosimeter for use and to maintain it in operating condi-

**Detecting combustible gas**

tion. This single control is used to turn the instrument on and off, balance the electrical circuit, and indicate the extent to which the battery in the instrument has been consumed.

Some of the fields in which the Explosimeter is now being used include distilleries, public utilities, oil refineries, paint and varnish plants, iron and steel mills, chemical by-product plants, and so on. It is especially well adapted to use by municipalities for investigating fire hazards and gas hazards in sewage disposal plants.

## House That Research Built

REVOLUTIONARY changes in the design and construction of industrial buildings through the liberal use of sheet iron and steel instead of conventional materials were demonstrated in Middletown, Ohio, recently by The American Rolling Mill Company at the dedication of its new research building.

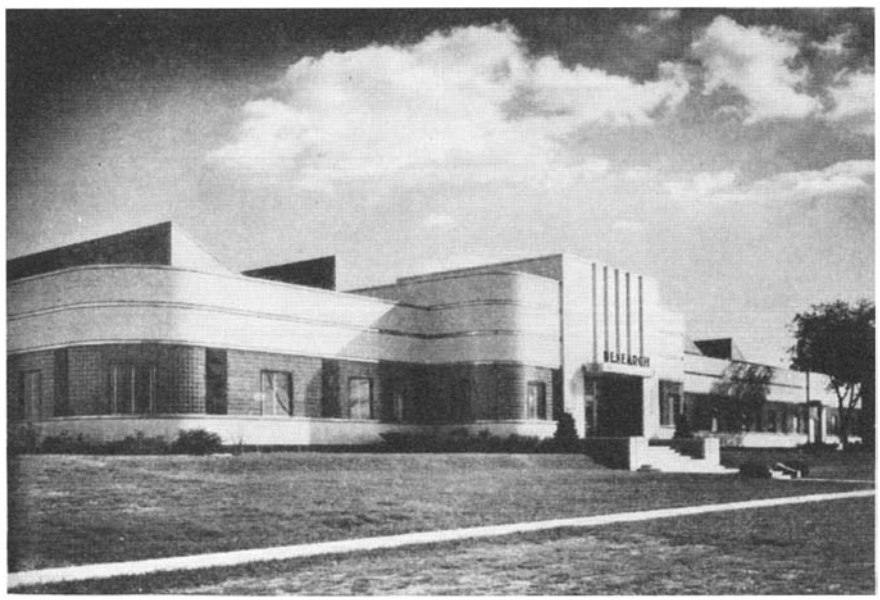
Dr. Anson Hayes, Armco research director, said the building was erected after extensive investigation to prove the practicability of the use of sheet iron, sheet and strip steel, and stainless steel in building construction. Six different types of iron, steel, and stainless steel were employed. There is not a rivet in the entire building, the walls being fastened to the structural frame with electric welds.

The extent to which use of new materials and the new designs they make possible can change building architecture is emphasized in the new laboratory building by the elimination of sharp corners which give way to graceful arcs. Horizontal bands of cream-colored porcelain-enameled sheet iron sweep uninterruptedly across 600 linear feet of front and side walls, accentuated by bright strip-moldings of stainless steel. Black porcelain-enameled pilasters separate the lighting bays, which are filled in with opaque glass block, into which are set steel frames to hold the window areas of clear glass.

The interior walls also are of sheet steel, highly finished in imitation wood patterns. The building is wrapped in a three-inch blanket of insulating material, spread between the interior and exterior wall sections.

A daylight interior is achieved with a roof of special saw-tooth design faced with glass block. The acoustically-treated roof deck is made of galvanized sheet steel, rock, cork, and asphalt. A combination system provides heat in winter and complete air-conditioning in summer. Because of the compactness of the welded joints and the efficiency of insulation, it is anticipated that great economies in heating and cooling will be realized. There are approximately 100 laboratories, offices, conference and reception rooms, with ample storage and receiving space.

Engineers say the building is as near 100 percent fireproof as it is possible to be. It was erected by the Austin Company of Cleveland. Harold Goetz of Middletown, Ohio, was associate architect.



Research dictated the design of this modern research building

### PLATES

**THERE is an increasing tendency to jumble numbers and letters together on automobile license plates. It is well-known, however, that the most legible grouping of six-digit license plate numbers would be by twos and threes without an additional letter or two to confuse.**

## "Natural" Portrait Photography

FINER lenses and faster films long ago eliminated the head rack which was used by old-time photographers to hold the "patient's" head while his portrait was being made. Nevertheless, most portraits still have a stiffness, a lack of life-like quality because posing is still the fashion in most photographers' studios. Such is not the case when Polyfoto equipment, which comprises the adaptation of the candid camera to portrait work of a different kind, is used in the studio.

Polyfoto is a candid camera on wheels. Employing all the features of fine lens equipment, automatic shifting of negative surface, range-finder focusing and precision

A few of the 48 exposures made in sequence with new Polyfoto camera

manufacture, it is a specialized patented device for making natural portraits of people and pets. Mounted on a movable base with rubber-tired wheels, it is operated within a studio in conjunction with standard lighting equipment and makes 48 different exposures of the subject on one small negative plate. These tiny negatives are "blown up" in precision enlarging cameras and the finished portraits of any desired sizes up to three feet square are delivered to the purchaser.

Its advantages over conventional methods are numerous, but the outstanding one is naturalness of pose. Polyfoto operates so rapidly and so many exposures are made that no sitter is ever asked to hold a pose. She is put at ease by the photographer, he converses with her, she falls naturally into relaxed positions, her expression becomes interested, animated, mobile. As these fleeting expressions come and go he flips a handle; each exposure is made instantaneously and the negative is moved automatically to the next taking position. Exposures can be made as rapidly as two per second or as slowly as the photographer chooses. Every one is under his control. Consequently, out of the 48 separate poses at least one favorable picture is certain to be found. Usually there are several.

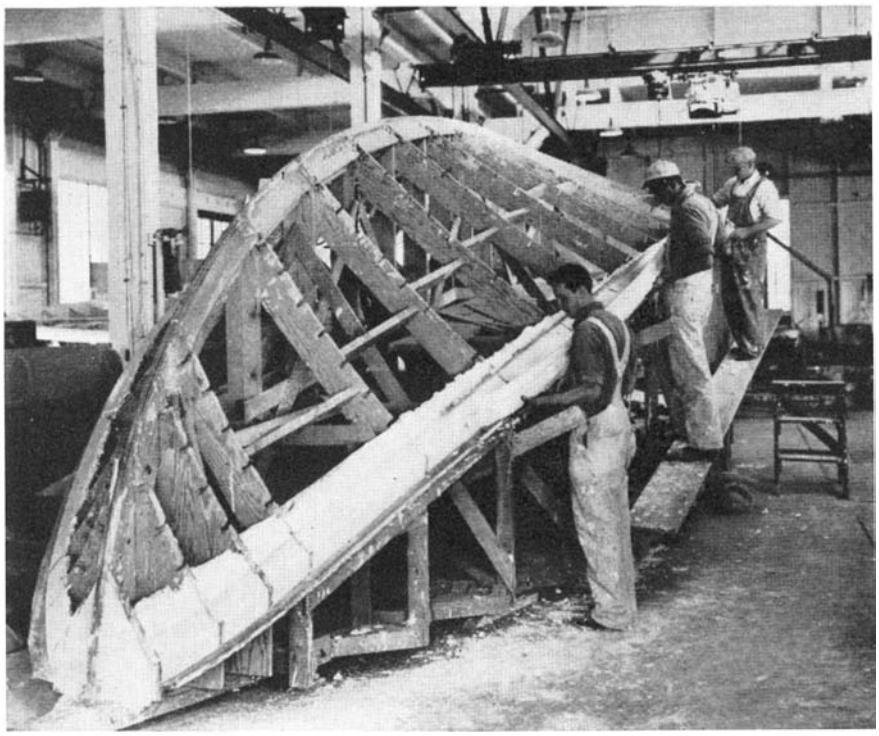
These 48 poses are enlarged on a single sheet, for the purpose of guiding selections for enlargements.

## Milk in Foundry Cores

A NEW binder for the sand used in making cores for foundry castings is made from the solids of milk of a non-edible grade. This binder holds the sand together until the metal has solidified but burns off, leaving the sand clean for re-use.—*D. H. K.*

## Highway Killers

IN a report delivered before the Society of Automotive Engineers, Mr. Charles A. Hartnett, New York State Commissioner of Motor Vehicles, expressed the belief that "Speed too fast for conditions is the highway's hungriest killer," according to the Associated Press. He included tabulations



*Above:* **Plaster of Paris cast being made of clipper-ship hull. From this cast will be made dies for drop-hammer work.** *Right:* **Mock-up of pilot's compartment for studying controls and location of instruments**

of the opinions expressed by 42 members of the American Association of Motor Vehicle Administrators based upon their personal experience and observations. Of these administrators—

Thirty-four believe present brake performance to be satisfactory.

Thirty-three said headlights were unsatisfactory; 20 favored the three-beam position—city driving, passing, open country.

Twenty-seven advocated high mounting of the tail light.

Sixteen favored the blinking type of stop light; 22, the steady dual stop light.

None believed cars had insufficient speed.

Twenty-three opposed use of speed governors; 12 favored them.

Twenty-nine opposed elimination of running boards.

Thirty-four favored recessing the choke, throttle, light switches and ash receivers; 37, recessing the robe rail hardware.

Nineteen considered the driver's seat too low for adequate visibility; 17 thought it was not; 26 believed the hood too high.

Forty-one expressed the view that dual windshield wipers and some form of defrosting device should be standard equipment.

Fourteen felt a radio was distracting to the driver; 21 disagreed.

Mr. Hartnett said he believed a three-color speedometer face—green for up to 30 miles an hour, amber from 31 to 50, and red above 50—"would have a psychological effect on the driver."

## Mock-Ups

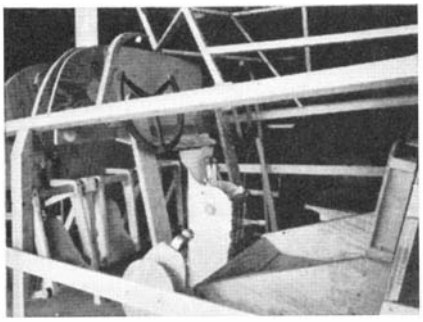
THE most careful engineering has gone into the construction of the huge Boeing Clipper flying boat, and "mock-ups" or dummies of various parts of the seaplanes were built in most elaborate fashion. Made of Douglas fir plywood covered with muslin, these "mock-ups" were to full scale and in complete detail and serve the most useful purposes. For example, simulation of the pilot's cockpit enables the designers to test out the working of the controls, the convenience of the instrument board, and so on. A plaster of Paris cast of the hull shown in one of the photographs was used in the process of making zinc dies for drop-hammer work. The drop hammer and huge hydraulic presses are now freely used in aircraft production and have completely displaced the bumping out of metal sheets by hand.—*A. K.*

## Mapping from the Stratosphere

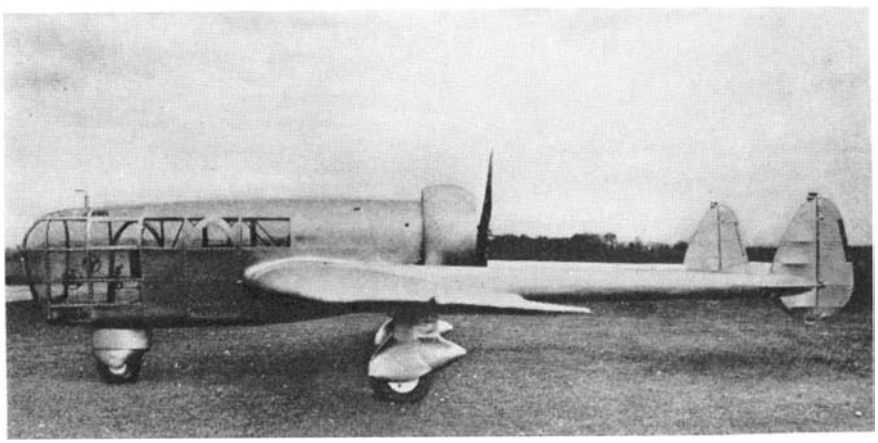
AERIAL mapping had its birth in the World War, when it was introduced as an aid to military reconnaissance. Now it has become an aid to innumerable peace-time activities. Government agencies utilize aerial mapping in studies of flood control, soil erosion, crop planning, navigational improvements, water power developments, highway location, city planning, and other important projects. Private industry makes use of the art, sometimes termed aerial photogrammetry, in the development of coal and oil fields, in timber surveys, real estate planning, water and power distribution. Aerial mapping formerly was undertaken at relatively small heights; today it is venturing almost into the stratosphere, for two reasons—the greater the height, the greater the area of terrain which may be photographed in a given time; second, the greater the height the smoother the air and the steadier the aircraft, which is, of course, a real help in accurate work.

To keep pace with the growth of the art, and the improvement in technique and camera equipment, a special photographic airplane has been designed, built, and successfully test-flown by the Abrams Air Craft Corporation. The new plane, termed the "Explorer," is illustrated in one of our photographs. It differs in appearance from more conventional airplanes, because it has been designed on a strictly functional basis—although no sacrifices in efficiency have been made.

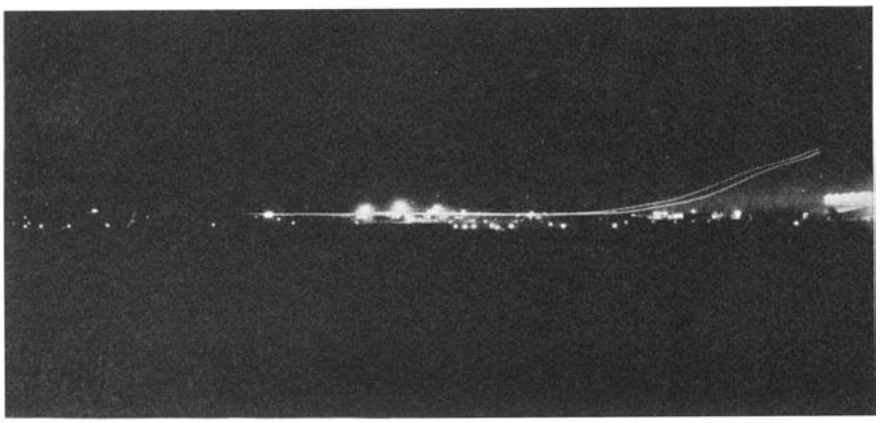
One of the foremost requirements of the mapping plane was to give the pilot perfect visibility forward and downward for precise location flying. This objective was achieved by making the airplane a "pusher"



and seating pilot and camera-man in a glass-enclosed gondola projecting far ahead of the wings. The next requirement of very rapid climb was achieved by loading the wings rather lightly and supercharging the engine. Since the camera-man may have a long job to do, and accuracy is greatest when photographs are taken in a single flight, the flying endurance has been made large and the "Explorer" is capable of eight hours flying at cruising speed. So that the crew can be perfectly at ease at great altitudes for a long period of time, the glass-enclosed gondola has been hermetically sealed, and special oxygen equipment has been provided. Again, so that pilot and camera-man may relieve each other, dual controls and instruments in full



**High-altitude aerial mapping gave birth to this novel plane design**



**The camera registers the landing curve of a transport plane**

view of both men are a feature of the installation.

An additional photographic feature is what the constructors have called a "door within a door." This allows the cameraman to sit in his regular seat and, without opening the main outer door, to take pictures at oblique and forward angles. A mapping porthole with a special camera mount is provided in the floor of the gondola, and the aperture is hermetically sealed when the camera is in place. The interior has been made compact to minimize the oxygen supply requirements.

Our readers can judge for themselves of the streamlining and general neatness of the craft. The pusher arrangement necessitates the carrying of the tail surfaces on two booms. The new type nose-wheel landing gear which prevents nosing over and facilitates side wind or drift landings has been very logically incorporated in the design. The gross weight of the ship, fully loaded and equipped, is only 3200 pounds. With a Wright R 975-E engine, developing 350 horsepower at 2100 revolutions per minute, and appropriate supercharging, the speed at 10,000 feet is 200 miles an hour. The service ceiling is 21,000 feet, and the initial climb is extremely rapid—1800 feet per minute. —*A. K.*

## Photograph of a Night Landing

WE believe that the accompanying photograph of the landing of a United Airliner at night is the first of its kind. The "candid" camera is registering a landing at the Chicago Municipal Airport after a nonstop run from New York. The twin white lines cast by the two landing lights on the wings of the plane clearly define the path followed by the pilot, and show how the glide is converted into more or less horizontal travel a few feet above the ground. —*A. K.*

## World's Largest Naval Patrol Bomber

THE experimental bombing plane, *XPBS-1,* developed and built by Sikorsky Aircraft for the Navy Department, is remarkable in many respects, and is a valuable addition to national defense.

It has enormous range, high speed, and the ability to function as an independent unit. Further, it will have a bomb load comparable with that of any known land plane. Armament will consist of bow, rear, and center gun turrets.

Among noteworthy features in design are a gross weight five or six tons greater than in any commercial Sikorsky flying boats, and the elimination of bracing structure to give a full cantilever high-wing monoplane. The design and construction of the huge patrol boat required two years and hundreds of thousands of man hours in the engineering office, the drafting room, and the shop. The "mock-up," a model in wood and fabric of the finished article, took six months' work in itself. The four twin-row Wasp engines, incidentally, are of 1050 horsepower each. There is no attempt to make the *XPBS-1* an amphibian, but a beaching gear, as shown in the photograph, is carried on board to facilitate beaching, docking, or ramping.

What is perhaps most striking in the new machine, however, is the further development of facilities which make the flying boat as comfortable to live in and as completely equipped as a naval surface vessel. Thus, a complete radio compartment is installed, comparable with that provided in a destroyer. The crew's quarters include comfortable living accommodations, a mechanic's workshop, galley with electric stove, a water distiller, and a dry-ice refrigerator. Hitherto the electrical equipment on aircraft has been actuated by 12-volt batteries, or by a generator driven from the main engines. The Sikorsky provides an innovation which may be of the utmost practical importance; namely, the installation of a complete 110-volt electrical system, driven by an auxiliary gasoline engine and supplying power for all the electrical units such as flap actuators, anchor winch, radio, lighting, heating, bomb controls, galley, and so on. There are obvious advantages in lighter weight and greater reliability when a 110-volt generator is substituted for a 12-volt battery. Also, the electrical system, since it has an auxiliary engine as the prime mover, can continue to function even when the main power plant is out of commission. Another useful feature, recalling surface vessel practice, is the complete telephone system which makes communication possible from any point of the airplane from the extreme tail to the bow, with thousands of feet of electrical wiring carried in light conduits and through junction boxes.—*A. K.*

## Inventions in Aircraft Radio

WRITING in *Aero Digest,* Henry W. Roberts makes some valuable suggestions for inventors and engineers interested in the field of aircraft radio. He describes what he calls "Inevitable Inventions" and argues that such inventions are logical in conception and feasible in execution, with the knowledge already available. These suggested inventions are:

*An absolute altimeter* using radio waves transmitted from the aircraft and reflected by the ground. Ultra-high-frequency short waves would be employed and automatic continuous indications of absolute altitude would be given by use of a cathode-ray tube arrangement. Such a short-wave apparatus would be immune from the vagaries of the atmosphere which vitiate the readings of the barometric type altimeter. There are many technical difficulties involved, but no impossibility in principle.

*A radio-controlled Gyropilot for commercial use.* Successful radio-controlled flights for military purposes have been made in half-a-dozen countries, and dozens of radio-controlled boats have been constructed by radio amateurs. It is theoretically possible to navigate an airplane by radio, from take-off to landing, by any of the three methods of radio navigation—radio range beacons, airplane direction finders, or ground-direction finders—and to bring the ship to its destination without collision with ground obstructions or other aircraft. At present the density of aircraft traffic does not warrant such complicated mechanization, but who knows what will be needed as air traffic steadily increases?

*A radio drift indicator* might be improvised by combining the readings of an aircraft radio direction finder, capable of bearing indication in degrees, with the readings of the directional gyro. Rudder correction

**Not an amphibian, the XPBS-1 carries a beaching gear on board**

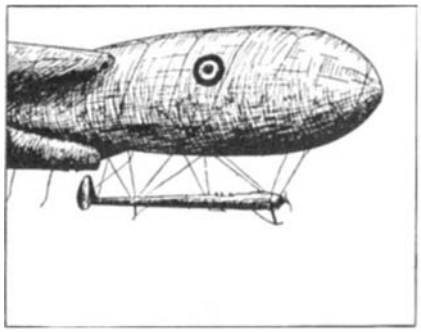
would be applied until there was no divergence between the two.

Mr. Roberts also outlines new types of radio marker beacons with which experiments are already being made, and suggests the revival of electromagnetic guide cables when flying over particularly difficult terrain.

In spite of the manifold advances already achieved in aircraft radio, a fruitful field of invention still remains.—*A. K.*

## Motorized Observation Balloons

CAPTIVE balloons have played useful wartime rôles in observation, in the guidance of artillery fire, and in many other ways. They have often been shot down, and have suffered extensively from their lack of mobility. Hence, military opinions both in the United States and in European countries have veered to favor motorized observation balloons; it is an open secret that



**Kite balloon with motorized fuselage**

motorized balloons have been built for our own Army Air Corps, although pictures of them are not available. Hence the accompanying sketch of a motorized observation balloon exhibited at the "Air Infantry" show at Villacoublay, France, is of considerable interest.

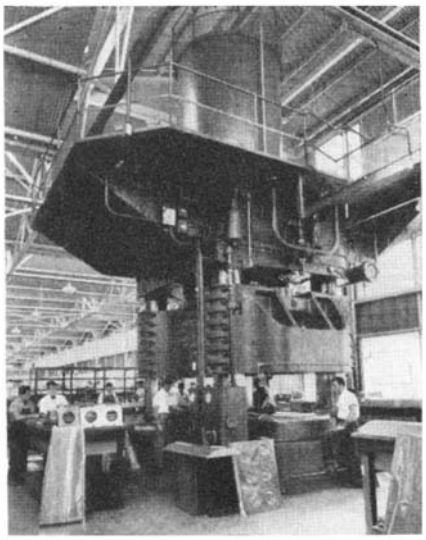
It will be noted that the balloon itself is rather longer and more streamlined than is customary with stationary or kite balloons. Inflated lobes are still provided at the rear for stability, but instead of a simple observation basket, there is a suspended airplane type fuselage, with engine and propeller disposed in the conventional manner. No landing gear is provided—there is nothing but a peculiar form of landing skid. Since the motorized balloon can rise vertically or land vertically, wheels are not necessary. In fact, the motorized balloon comes very close to the combination airplane-airship which inventors advocate so frequently. It is doubtful whether there is anything to be gained by such a combination, however—except in the special fields of artillery observation, or possibly in forestry patrol and photographic work.—*A. K.*

## Largest Hydraulic Press

AIRCRAFT manufacturers find it more difficult than automobile manufacturers to keep down unit production costs because they do not build large quantities of airplanes of the same type in one year. But with the boldness of pioneers they do not hesitate to invest in the most advanced and most expensive production machinery. Thus, Douglas has purchased from the Hydraulic Press Manufacturing Company the world's

largest hydraulic press—it required nine 12-wheel flat cars to transport this giant piece of machinery from Ohio to California. The press stands four stories high, and weighs 840,000 pounds, with individual parts correspondingly heavy.

A battery of centrifugal oil pumps, variable and reversible in delivery, are driven by two 150-horsepower electric motors. These pumps deliver oil under 2500 pounds



**Aluminum alloy parts for airplanes are formed in this hydraulic press**

per square inch pressure to the six-foot ram, and a total pressing force of 10,000,000 pounds is the result. Hydraulic pressure is directly applied to the press rams without intervening valves. Thus there is obtained speed, delicacy of control, and complete reversibility. The maximum opening between platen and bed is four feet.

With this press it is possible at the same time to shape, form, and punch several unrelated aircraft parts at a single pressing. Three thousand different parts, all of aluminum alloy, will be pressed with this new equipment. Because of the methods employed, tool costs have been greatly reduced as compared with conventional tool methods.—*A. K.*

## Fighting Deafness in the Air

We are indebted to Roger Humphreys for a first-hand account of a device of his own invention which will counteract temporary deafness induced by the impact of reproduced crashes of radio static when in flight. Mr. Humphreys, a pilot himself, has found that violent static has affected his hearing frequently, although temporarily. The original experiments were inspired by the fact that there are available, in commercial form, bone-conduction hearing devices. Ordinarily sound waves enter the outer ear, strike the ear drum, and are carried by a hammer-like device through the middle ear to the inner ear where the nerve centers pick up the message and transmit it to the brain. The new device short circuits the ear altogether. Sensitive, electrically charged diaphragms are attached on both sides of the head over the mastoid bone behind the ear. The two diaphragms are held in place by a light steel head piece. They may be applied with equal success but less conven-

ience on the cheek bones. Since no restrictions on electric power or appearance have to be studied, the flight "Sonotone" has been designed for great sound volume.

Flight tests have proved entirely satisfactory. Mr. Humphreys sets down a four-fold objective: 1, to provide means of hearing signals in severe static conditions; 2, to eliminate the probability of congestion of the middle ear with the attendant loss of hearing during rapid descents; 3, to prolong the usefulness of a pilot who is growing deaf through constant noise punishment; 4, to aid pilots in their old age by actually preventing deafness. No one can question the desirability of these objectives.—*A. K.*

**FUSES**

**ONE utility company spends a quarter of a million dollars yearly replacing residential fuses.**

## NAVAL CONSTRUCTION

ALTHOUGH this is being written days later than the editorial on Naval Construction on page 137 of this issue, there still is no definite word as to what will be the extent of future construction. That we are committed to a definite increase over and above the plans of a few months ago is quite certain. This increase may reach as high as 20 percent although until the President, Navy officials, and Congress work out the details, one guess is as good as another. In view, however, of this increased activity it is well to review the status of naval building in this country as of December 1, 1937, the last available complete figures.

Of the two battleships which are to be completed in 1941, the *North Carolina* was laid down at the New York Navy Yard last October, while the second one, the *Washington*, is to be laid down at a later date at the Philadelphia Navy Yard.

The only aircraft carriers on the present schedule are the *Enterprise* and the *Wasp*. The hull of the former ship was 96 percent complete and the machinery 93 percent complete on December 1, and it should be commissioned this coming May. The *Wasp*, hull and machinery, was something under 50 percent complete and it should be finished in November of this year.

One heavy cruiser, the *Wichita*, was almost three-fourths complete and should be ready for commissioning by February, 1939.

Of the eight light cruisers which were on the ways one was finished in January, another was scheduled for completion in February, four others will be completed later this year, and the last two will be commissioned in 1939.

Sixteen submarines were scheduled on December 1, but of these the keel had not been laid for four although some work had already been done on their hulls and machinery. One of these four is scheduled for completion in 1939, and the other three in 1940. Of the remaining twelve, all in the process of construction, six will be completed in 1938 and six in 1939.

Until recently our Navy was sadly in need of destroyer flotilla leaders. Four 1850-ton destroyers are scheduled for completion this year, one as early as February.

Smaller destroyers of 1500 tons now scheduled total 32. Seventeen of these have not

yet been laid down but considerable work on the hulls and machinery has been done on nine of these and the entire seventeen are scheduled for completion in 1939. Four of the remaining fifteen now on the ways will be completed in 1938 while the final eleven, on some of which the work is rather far advanced, will be completed in 1939.

During the late fall of 1937 the light cruiser *Philadelphia* and the destroyers *Somers, Helm, Ralph Talbot,* and *Jarvis* were commissioned and delivered.

## Water Resistance of Paints

OILS used in paint vehicles are useful because they exclude air and moisture from the protected surface. Recent investigations have shown that both the kind of oil used and the drier compounded with it affect the rate of penetration of the film by moisture. Linseed-oil films are more resistant to moisture when they contain cobalt driers than when lead compounds are used. The reverse is true of tung and oiticica oils which lead driers make more resistant to moisture than do cobalt compounds. The explanation of this effect is probably in the relative importance of polymerization and oxidation in the drying of these two different classes of oils. Linseed oil dries largely by oxidation, which is promoted by cobalt, and tung oil depends principally on polymerization, promoted by lead, to form its films.—*D. H. K.*

**BERIBERI**

**YEAST, bacteria, mushrooms, peas, tomatoes, beetles, birds, goats, monkeys, rabbits, rats, mice, and men have all been shown experimentally to need the beriberi vitamin, vitamin $B_1$.**

## Safe Tool Steel

ANYONE who has occasion to do any hammer drilling or hand chisel cutting will realize how impossible it is ordinarily to keep the head of the drill from spalling or mushrooming under constant impact of the striking hammer. From the mushroomed head splinters of metal often fly into the eyes of the operator or cause jagged cuts. An appalling number of accidents are chargeable to such flying fragments of steel which strike vulnerable parts of the body. Another unsatisfactory characteristic of ordinary tool steel is the ease with which it may be burned under a tempering treatment. Nowadays it is difficult to find a workman who knows the art of tempering properly.

For the express purpose of putting an end to the dangers pointed out above and at the same time provide a steel that eliminates guess-work and simplifies tool making and tempering, research has finally developed a product revealing unique qualities. This new steel is Malga, an electric furnace tool steel. Because of its low carbon content and inclusion of molybdenum, tungsten, silicon, and manganese, Malga non-tempering steel forges easily within a broad range of high temperatures and is hardened simply by reheating to a salmon color and quenching

**Carving salt brick ornaments offers possibilities as a home hobby**

## SALT SCULPTURE—ANOTHER HOBBY

A NEW hobby, carving in salt, has been added to the growing number of home hobbies. Sculpture in soap has cut a wide figure during the past few years, and now comes salt—compressed salt bricks of uniform texture. Incidentally, salt is even less expensive than soap.

L. R. GrosJean, of Watkins Glen, N. Y., hit on the hobby, no doubt because of two coinciding reasons: he uses tools in mechanical hobbies of other kinds and he has a very "considerable" amount of salt within arm's reach, since he is Manager of the large Watkins Glen plant of the International Salt Company, Inc.

What Mr. GrosJean uses in his carving is not natural rock salt but artificial rock salt made by submitting ordinary table salt to a pressure of 1000 tons, thus making bricks of it. Such bricks are not made especially for carving, but are the common product sold to ranchers and farmers for stock feeding.

The photograph shows how the carving is done—by means of a small rotary abrasive wheel driven by a high-speed electric motor, in this instance the Handee Tool. However, the salt may also be carved with ease by means of a jack-knife or other common tool.

Because the calcium chloride in the salt has been eliminated, the bricks are not hygroscopic and will not draw moisture from the air and become sticky.

in water. No tempering is required after hardening; hence the most inexperienced mechanic can easily obtain perfect results. Malga is said also to maintain a keen cutting edge so that it bites into extremely hard materials without turning. It does not have a tendency to batter or chip; the danger of flying splinters due to mushrooming is eliminated.

### TELESCOPE

**IF the earth were flat, a 200-inch glass telescope reflector would permit a man in San Francisco to read a sign in New York as clearly as the New Yorker reads it from across the street.**

Inlays may also be made. This is done by filling in the incised depressions or carvings with du Pont's or LePage's transparent cement having the consistency of putty, and then allowing this to set and smoothing off the surface with sandpaper. Or these may be filled in with cement made of loose salt, transparent cement, and dye of any desired color.

In the photograph, at the center of the left-hand group of carved objects, is a unique object, a salt saltcellar, no doubt the first made by anyone.

## LOW TEMPERATURES MAGNETICALLY

TEMPERATURES close to absolute zero, a point 459 degrees below zero, Fahrenheit, and the theoretical low limit of cold, will be obtained by means of a powerful electromagnet described by Dr. Francis Bitter of the Westinghouse Electric and Manufacturing Company.

The magnet will be used to restrain the motions of atoms magnetically, Dr. Bitter explained. This will produce cold close to the absolute zero limit because of the fact that heat is nothing more than motion by the molecules. At absolute zero molecules and atoms have practically stopped vibrating. Magnetic restraint of the atoms can thus be used to achieve extremely low temperatures more easily than by liquefaction of helium.

## SYNTHETIC MAGGOTS

SUCCESSFUL use of maggots in healing wounds has led to the synthesis of the compound produced by the larvae responsible for their effectiveness. Known as Allantoin, this synthetic glyoxyl diureide is compounded into a variety of preparations convenient for use in healing wounds of various kinds and in various parts of the body. The effect of this material is to cause granulation of the tissue.—*D. H. K.*

## SUPER SPECIAL ON WHEELS

THERE are at least 57 varieties of unusual innovations in the remarkable new super-automobile that has just been designed and built by Rust Heinz, young scion of the Pittsburgh House of Heinz. Although

**WAGES**

**MORE than half the motorists in the United States earn less than $30 a week.**

only 23 years old, he has evolved one of the most striking motor-cars ever conceived, which he calls the "Phantom Corsair." It is distinguished by its unusual provisions for safety and comfort at high speeds.

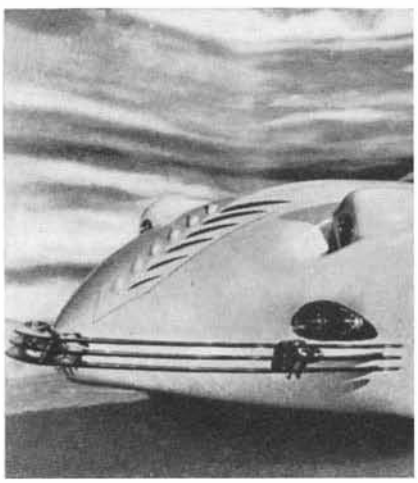
Four passengers ride abreast in the front seat and two more in the interior rumble seat. The interior is lined throughout with slab rubber in all places where injury might occur to occupants in an accident.

The car is built with front-wheel drive, electric gear shift, four forward speeds, and develops a speed of 122 miles per hour with a small engine. The wheels are independently sprung and mounted on General-made, multi-vaned, Dual-10 tires, whose squeegee action under braking conditions provides maximum traction. The hydraulic double-action set-type shock absorbers are adjustable at the dash and thermostatically-controlled air conditioning provides either heat or cold.

The "Phantom Corsair" has neither fenders nor running boards. The seats are molded of cast rubber, without springs, and the ceiling and interior side-walls are lined with cork composition three-quarters of an inch thick. There is a layer of sponge rubber under all upholstery, while the steel crash-board has a two-inch thick rubber covering; everything is sound-proofed and shock-proofed.

All of the glass is bullet-proof for safety, is tinted green to prevent glare, and is slanted inward toward the top to eliminate reflections. The hidden all-wave radio has two speakers and the roof doors open simultaneously and automatically with the regular doors.

Young Heinz, educated at Andover and Yale, followed naval architecture in New York until he designed and developed the "Phantom Corsair" on the West Coast. Preliminary models were studied in a wind-tunnel of his own design. He is now busy in Pasadena on several other unusual cars that he has been commissioned to build.



*Below:* **Ultra-modern in design and conception is the "Phantom Corsair."** *Above:* **A close-up of the front end, showing the louvres and headlights**

## A New Insecticide

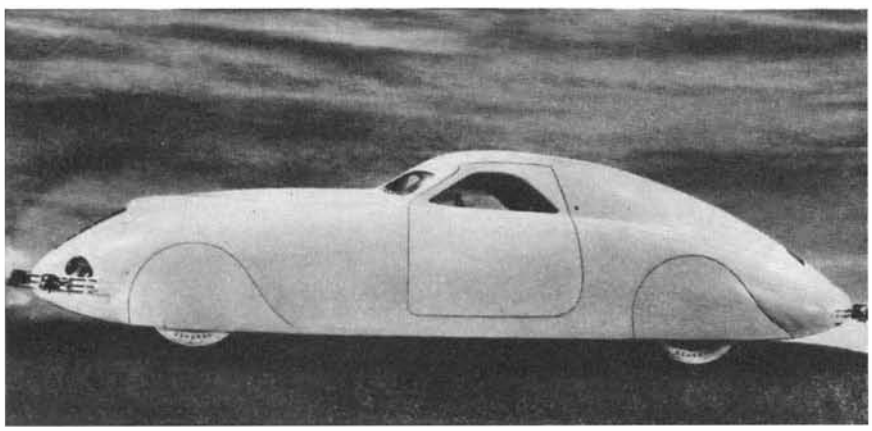
IN the effort to find insecticides which leave no poisonous residue on the crops they protect, many new chemical compounds have been studied. One of the most recent of these is nicotine thiocyanate. This compound, prepared from the nicotine by-product of the tobacco industry by reaction with ammonium thiocyanate, is definitely more stable in use than other nicotine compounds. Tests with red spiders and with aphids have shown it to be effective particularly if a wetting agent is included in the spray. One of its important advantages is that it does not affect foliage nor does it leave a toxic residue.—*D. H. K.*

## Electricity and Human Welfare

THOSE engaged in the electric utility business have long felt that electricity has been the greatest single factor in promoting prosperity in this country in recent decades. Figures recently released by the National Industrial Conference Board portray this relationship in a striking way.

They show that for the three decades ending with 1929, the industrial production of the nation increased 210 percent. During this same period, the power used in industry increased 331 percent. What this much greater use of power has meant to the people of the country is indicated by the figures showing that while during this 30-year period the level of wholesale prices gained 80 percent, the hourly earnings of industrial workers increased by 260 percent, and their real wages, measured by what their wages buy, increased 100 percent.

Some further figures recently published by the Conference Board show how effective the utilities have been in recent years in pro-



ducing economies. Since the low point of the depression in 1933 and up to June, 1937, the cost of living has advanced 18.7 percent. In this total, the item of food has increased 30.1 percent and housing is higher by 35.7 percent. In contrast, the cost of fuel and light has actually decreased 1.8 percent.

Departing now from the Conference Board figures and using those of the Edison Electric Institute, we find that the average rate per kilowatt hour for residence electricity has gone down over 18 percent during the same four-year period, and that this impressive showing has been made in spite of the fact that the proportion of gross earnings paid out in taxes by the electric utilities has risen 16 percent.—CHARLES W. KELLOGG, in Stone & Webster *Bulletin*.

## HEART AFFLICTION SEEN AS CAUSE OF ONE KIND OF INSANITY

THE old time novelists frequently saw a broken heart as a cause for insanity. Today a modern scientist traces one form of insanity to a physical heart affliction, *Science Service* reports.

Investigations which seem to link the widespread mental disease known as dementia precox with rheumatic heart disease were recently described before the American Association for the Advancement of Science by Dr. Walter L. Bruetsch of the Indiana University School of Medicine and the Central State Hospital at Indianapolis. The hearts and brains of eight out of every 100 dementia precox victims that Dr. Bruetsch was able to examine after death showed signs of a chronic rheumatic infection, he reported.

The findings suggest, Dr. Bruetsch said, that the large group of mental disorders which today go by the name of dementia precox will in future turn out to be a number of different diseases with different causes.

Dr. Bruetsch's findings also suggest that the old time novelist who ascribed mental disease to emotional upsets was pretty far off in his diagnosis. Even modern psychiatrists who hold that mental disease is always the result of emotional or environmental stress are wrong, in Dr. Bruetsch's opinion. Changes in the brain tissue, such as the rheumatic condition he found, he indicated, may be responsible for mental disease, rather than disturbances in the mental activity of the brain.

## ELIMINATING BOVINE "MILK-ITOSIS"

THE bovine female is a ruminant without ability to ruminate (in the mental sense). Cow carelessness is nowhere so much in evidence as in the complete disregard for consequences with which the animal packs away her food. In the spring a cow's fancy lightly turns to garlic, to wild onions. If she had happiness in her soul, as Yale's famed William Lyon Phelps contends, the cow must surely have considered the irrelevance of dining on garlic. If she had the public's welfare at heart, she'd think twice, if she could, about loading her milk with the objectionable odor of onions, odoriferous weeds, and similar tasty, if foul-smelling morsels, all of which transfer their odors to the milk.

In the past, boiling, steaming, or blowing air through the milk have been used to remove part of the odor and taste of onions and garlic. These methods, however, generally make the milk less suitable for sale than a newer method which removes all odor and taste of onions and garlic.

The answer to the dairyman's problem was uncovered by the Agricultural Experiment Station of the University of Tennessee at Knoxville. This agency worked on the problem of treating the milk so the fat in it would give up its odors. Technicians at the Station found that petroleum white oils act as odor removers when applied to milk.

The Station experimented with a number of oils and found that best results are obtained when 10 percent white oil is added to 90 percent milk and agitated rapidly in a milk can, bucket, tank, or other suitable vessel. Less than two minutes' stirring is ample. Beating or too severe agitation must be avoided as this may cause air bubbles to form and interfere with separation of oil from the milk. After the oil has been broken up into minute particles and dispersed throughout the milk, the mixture is permitted to stand undisturbed until the oil and milk separate. The oil rises to the top, carrying with it the minute particles of fat which contain the offensive odor and taste, and is then siphoned off. A comparatively small amount of butter fat is lost in this way. A faucet at the top of the container may be used to draw off the oil or one at the bottom to draw off the milk. One treatment is usually sufficient, though sometimes two may be necessary to remove all odor and taste. Exceptional cases have occurred where milk had to be treated three times.

An alternate method suggested by the Experiment Station for removal of the oil calls for the use of a creamery-type strainer with a pad of absorbent cotton or several thicknesses of cheese-cloth on the surface. When the cloth is wet with milk or water, only milk will pass through, leaving the oil in the strainer. The cloth may be removed and the oil squeezed or washed from it.

To reclaim the white oil, a soda solution is suggested which removes the odor-bearing materials absorbed by the oil. This process is followed by a series of washings in water and steaming to free the oil of other foreign matter. The oil is then sterilized and may be used over again.—*Esso Oilways*.

### FIRE FIGHTER

**METHYL bromide, which has the advantage of a much lower boiling point, is a far more efficient fire extinguishant than the widely used carbon tetrachloride.**

## DULL VARNISHES AND ENAMELS

DIATOMACEOUS earth, composed of nearly pure silica, the remains of microscopic animals, is now used after special treatment to produce a dull finish in paints and varnishes. The minute particles of silica produce a microscopic roughening of the surface which gives it a smooth, velvety finish. The advantage of the new

flatting agent is that it does not reduce the life of the film as do waxes and other flatting agents previously used. The surface can be washed and cleaned in the regular way without harming the surface or destroying its finish.—*D. H. K.*

### A CAR IS BUILT

**CONSIDERING the time for mining coal, growing cotton, tapping rubber trees, shipping various products to and fro, and the fact that there are in the modern automobile something like 35,000 individual parts, an executive of the Chrysler Corporation says that it is ridiculous to speak of one car being built every few hours or few days. The man-hours would be impossible to calculate with any degree of accuracy but would run to a sizeable figure.**

## Electric Furnace Elements

IN a brief article in our January issue regarding a new electric furnace element, the statement was made that "the elements now in use in electric furnaces cannot reach higher temperatures than about 2400 degrees, Fahrenheit. . . ." This statement should have been modified as we later learned from Mr. W. S. Evans, of the Globar Division of the Carborundum Company. He writes us, in part, as follows:

"The Globar electric heating element, which has been manufactured since 1923, can attain temperatures up to 3000 degrees, Fahrenheit, and in some special elements a higher temperature. We have many furnaces which operate at a great deal higher furnace temperature than 2400 degrees, Fahrenheit."

## Half of Average American Families Eat Third-Rate Diet

MANY an American family that would not buy second-hand furniture or wear second-hand clothes is eating a third-rate diet. This is apparent from a survey of typical food expenditures made by Dr. Hazel K. Stiebeling of the United States Bureau of Home Economics which the Bureau has published at Washington.

Size of the family pocketbook was not the only or perhaps even the chief factor responsible for the poor nutritional quality of the family's diet. At every expenditure level above 100 dollars per person per year, some families were able to provide themselves with very good diets. The reason more families do not get good diets is chiefly because they do not know how to select the most nourishing foods for the money.

As might be expected, the tables of the well-to-do families were more frequently and more liberally supplied with milk, butter, eggs, fruits, and green and leafy vegetables. These are classed by nutritionists as the "protective foods" because they protect against such serious ills as rickets, beriberi, and scurvy, and also against numerous minor degrees of ill health and undernutrition. Families spending less than 85 dollars per year per person for food, as might also be expected, obtained very poor diets.

At the median expenditure level, however, which is 130 dollars per person per year, almost one half were eating a third-rate diet and nearly another fifth a very poor diet. At this expenditure level a little over one fifth of the families had a first-rate diet.

Three fourths of the families were at the 100 dollars or more expenditure level but less than one third of them were selecting good diets.—*Science Service.*

## Increasing Friction

WITH the efforts of engineers directed toward reducing friction in machines, a compound for increasing friction is especially interesting. This material is applied to rugs to prevent them from slipping on polished floors. It is a synthetic powder which has a high coefficient of friction yet which will not scratch or mar the floor or damage the rug. Rugs treated with it are easy to pull about but will not move when weight is applied. The powder can be readily removed with a vacuum cleaner when desired, leaving the rug uninjured. The name under which the material is sold is Rug Root.—*D. H. K.*

## Meters

WIRE but three thousandths of an inch in diameter, smaller than the hair from one's head, is flattened between powerful polished rollers and made into delicate springs for light or exposure meters such as used by photographers; wire three times as small, so fine the human eye can scarcely see it, is smoothly wound into tiny coils of a definite and exact number of turns for aircraft instruments; instrument pivots are made with points sharper than the most perfect needle. All this is done in the meter and instrument laboratory and workshop of General Electric in its West Lynn plant, as part of the daily routine which turns out 4000 or more meters and small measuring instruments per day.

Meters and other measuring instruments are the yardsticks of the electrical industry. Their most common use is the accurate integration of the flow of electricity into the home, but they also perform many other jobs equally as important. For example, there are now instruments which measure time more accurately than the clock with the long sweeping pendulum, which analyze and measure color far better than the human eye could do, which measure sound, detect and measure vibrations, search out strains in metals, measure illumination and films of oil but one molecule thick, and do dozens of other intricate chores where minute measurements are necessary.

To assure accuracy in the operation of such delicate measuring instruments requires thousands of small jewels, such as are used in balancing the wheels in a watch. These sapphires, some scarcely bigger than the head of a pin, are cut with a cuplike depression in which sharply pointed steel pivots are supported in perfect balance and with the least possible friction. These jewels are so small they must be handled with tweezers; each is inspected for imperfections under strong microscopes.

Making the sharp, pointed instrument pivots is another intricate job. A woman, sitting before a jeweler's lathe, guides a spinning disk of white, translucent stone. Back and forth across the face of the stone she moves the whirling pivot—a tiny bit of special steel, unbelievably hard, mounted in aluminum. She examines the point with a magnifying glass. One more touch of the stone, and the pivot is sharp—sharper than the most perfect needle. It is, in fact, too sharp for a bearing. So, with a tool made from jasper, she rounds the end. The finished point is still sharper than any needle, but the end is rounded and its radius is about half the diameter of a human hair.

An operator, armed with tweezers, lifts each of the springs mentioned above, slips it on a torsion-measuring device, and measures the force it will exert. Unerringly, this device detects differences in spring torque measured, not in inches and ounces, but in much smaller units—millimeters and milligrams. By this classification a spring is chosen that exactly fulfills the engineers' specifications.

Included in this unusual workshop are four small rooms. In two, frost covers the window panes; the temperatures within are 4 and 40 degrees below zero, respectively. The other two rooms are maintained at the torrid temperature of 122 degrees above zero, Fahrenheit, and one of the two is a miniature tropical jungle dripping with moisture, for the humidity within is 100 percent. In each of these rooms a representative collection of meters and instruments proves, by withstanding unnatural conditions, that every instrument is fit to meet the severest tests that ordinary service can offer. These meters and measuring devices must also pass a severe vibration test before they leave the factory, to assure that they will stand up if used in a locomotive cab, on an airplane dashboard, or in some industrial plant where there may be excessive vibration. In other words, these instruments are delicate in the sense that they can measure the smallest quantities, but rugged in the sense that they can withstand almost any condition to which they may be subjected.

## Motor Reversed on Fiat "500"

ONE of the ingenious methods by means of which a large amount of passenger space is secured in the little Fiat "500," which is called a miniature big car, is the fact that the engine is actually turned end-for-end as compared with the usual method of mounting. The radiator is at the rear of the engine and rests just above the bell housing or clutch cover. Not only has a great deal of space been saved in this manner but visibility is increased at the front end of the car because it is possible to slope the hood down over the engine and out of the line of vision of the driver.

Another interesting feature secured in this actual reversal in position of the engine is the fact that the hood can be hinged at the front lower end so that it can be swung down out of the way, forward from the top, exposing the entire engine to view.

This re-arrangement of the design of the interior of the Fiat "500" coupé brings the passengers squarely between the wheels. The passenger seats are almost at the exact center of the wheelbase which is, of course, a factor in easy riding. The drive from the transmission, which is mounted well forward of the dash, is conventional, but since the transmission is out of the way of the passenger compartment there is no hump or tunnel in the floor.

In connection with turning the engine end-for-end, the entire power plant is moved up ahead of the front axle with the rear end of the engine and the radiator being located approximately at the center of the front wheels. This entirely new arrangement of the power plant, as well as of the steering gear, transmission, and other drive units, permits the car to take care of the space needs of two six-footers without any trouble while, at the same time, the compartment behind the front seat affords an unusually great amount of baggage space.

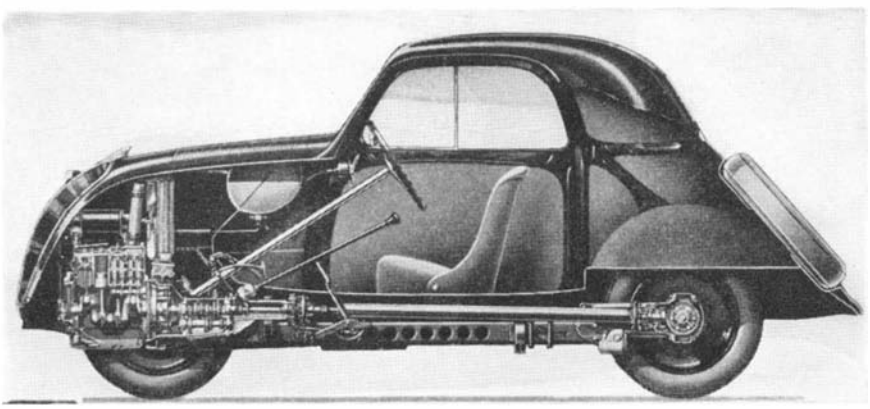
### GENERATORS

**EIGHT of the world's largest generators are located in the power house at Boulder Dam. Each of these huge machines contains between 27 and 28 tons of copper and its alloys.**

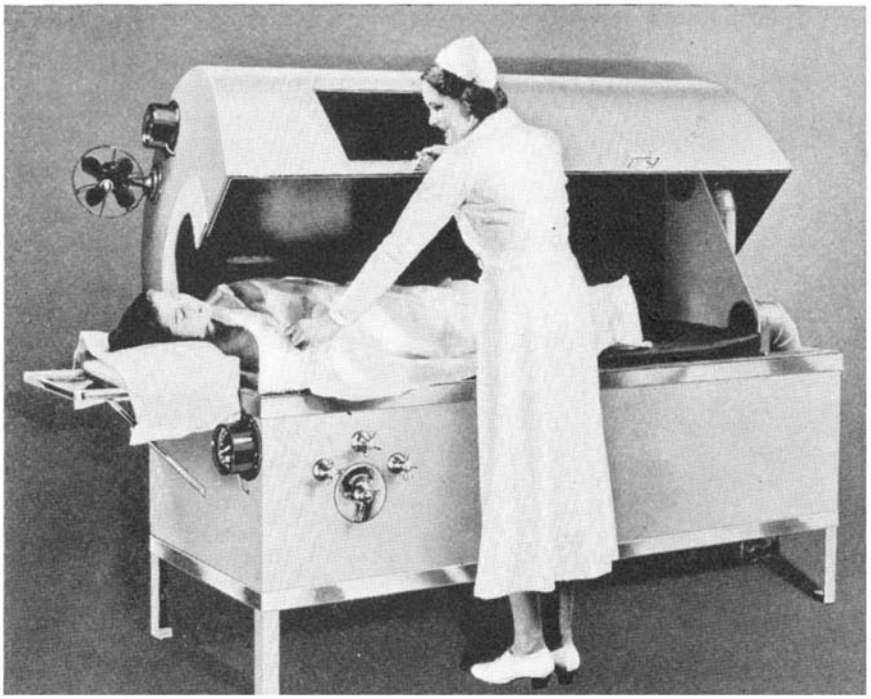
## Three-Year Study of Fever Therapy

THE School of Medicine of the University of Pittsburgh announced recently the appropriation of 50,000 dollars by the Westinghouse Electric & Manufacturing Company to launch and support a three-year program of research in fever therapy.

The Westinghouse contribution was made to aid research which may have widespread beneficial effects on the health of persons



The radiator is at the rear of the engine in the Fiat "500"



**Latest fever therapy equipment for treatment of a variety of ailments**

employed in industry as well as the general public. The company will not participate in the research beyond making the contribution that supports it. By agreement, the results will be made available to all medical authorities for use in improving the public health.

One of the newer fields of medical research, fever therapy has as its objective the artificial duplication of a natural process in the treatment of disease. Developing high body temperatures is one of nature's methods of killing germs. In using fever therapy, physicians induce "artificial fever" in patients as a treatment for a variety of ailments.

The full extent of usefulness of this method is at present unknown. Fever therapy has been used in treating syphilis and other venereal diseases, in the treatment of rheumatism and some forms of arthritis. The research at the University of Pittsburgh will include studies in the use of this method not only in these diseases but also as a possible method of treating a variety of other ailments including the common cold, influenza, rheumatic fever, St. Vitus dance, some forms of heart diseases, tuberculosis, and certain brain disorders, such as encephalitis.

The study will provide data on humidity and temperature as it affects the human body. This will be of great importance to industrial workers and others subjected at times to unusual conditions. It will also guide air-conditioning engineers in producing "artificial climate" suited to the needs of the public.

## Of Small Packages

NEW containers are meeting special requirements in modern marketing and not the least interesting is the single-use type of package, which is being developed for a number of purposes.

Beer cans made a spectacular entrée into the container field, once a satisfactory lacquer was found to keep the liquid from the metal. Paper, pulp, and transparent film containers for liquids have had less spectacular success, but certain types seem to be making reasonable progress. One large oil company is experimenting with an automobile oil container which gives the customer a view of the oil, is non-refillable, and can be burned up when empty.

For similar reasons, special single-use dispensers have been developed for several proprietary articles. In this way, the serious problem of substitution of cheaper, non-advertised products is met effectively. A well-known hair tonic sold largely to the barber trade is now put in a tin tube which is destroyed as a container with the first use of the contents.

Twenty-five million single-use tubes for as many cups of coffee were made during 1937 for a well-known brand of soluble coffee. One of the principal advantages of the utilization of single-use containers for coffee is the prevention of flavor loss on exposure to air once the container is opened. Such air- and moisture-tight single-use containers may be adapted for other food products now sold in larger bulk, wherever the quality improvement would be economically justified.

A manufacturer of paints has found an application for single-use tubes which may be the start of an interesting new development. He sells uncolored or white paint in the standard sizes and supplies his dealers with tubes of colored pigments in oil. Thus the dealer needs to stock only a seventh the usual inventory, and, by maintaining a large number of colors in the tubes, can meet a wide variety of customer demand.

Single-use containers of all types, from miniature bottles to tin envelopes, are being used increasingly for dispensing powders, liquids, and pastes. One such container, a tube hermetically sealed by autogenous welding, has recently been awarded a certificate for consumer convenience in the American Management Association's Wolf Awards Competition. Such hermetically sealed containers make possible the dispensing of hair tonics, flavoring extracts,

and even alcoholic beverages, in "one-dose" quantities. The "tooth paste cocktail" is on the way. The number of applications for single-use containers is daily increasing, and special packing equipment is being developed for even wider application.—*Industrial Bulletin* of Arthur D. Little, Inc.

### SAP PRESSURE

**TOMATO roots grown as orphans—without plant bodies—have developed under test a pressure powerful enough to send sap as high as California big trees, or about 100 pounds per square inch.**

## U-V-Ray Hand Lamp

ULTRA-VIOLET light, which has many uses in industry in the examination and careful inspection of materials and in crime detection and legal work, may now be produced by a small and easily portable instrument. The new lamp, called the Eveready Fluoray, is a carbon arc lamp suitable for field and laboratory work wherever 115-volt current, either alternating or direct, is available. The arc is entirely enclosed and ultraviolet rays are emitted through a removable filter of special glass which transmits ultra violet yet screens out all but a trace of the visible light from the arc. Several other filters are available for light of various wavelengths. In addition to being a very powerful source of ultra violet, the essentially continuous spectrum of the carbon arc assures the presence in the light source of all wavelengths to which fluorescent materials respond.

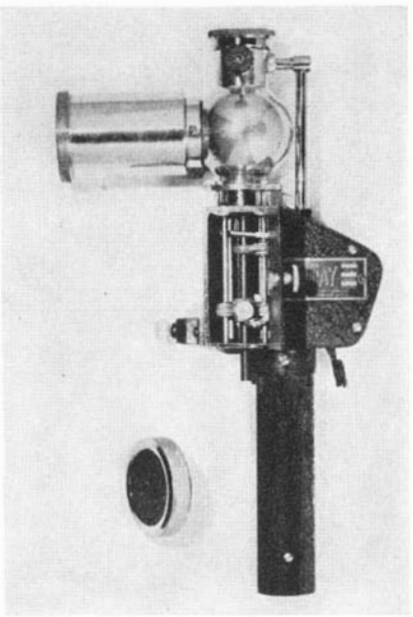
The lamp is made into a simple hand instrument as shown in the accompanying illustrations and is a sturdy, light-weight unit, weighing approximately 2½ pounds. Operation of the lamp is said to be simple and inexpensive.

This new lamp is of particular value in producing fluorescent effects in the examination of such materials as minerals, chemicals, oils, drugs, organic substances, and food products, where fluorescence is a determining characteristic of the material itself or where, by means of fluorescence, adulterants, lack of uniformity, or non-identity of specimens can be detected. It is also admirably adapted to the examination of documents for evidence of alteration, forgery or fraud, disclosing chemical erasures, differences in ink, and peculiarities of paper. It is used to detect invisible writing and for many other purposes in the field of crime detection.

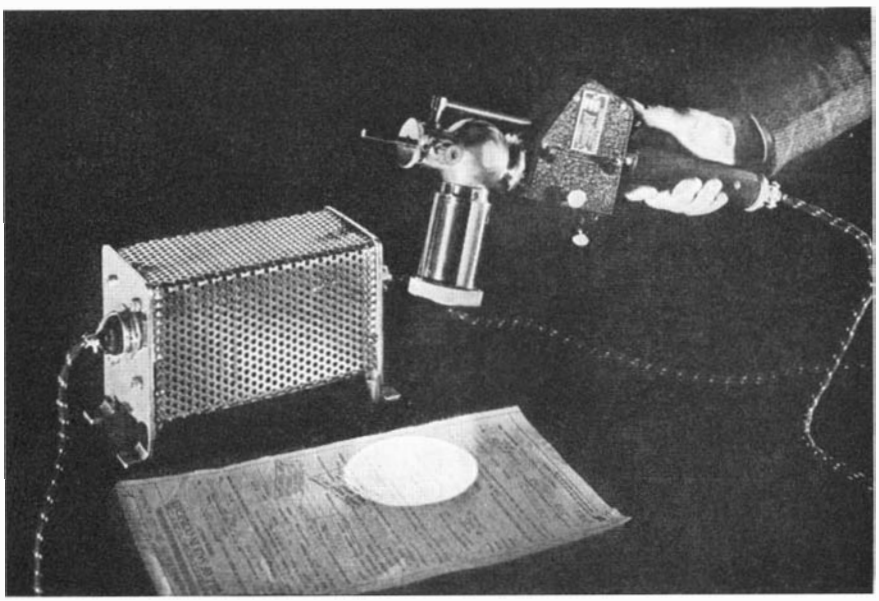
## Silent Wall Switch

THE snap of a switch, indicative of progress and the adoption of modern methods, has finally been superseded as the symbol of electric control. After several years of development, General Electric's construction material division at Bridgeport has placed in production a new switch in which the contact is silently made and silently broken by the movement of mercury.

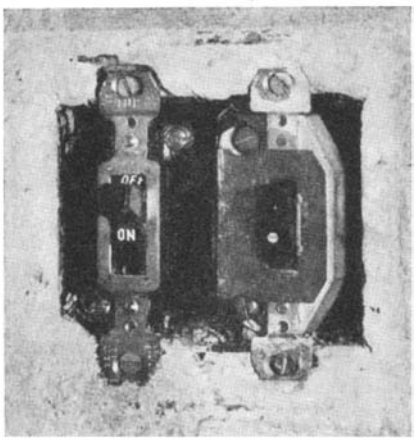
More important to eventual users than the silent operation is the fact that the new switch, small and compact, has literally nothing to wear out. There is no spring that can be broken and no blades to hammer them-

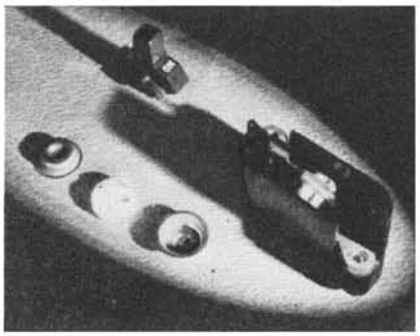


*Above:* **Portable lamp for U-V ray production.** *Below:* **The lamp in use examining a document for erasures**



*Right:* **The few and simple parts of the new silent wall switch in which the contact is made by mercury. The new switch *(below)* is much smaller than the conventional wall switch**



selves away. Actual switching elements have operated more than 65 million times in two years in a laboratory life test without failure. Some indication of the possible applications of the new switch in a single field is given by the fact that approximately 15 million house switches are purchased in the United States every year.

The actual switching element in the new device is the size of a small coat button, composed of two metal disks sealed with glass, completely enclosing the mercury make-and-break of the switch which consists of a tiny globule of mercury which completes the circuit between two contact points when the switch element is rotated by the conventional lever. The switch can be installed in any standard switch box, and must be mounted vertically.

## Salt Dries Turpentine

TURPENTINE which has been dried by passing it through a thick layer of rock salt can be successfully packed in iron drums. Turpentine made in the ordinary way without dehydrating is discolored by the corrosion of iron and hence has always been packed in wooden barrels. By using this new process for removing traces of moisture an economy can be effected in shipping turpentine in iron drums, which are returned after use.—*D. H. K.*

## For a Future Generation

A SCIENTIFIC experiment which will take 200 years to complete is being attempted at the University of Notre Dame.

Six cultures of bacteria, sealed in glass test tubes, have been deposited in the cornerstone of the new biology building to remain there until the building is torn down. According to present building statistics the structure should last at least 150 or 200 years.

The object of the experiment is to determine how long this type of microbe can exist outside of bodies. Sealed with the test tubes is a statement typed on linen paper which reads:

"These cultures are being sealed June 6, 1936. They have been taken from the culture library of the bacteriological laboratories at the University of Notre Dame. They have been examined microscopically and have been shown to be in the spore state. They were viable when sealed.

"To the one that opens them it is suggested that they be cultured on the medium on which they have been grown. The medium is veal infusion agar. (Signed) James A. Reyniers, head of laboratories of bacteriology."

Spores are the resistant form of microbes and can withstand extremely high temperatures. They have been known to exist for years without food of any type. Stories have been reported of their being found in mummies taken from old Egyptian tombs, but these reports have never been scientifically substantiated.

Among the six cultures were the germ which causes lockjaw, another which for the most part is harmless, and one which eventually becomes food for protozoa.

## Aerogels

TO produce an extreme fluffiness in relatively heavy materials, water is removed from gels, similar to jellies, leaving what might be called an air jelly. By this process the oxides of silicon, chromium, nickel, and aluminum have been made so light that they weigh only two to seven pounds per cubic foot. These products expose enormous surface areas per pound of material and are hence highly reactive chemically as catalysts. They are also excellent heat insulators. When added to materials that tend to cake, they promote freedom of flow and make granulation easy.—*D. H. K.*

## A Nut to Crack

THE following communication was recently received from one of the readers of this magazine in Boone, North Carolina. Perhaps other readers who enjoy the exercise of their ingenuity and mental resourcefulness will wish to stop temporarily after reading his letter and attempt to deduce the correct answer, which is probably the one stated three paragraphs below. In advance, we offer the hint that the answer is scientific but perhaps not nearly so complex as might be anticipated, and it is not the will-o-the-wisp:

"There is an odd light down here," our inquirer states, "that appears in the woods at night. It is unlike a jack-o-lantern, since it seems larger and more transparent. While lying in my cabin one night I saw this light through the door and about 40 yards up the path. Suddenly it took a horizontal direction and after a few moments it went out. Then it came on again. A friend has informed me that on another occasion he saw a similar light and watched it for a half hour while it moved around. At times it would rise 30 feet or more in the air and come down again. A third person told me

that in Tennessee he had followed such a light and shot at it upon its near approach and that it seemed to fly all into little sparks. What is this light?"

The above description was referred to Prof. W. J. Humphreys, meteorological physicist of the United States Weather Bureau and author of a standard text and reference book entitled "Physics of the Air," which treats of many unusual atmospheric phenomena. Many peculiar phenomena have come to the notice of Dr. Humphreys, especially as other scientists, when they are stumped by such questions, often refer them to him as a final court of resort.

If one has conjectured all sorts of intricate explanations, Dr. Humphreys' reply, because of its simplicity, will perhaps entitle one to smile after reading the following:

"The curious, floating, ghostly light, now up, then down and round about, presumably was nothing other than an owl out hunting. His lantern was fox fire obtained by spending the day in a decaying hollow tree. When he came out at night the fox fire (phosphorescent fungi) was clinging to his feathers, hence the ghostly light that bobbed about as the owl himself rose and fell in his movements. This same phenomenon has been reported as ball lightning from another portion of the country."

No wonder the poor spook "flew into little sparks" when it was shot at!

**SUN HEAT**

**THE largest solar water heater in America was built and installed by students at the Punahou School in Honolulu. The system covers 308 square feet of roof area and contains 1400 feet of copper tubing.**

## FLUORESCENT CHALK

A FLUORESCENT chalk which glows with a strong green light and is visible at a distance has been developed recently by the Westinghouse Electric and Manufacturing Company.

This new material appears and marks like ordinary chalk under normal light. It glows in the dark when irradiated with ultra-violet rays such as from a sunlamp enclosed in a black globe.

Doctors find this chalk useful for jotting down memoranda on a blackboard during the course of a fluoroscopic examination. It also provides a new tool for the lecturer who, during the showing of stereopticon or moving pictures, wishes to put a visible written message on the blackboard for his audience. This novel medium is especially valuable for use during the showing of moving pictures with sound.

## DEMENTIA PRECOX— NEW TREATMENT

THE medical and psychiatric worlds are watching with interest the friendly rivalry which has broken out abroad between the insulin-shock treatment and the newer metrazol (cardiazol) therapy of dementia precox, especially since both forms of treatment have been introduced into this country.

The insulin treatment, introduced by

Sakel of Vienna, has already benefited a considerable number of cases previously considered hopeless. It consists essentially of the production of a series of daily shocks with gradually increasing doses of insulin. The insulin, after injection into the patient, exhausts the sugar content of the body and usually produces coma. In some cases, the patient may also have convulsions. After remaining in the coma a short time, the patient is revived by the feeding or injection of a glucose solution.

The metrazol treatment, which may be classed also as a shock treatment, was first developed by von Meduna of Budapest who calls it a convulsive therapy. The convulsions are induced by a rapid intravenous injection of metrazol.

According to von Meduna, the treatment is given twice a week for five to ten weeks. The results reported by this investigator compare favorably with those obtained with the insulin shock treatment.

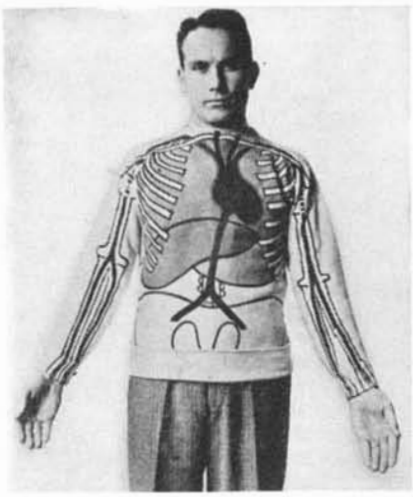
The metrazol treatment is being introduced in the state hospitals for mental disease in New York State and the results thus far are encouraging. The insulin treatment has been used in most of these hospitals for several months with results similar to those obtained in other places. A considerable number of patients who had been considered hopeless have recovered and have gone back to their homes. Marked improvement has occurred in many other cases.—*Health News* (New York State Department of Health).

## Gluing Copper Sheets

THIN sheets of copper are permanently attached to walls by a new type of adhesive, based on glue, recently developed, giving the interior decorators a new medium with which to work.—*D. H. K.*

## Anatomical Shirt

THE Mine Safety Appliances Company recently placed on the market a unique garment known as the Anatomical Shirt, for practical and graphic instruction in the location of arteries, bones, and organs of the torso and arms.



For first-aid instruction

Vastly superior to charts in human interest, the M.S.A. Anatomical Shirt is true-to-life and provides an unforgettable picture of the physical features constantly referred to in instruction and is essential to a working knowledge of first aid.

# CAMERA ANGLES

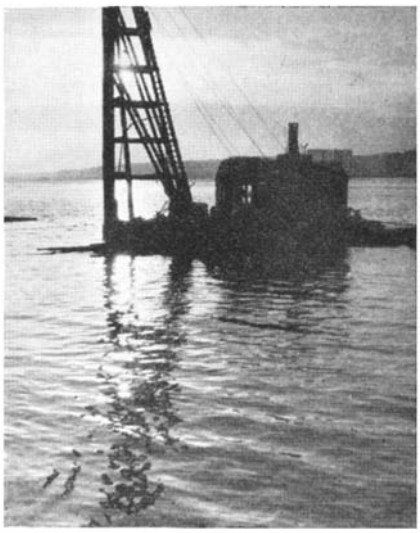
**Conducted by JACOB DESCHIN**

## The Setting Sun

SUNSETS are exasperating subjects to photograph, as any camera user knows who has attempted to reproduce in a "black-and-white" negative the wonderful beauty of a wonderfully beautiful sunset. If you are one of those who have sighed for sunsets to conquer (and of course you are), why not try the alternative of tilting your lens down to earth (or water) and photographing the effect of a setting sun rather than the source itself? You will have greater chances of success and come away with pictures that often will prove ample compensation for the effort.

Exposures will have to be made on the full side to record detail, where possible. For example, take "The Setting Sun." In order to get a proper reading for the subject, the meter was pointed not towards the area where the sun is actually shedding its beams, but towards the darker portions of the water. The silhouetted subjects are practically without detail, as silhouettes should be, but the water is properly rendered in the relative contrasts observed in the original. The position of the camera was so maneuvered as to avoid the direct rays of the sun, which is here effectively "screened" by the framework of the taller silhouette.

In "Ice Glamor" a similar effect was obtained, this time on the thin ice of a partly frozen surface of a park lake. The sun was

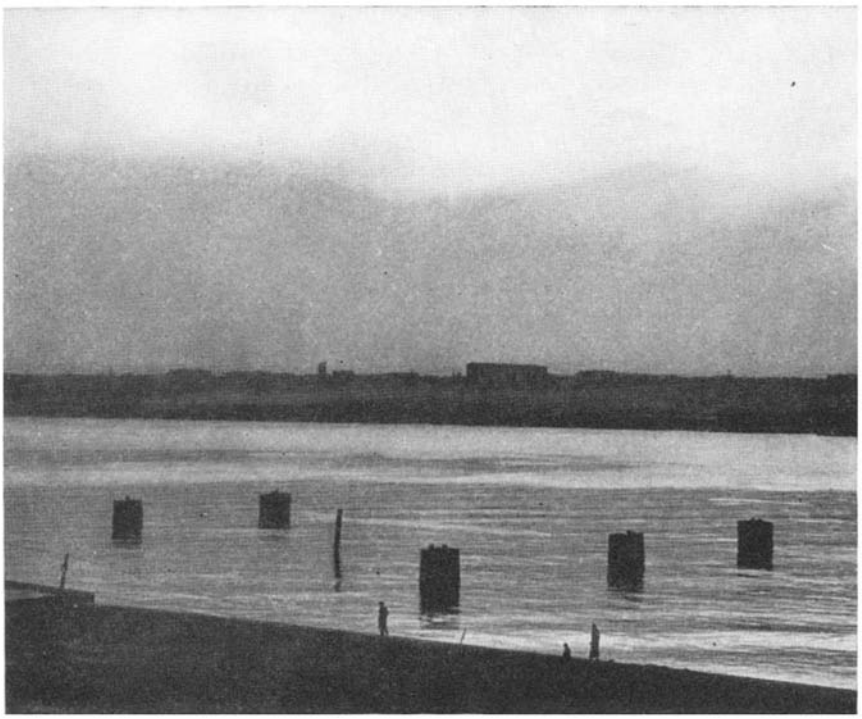


"The Setting Sun"

hidden by the clouds, which may often be relied upon to help out in similar circumstances, rendering a seemingly impossible subject eminently possible and worth the patience involved in waiting for clouds of sufficient density to come along to do the job.

"The Home Trek" and "The Day Ends" interpret the human interest viewpoint and indicate some possibilities in this field that are well worth trying at any time. Taking

"Ice Glamor"



"The Day Ends"

several exposures of the subject, some over and, perhaps, some under that which you believe is correct, will afford you the darkroom opportunity of deciding which of the negatives best expresses what you had in mind when you pressed the button.

"The Home Trek" pictures a string of cars in each direction, all of them presumably on their way to some resting place for the night, if not actually home. The exposure of 1/50th of a second was the fastest that could be risked considering the lighting available and the necessity for stopping down a little, to F:5.6, in this case, in order to get fairly satisfactory depth of field. However, because of the distance, this speed was sufficient to "stop" the cars. Full detail, of course, was not essential because atmosphere and not representation was the effect sought. Maybe the sun splotch on the water doesn't look especially attractive, but this is just the way the water looked. In order to get some detail in the water, it was necessary to do some dodging under the enlarger, the land portion being exposed for what was considered the required time and then shaded with a cardboard to allow extra exposure of the water.

"The Day Ends" is distinguished chiefly by the delicate contrast between the sky and water tones and the general contrast of these tones with the monotone of the rest of the picture. Happily, three figures came along to add the human touch—a man, a woman and a child—and the manner in which they are spaced helps considerably to add interest and a story-telling quality to a rather solemn subject.

"The Home Trek"

## Speed Films and the Meter

THE recent announcement of the unprecedentedly high-speed Agfa film emulsions has created the necessity of stepping up the film speed range of contemporary exposure meters. Quick to fall in line with this newest development in modern photography is the Mini Photoscop electric exposure meter, which is now available with the "29" marking, the Photoscop speed number for Agfa Super Plenachrome Press in daylight and also used for Agfa Ultra-Speed Panchromatic film for 35mm cameras. Owners of the Mini Photoscop in which the film speed scale does not exceed "26" may arrive at the same results by a simple adjustment. All that is necessary is to set the meter at "26" and then reduce the lens opening by one stop. The alternative method is to use the "26" exposure but cut the indicated time in half. For example, if the exposure data reads F:8 at 1/50th, use stop F:11 at the same shutter speed, or keep the lens opening at F:8 and shorten the shutter speed to 1/100th of a second. A similar procedure may, of course, be followed with other meters as well.

The significance of the new high-speed films is being appreciated by users of cameras equipped with F:2.9 or F:2.8 lenses, for the new film does the remarkable service of

actually increasing the speed of the lens to F:1.5. Thus, an F:1.5 lens using "23" speed film and an F:2.9 lens using the new "29" film would give approximately equal exposure results.

## Super-Sport Dolly

INCLUDING a built-in, lens-synchronized range finder of the split-image type, the Super-Sport model is announced by Burleigh Brooks, Inc., as the newest camera in the Dolly series imported and distributed by this firm. Available either with the Schneider Xenar F:2.8 lens or the Zeiss Tessar F:2.8, the Super-Sport has a self-erecting closed front, front lens focusing up to 5 feet (with lens and shutter moving together, not merely the front element alone), optical eye-level view finder, leveling piece, hyperfocal distance table on back of camera and genuine leather bellows, with the camera body finished in fine grain leather.

The Super-Sport Dolly delivers either 16 vest pocket size (1⅝ by 2¼ inch) pictures or 12 square-type (2¼ by 2¼ inch) pictures, using Number 120 roll-film. The view finder listed above is so designed that suitable masking is provided when the smaller size negative is wanted.

When supplied with either of the lenses, the Super-Sport Dolly may be had either with the delayed action Compur shutter, giving shutter speeds up to 1/250th of a second, or with the Rapid Compur shutter, giving speeds up to 1/400th of a second.

The camera measures 5¾ by 4⅛ by 1⁹⁄₁₆ inches and weighs 24 ounces.

## Photographing Seagulls

LIKE the pigeons and the sparrows, the seagulls are always with us, and we doubt if there is a single amateur in existence who has not at one time or another taken a shot at one or all of these subjects —if only just for luck. And luck, indeed, plays a great part in these camera adventures, particularly where seagulls are concerned. The beautiful compositions which sometimes may be caught must be watched closely, with the camera set and the finger alertly poised on the release.

One such lucky shot was "High as the Sky," here reproduced. If the engraver has done his job properly, you will see four seagulls (count them, four), graduated in perspective from the smallest (that is, farthest

"High as the Sky"

"Welcoming Committee"

away), in the lower left hand corner of the picture to the nearest, brightest, and most distinct, in the upper right hand corner. Also, if you will study the relative positions of the seagulls in the picture space, you will see that a sort of lazy curve leads from the farthest to the nearest bird, tying the whole together into a picture that looked good enough in the negative to encourage us to make an enlargement. Incidentally, the picture reproduced was enlarged from a part of a 2¼ by 2¼-inch negative and so cropped as to give the impression of wide open space naturally associated with birds.

"Welcoming Committee" is another chance shot, with the principal member of the "committee" poised atop a lamp post in one of the "strong points" of a composition and the other occupying a subordinate position. If you will cover up the wharf pilings, incidentally, you will see how necessary these latter are to the giving of strength and body to the general composition.

## Monel Stirring Rod

YOU fellows who have been accidentally dropping your glass stirring rod thermometers to the tune of two or three a year, listen to this one: Announcement is made of a new-type item in this field—a combination Fahrenheit thermometer and stirring rod made of Monel metal. It is perforated on top so it may be suspended from a convenient hook or nail and has a crusher on the bottom.

Another item in this connection is a much less expensive stirring rod only, of stainless steel, with a crushing device at the bottom.

## Viscose Sponge Hint

KEEPING the viscose sponge clean and moist while working at dark-room chores is one of the minor problems of the photographic hobby. Placing the sponge just anywhere until you get around to using it again for such work as swabbing off negatives and prints is not a satisfactory method by a long shot. It is obvious that any kind of grit that might adhere to the sponge while thus carelessly put down for a moment or so is bound eventually to do some damage to the delicate, though hardened, emulsion surface. One worker solves the problem by keeping the sponge in a 4- by 6-inch developing tray filled with water. Thus it is in-

stantly available, having a place of its own, and is clean and moist for whatever work is in store for it. Also, after each swabbing, it is helpful to rinse the sponge in clean water and squeeze out the excess. Incidentally, the term squeeze is used advisedly, for the viscose sponge should never be wrung.

## Seeing Her In

RECENTLY this department had the more or less novel experience of meeting an ocean steamer in the company of news cameramen and reporters aboard a Coast Guard cutter. It so happened this particular ship was not specially fruitful in the way of celebrities and the nearest the cameramen could get to a picture was that of a couple of young girls who had crossed the ocean alone. However, the girls declined very decidedly, simply by running away from the cameramen and nothing would bring them within lens-shot.

One of the advantages of boarding a cutter in the early morning (7 A.M., Sunday) is that it gives one the opportunity of seeing how things look that early in the day. The tugboats swirling about the ship looked good to us, with the sun high-lighting the smokestacks and the smoke rising skyward, and penciling a light spot here and there on the body of the busy little boats. The picture we exhibit here shows a tugboat at the end of a sharp turn, creating in its path a seemingly sunken platform.

## The Zeiss and Leitz Shows

THE fourth annual exhibitions held both by the Zeiss Ikon Company and E. Leitz, Inc., Contax and Leica distributors, respectively, are now touring the principal cities of the United States following their opening in New York City during January. Tremendous enthusiasm was evident during the New York sojourn of the shows; the pictures brought thousands to the galleries to witness the work done during the year by amateur, professional, and press photographers throughout the country.

The Zeiss show was distinguished by the fact that about 80 percent of the successful amateur contributors to the exhibition had never exhibited their work before. The show sponsors found their work often on a par with that of the better known professionals and veterans of salons. The following comment by the sponsors will be found significant:

"The amateur, and particularly the newcomers among the exhibitors, have a fresh point of view. They are not really influenced by any one or any school; they shoot on their own."

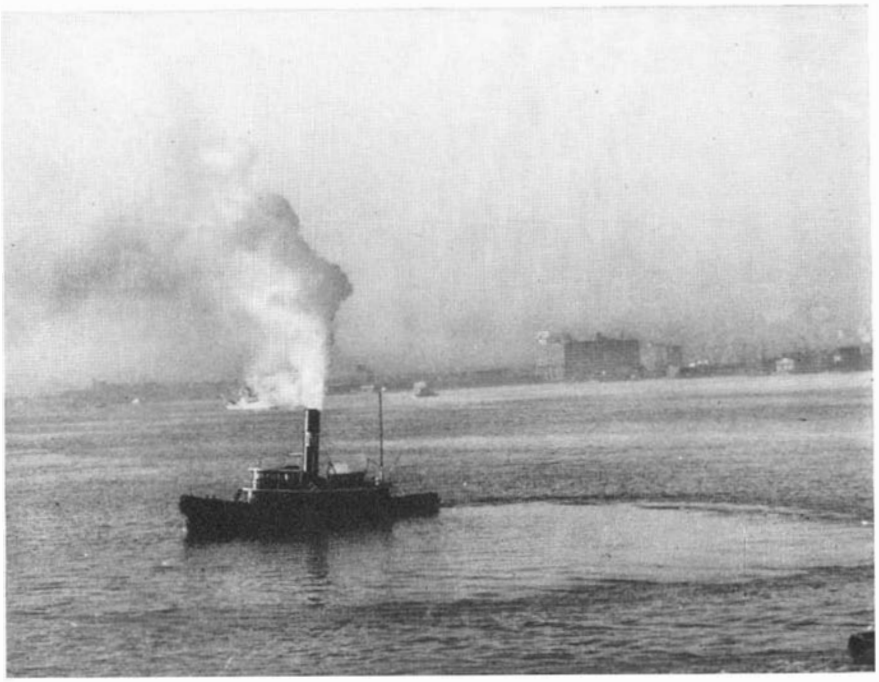
Untutored, uninhibited, they shoot what they like and the way they like. The amateur spirit alone influences them—let's shoot it this way; what's the odds, we're not asking anybody to buy this picture, and it's a wow.

The Zeiss show included more than 300 photographs, though a greater number could easily have been shown if space had been available. It must have been a heart-rending business for the jury of selection to pick 300 out of the total of more than 2000 pictures submitted.

Partly due to the greater space acquired for the showing of the Leica pictures, more than 700 photographs were included in the Leitz show. These were made by nearly 300 amateur, press, and professional photographers in 30 states of the union and 10 foreign countries.

Sponsors of both shows saw in the work submitted a real and decided trend toward solid, pictorial achievement, rather than pure trickery, slapstick, or merely candid photography. Augustus Wolfman, chairman of the Leica exhibition committee, said:

"The improved quality in candid photography, particularly among the amateurs, is evident not only in the composition, but in the tone, clear detail, and print caliber of the individual picture. Candid camera enthusiasts used to seek odd pictures of relatives and friends in awkward acts or circumstances. They were after the unusual. This humorous or sadistic trend has disappeared. Amateurs are recognizing that good candid camera pictures must have good composi-



**"Seeing Her In"**

tion, accurate detail, and good print quality."

The Zeiss show committee felt the same way:

"The selections this year are more varied than last. This is perhaps due to a definite trend toward the pictorial, even in the so-called candid camera shots. That trend is now the prime characteristic of the new photography. The candid camera photographer is not content with just 'stopping the action.' He is now intent on composition as well. His success is shown by better cropping with an eye to the increased artistic values of the pictures selected for the exhibition."

## Exposure Meter

DESIGNED for use over a wide range of illumination levels, a new exposure meter has been announced by the General Electric Company. Simple in operation and sturdy in construction, the new meter is a compact, precision instrument for use in

**G. E. exposure meter**

taking either still or motion pictures under all sorts of conditions.

One of the outstanding features of the new instrument is the use of a hood to limit more effectively the angle of the light received to approximately that of a camera lens. The particular shape of the opening in the hood is advantageous because, when pointed at a normal scene, the full angular width of the camera lens is included in a horizontal direction, but in the vertical direction a much narrower angle is used. This lessens the error of indication caused by strong sky light. This hood, when not extended for taking readings, slips snugly over the instrument, protecting the face and light cell.

The hood, in addition to being very sharply directional, is provided with a hinged, slotted cover which when opened increases the sensitivity of the instrument by 10 to 1. In extremely low illumination, where incident light can be measured, the hood may be removed and another increase in sensitivity of approximately 10 to 1 obtained.

A direct-reading scale is provided giving *f*-values and exposure readings for the most popular films. Values for films of other speeds can be obtained by using the calculator on the hood. This calculator, consisting of a fixed plate and only one moving plate, translates foot-candles into shutter speeds for any film and lens aperture.

# TELESCOPTICS

## A Monthly Department for the Amateur Telescope Maker

### Conducted by ALBERT G. INGALLS

AN observatory dome which observatory-dome-specialist Leo. J. Scanlon has characterized as the neatest appearing hemisphere he has seen on an amateur observatory is shown in Figure 1. Alfonson R. Ibarguen, Box 524, West Farmington, Me.,

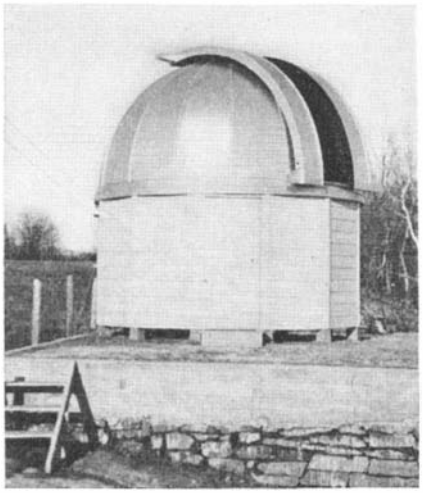


*Figure 1:* **The Ibarguen Observatory**

is the maker and he states that the construction is such that the whole thing can be taken apart, since the pieces are put together with a total of about 6000 bolts and screws, all numbered. He plans later to disassemble it and ship it to his home in Guatemala. He has also made a duplicate of this observatory for Middlebury College, Middlebury, Vermont. The outside diameter is 14′ 6″ and the covering material is composition board with five coats of aluminum paint. There are 17 wooden ribs, each built of two thicknesses screwed together, and the dome rotates on eight 8″ wheels with grease cups attached. The effective shutter opening is 30″ and the shutters run on two channel iron tracks, being opened and closed by an endless rope and sheave.

The telescope is a 12½″, *f*/8 Pyrex-mirrored reflector and the 50-pound tube (Figure 2) is made of 20 strips of wood, 1″ x 2½″, each grooved, the whole glued together, planed, and sandpapered. Ibarguen writes: "My wife, who has worked with me from the grinding of the mirror to laying the stone terrace seen in Figure 1, and on the construction of the observatory, helped paint the tube." This attitude—correct attitude, of course, for any telescope making amateur's wife—doubtlessly accounts for the place of honor given the tube in the Ibarguen living room (Figure 2). This is the place where all amateurs should store their telescopes. In addition to this evidence of uxorial straight thinking, Ibarguen's communication states that his wife painted the inside of this tube by crawling through it, but it possibly will be inexpedient to call this little technicality to the attention of the average wife (inside diameter of tube, 14⅜″).

[Speaking of amateur telescope makers' wives, the old joke about the man whose wife gives him an urgent letter to mail and then discovers it the following spring in his overcoat pocket—unmailed—is no joke, but here is reverse English: An order for ATM has been received bearing a penciled P.S. in another handwriting which frantically asks: "Please rush! My husband gave me this to mail and I forgot it!" The letter was received 13 days after its own date-line, from a distance usually requiring only one day in transit. (To the one reader on whom light and suspicion are now dawning: no, not even if you correctly guess it will we let the lady down. See Luke 6: 42.)]

Heeding innumerable recommendations for solidity, loudly preached and prayed for by Porter, Ibarguen based his telescope on a 7′ concrete pyramid reaching 6′ below ground (deep frost line in Maine), 68″ square at base and 32″ square at top, surmounted by another concrete pyramid 14″ x 32″ which tapers to 9″ x 11″ at top. The mounting (Figure 3) is by Harry Lee Armiger, of Detroit, and is rugged and pleasing in design. Note latitude saddle.

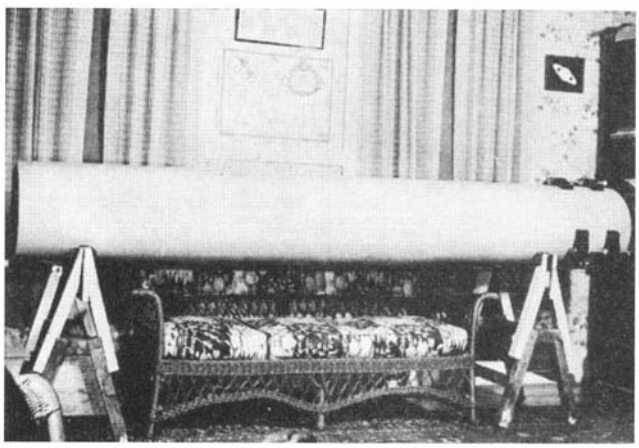


*Figure 2:* **Try this on your own family**

IF you admire stick-to-it-iveness, and perhaps envy it, the job shown in Figure 4 may tell you the kind of patience you will have by the time you reach about 74—the age of Mr. Elroy Gray, of North Jay, Maine. Ibarguen thus describes Mr. Gray's celestial globe: "The complete globe is the product of Mr. Gray's ingenuity. Even the wood for the stand was grown on his farm. The sphere is over 17″ in diameter and about 7000 stars are shown. The ball is constructed of successively smaller and smaller wooden rings, glued together, beginning with the largest at the equator and working toward the poles. This rough ball was then put on a lathe and made accurately spherical—and it is accurate!

"Triangles were then cut from a good grade of paper and cautiously glued to the wooden ball. This procedure is extremely difficult and guaranteed to make the most delicate of men use profanity befitting a mule driver. The various circles were beautifully drawn, and finally the stars were carefully printed. The dies used for printing these were made of common nails, filed flat on the ends and cut into various shapes and sizes, to represent stars of different magnitudes. The prevailing background of the globe is blue, the Milky Way being of a slightly different shade. Description is inadequate, for you must see the globe to appreciate fully its exquisite workmanship. The following are a few of Mr. Gray's hobbies: telescope making, including mirrors, objective lenses, flats and prisms; violin making; photography; and wood working. He made his first telescope about 50 years ago, and has made in all 18 or 20 telescopes, his latest triumph being an excellent 5″ refractor."

FOR an observatory dome, which paint is superior, aluminum or white? "To help settle the point," H. E. Dall writes from 166 Stockingstone Road, Luton, Beds., England, "I have obtained two maximum-minimum thermometers and am painting two similar boxes—each ventilated to about the same relative extent as my observatory—one white and the other aluminum. A week's readings of the temperature differences in each box exposed to the sun, etc. ought to prove helpful. The one showing the least daily difference between maximum and minimum should be best." Some time later Dall writes as follows: "The tests have taught me quite a lot about the subject of radiation and emission. The upshot is that, if an observatory is for purely solar purposes, white paint is best; but if for night work, aluminum paint is best, and by considerable margins at that." The domes on Mt. Wilson are aluminum painted.

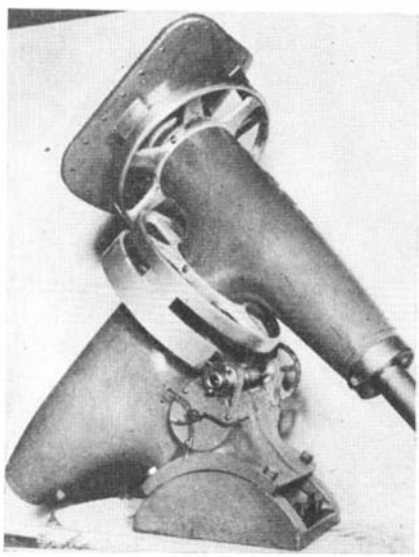


*Figure 3:* **The Armiger mounting**

FOR several years many amateur telescopticians have known that a Schwarzschild reflector was being made by Professor Cogshall of Indiana University, and now the job is completed. Professor Cogshall has not been doing much shouting about this job; we suspect he was mainly busy really doing it. On another page in the present number readers will find a photograph of this telescope, in connection with Professor Russell's

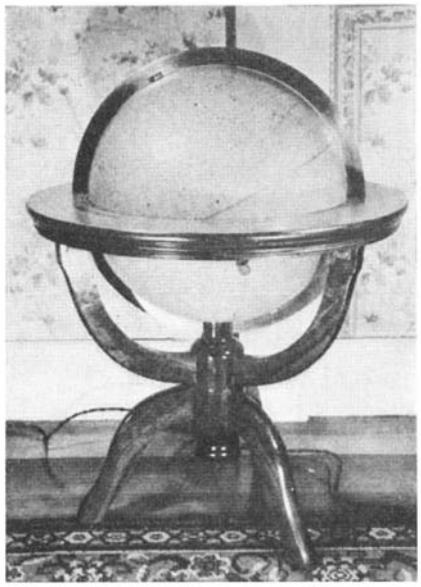


*Figure 4:* Gray's celestial globe

article. There it is characterized as "unique." This means that there is only one Schwarzschild and this is it. For years writers have written and speakers have spoken of the Schwarzschild as if it were old stuff but the plain fact is that, all this time, it has existed only on paper—Schwarzschild worked out its optics and nobody had the enterprise to go ahead and actually make one. In the photograph shown with Professor Russell's article the guiding telescope will interest amateurs: the objective is separate—no tube—and there is a diagonal opposite the declination axis which shoots the light down that hollow axis and to another diagonal belonging to an eyepiece.

Professor Cogshall, who designed this instrument, and ground and figured the mirrors, is at the guiding eyepiece.

Anticipating inquiries from amateurs who will now itch to build Schwarzschilds (and probably itch worse while doing it) we answer these here, in advance. There are no "instructions," therefore you will largely be pioneering. This will be work for the advanced amateur, and beginners are honestly and sincerely advised to pass it up till they have made a dozen or so of the common or garden variety of reflectors. By that time most of them will no longer hanker after such a job, anyway. There is a brief mention of the Schwarzschild, also a cut, on page 395, ATMA. In his series of articles (1928-1929) in the *Journal of the Royal Astronomical Society of Canada,* Ritchey mentions (p. 175, May-June, 1928) Schwarzschild's original publication of the optical design, which was in a book entitled "Theorie der Spiegeltelescop," published at Potsdam, Germany, in 1905. This work is a compound of higher mathematics and German. Just how the average amateur would now go about locating this book, except possibly in a few libraries, is something on

which your scribe has no data at this writing. No doubt the small handful of advanced amateurs who thrive on this kind of diet will dig it out, and probably Professor Cogshall will later publish an account of his work in some of the professional journals. Like the curve on the Schmidt telescope's correcting plate, the Schwarzschild's is of the fourth degree type. Harold Lower, who with his father, Charles Lower, has pioneered in figuring the fourth degree curves of Schmidt correcting plates, mentions in a letter some of the odd hunches they have tried out, à la Edison (try anything once), for tools, including glass, gas pipe, buckshot, and shirt buttons. They speak calmly of making various curves and then destroying them without tears—all a part of the game and lots of fun. These curves are, of course, not parabolical but, according to the elder Lower, diabolical. The amateur—or professional—who tackles fourth degree curves should first stock up well on the old-fashioned commodities, patience, courage, stubbornness.

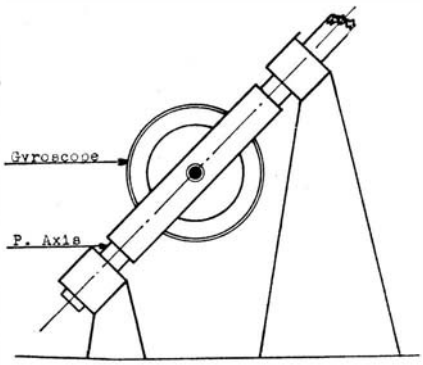


*Figure 5:* **The gyrotelescope idea**

No doubt, after the above discouragement, everybody will want to make a Schwarzschild.

INTERESTING, at least, even if it did not turn out to be applicable, is an idea submitted by James Murphy, 621 Third Ave., N. E., Mason City, Iowa—the use of a gyroscope for stabilizing a telescope on a fixed star. His letter:

"This one is a little odd, and I can't figure out yet whether it will grow up to be an idiot or a genius. Essentially, the thing is nothing more than a gyroscope attached to the lower end of the polar axis, the idea being that the thing will keep on rotating in the same plane and drag the telescope around with it. The sketch (Figure 5) shows no method of driving it, but an electric motor would do the trick. I don't know everything there is to know about a gyroscope, but I do know that it will offer a large resistance to any force tending to change its plane of rotation. Now it stands to reason that a gyroscope isn't an immovable object. Its resistance to a given force depends upon its angular momentum. The force in this case will be applied in the form of a couple acting on the ends of the shaft, its amount depending upon the balance of the mounting and the condition of the bearings, and also upon the direction and velocity of the wind, if the thing is used in the open. If these factors were reduced to the absolute minimum, and the angular momentum of the rotor made large enough, it would seem that the amount of drift would be rather small. The problem is, could this lag be reduced to a point where it wouldn't be troublesome, without making the rotor too large? In the case of visual observation, I believe it could, but for photography, where an exposure of several hours is indicated, I don't know.

"There is also another problem. If the thing would work out all right, what about vibration? A well-balanced rotor in good bearings isn't the sort of thing which produces ground-shaking vibration, but the amount of vibration which can be tolerated in a telescope is very small. It wouldn't do to have the star images dancing around in the field of view like a hula dancer's navel. About the only way of really finding out is to try it, so if you think it worth while, you can pass it on, and see what the results will be."

The above suggestion was referred to the Sperry Gyroscope Company, Inc., which replied:

"The simplest way to describe the value of this idea is to say that the scheme is theoretically possible, but practically away beyond the technic of gyroscope engineering at the present time. There are two possible methods of attacking the job. First is the direct application of a three-degree-freedom gyro. This would necessitate a gyroscope size and weight in excess of telescope, and would make such a cumbersome apparatus that, even if it were possible to balance it accurately, it would still be impractical. To balance a gyroscope of such a size with three degrees of freedom runs into tremendous problems of reducing the bearing friction, compensating all parts for temperature change and removing all flexibility of parts so as to prevent the center of gravity from shifting with changes of compensation of the gyroscope.

"The second way would be to have a small controlled gyro and a relay system or follow-up system which, through servo motors, would drive the telescope. This can be done with sufficient accuracy for many uses where time delay or angular lag of three to five minutes of arc are allowable. In telescope work, however, where the allowable error must be considerably less than that, the technic would be too complicated, if at all possible.

"It is not a new question to us, as it has been brought up many times and our ideas as expressed here are not the result of guessing, but of our own experience in attempting to stabilize other things than telescopes."

THIS letter was sent to Murphy, who replied: "Well, I guess that's the story. It doesn't look any too promising, but maybe some of the boys might surprise us all by getting it to work. If you decide to mention it in the magazine I suggest that you bear down heavily on the difficulties of making it work."

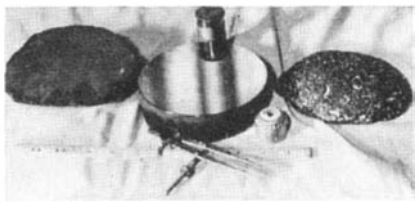


*Figure 6:* **Obsidian mirror—Bush**

A rumor in the press has hinted that the Navy had been working on the same method, to be used for anti-aircraft firing control mechanisms, also that the big guns of the

new battleships would have gyroscopes. We don't vouch for this—it may be merely old General Rumor speaking; also a telescope is a considerably more "tetchity" critter than even a naval gun. Nevertheless, the idea is intriguing.

OBSIDIAN is a natural product commonly called volcanic glass and it resembles black glass. As a possible material

*Figure 7:* **Telescope class at N.Y.U.**

for telescope mirrors it is mentioned in ATM, pages 316–317. However, without being aware of that mention, Dr. W. P. Bush, American Trust Building, Berkeley, Calif., made the mirror shown in Figure 6. "A piece was sawed from the median part of a small chunk of obsidian which I found on a mountainside," he states, "the objects at either side of the mirror in the photograph being the two slabs sawed off. A toothless copper blade in a hacksaw frame was used with Carbo to saw out the desired piece, which was then made circular by means of Carbo and a tube rotated in a drill-press. Grinding and polishing were done in the usual way. The mirror is an $f/10$, and when silvered it became very good."

Often your scribe has sawed 1″ by 18″ (cross-section) slabs of stone, using Carbo, water, and the back of a 48″ saw. Time, 45 minutes, less or more.

FOR some time the Pennsylvania State University (State College, Pa.) has been giving a course in telescope making, and now New York University (20 Washington Sq., N., New York, N. Y.) has followed suit. Figure 7 shows the classroom, which is not on the campus but in the deep basement of the Hayden Planetarium at the American Museum of Natural History. Ramiro Quesada, a member of the Planetarium staff and the instructor, is an old hand at mirror making. "This course consists of 24 lessons, three hours each, extending over a period of 24 weeks, during which time the student will not only have the opportunity to learn the technic of telescope making but will be expected to complete a telescope mirror. . . ." This official statement is quoted in order to show how our home hobby shapes up when it becomes a regular course at a university: 72 hours to make a mirror. Well, if you counted all the necessary make-ready, probably your first mirror took about that long —less or more!

NEW clubs of telescope makers, amateur astronomers, or both: Alabama Astronomical Association, B. L. Harrell, 105 N. 10 St., Gadsden, Ala., president. Amateur Telescope Maker's Club, Lorimer Knoll, secretary, 1807 Johnson St., N. E., Minneapolis, Minn. National Capital Amateur Astronomer's Association, Inc., Stephen Nagy, president, 104 C St., N. E., Washington, D. C.

# CURRENT BULLETIN BRIEFS

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

LIFE, LIBERTY, AND THE PURSUIT OF HAPPINESS tells in pictures and text how the modern machine age has given man many things that would otherwise be unattainable. It particularly emphasizes the fact that machinery does not enslave man—it emancipates him. The booklet covers briefly the whole scope of human activities, from improved homes and automobiles through various businesses and industries. *The National Machine Tool Builder's Association, 10525 Carnegie Avenue, Cleveland, Ohio.—Gratis.*

TRANE WEATHER MAGIC is an 8-page illustrated pamphlet that deals with various phases of air conditioning, particularly those concerned with theaters, hotels, and other public buildings. *Write for Bulletin 338A, Scientific American, 24 West 40th Street, New York City.—3 cents.*

PRACTICAL SPEEDS OF FILMS AND PLATES is a vest-pocket size booklet that compares speed ratings and gives the practical speed values of all the various negative types available on the American market. It is furnished in a protective celluloid envelope. *Willoughbys, 110 West 32 Street, New York City.—10 cents.*

HIGH STRENGTH CORROSION-RESISTING RIVETS FOR MARINE CONSTRUCTION is a specialized technical pamphlet dealing with the subject of its title and giving in tabular form the physical properties of special alloy rivets. *Write for Bulletin 338B, Scientific American, 24 West 40th Street, New York City.—3 cents.*

THE OBSERVER'S HANDBOOK FOR 1938 is an 80-page annual containing numerous tables, lists and maps for amateur astronomers—lists of double and variable stars, star distances, clusters and nebulae, also an ephemeris of the sun, and, especially, data on each planet for each month of 1938. Every amateur should obtain this book annually. *Royal Astronomical Society of Canada, 198 College St., Toronto, Ontario, Canada.—Postpaid 25 cents (20 cents each if ten or more are purchased).*

NICKEL ALLOY STEELS IN OIL WELL TOOLS, by George W. Whitney, tells of the many advantages to oil-well operators which may be had by the use of alloy steels in different parts of their equipment. *Write for Bulletin 338C, Scientific American, 24 West 40th Street, New York City.—3 cents.*

GEM STONES is a U. S. Bureau of Mines pamphlet summarizing the state of the gem industry, imports, market and so on, for 1936. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

HOW TO CHANGE OVER TO WELDED DESIGN FOR PROFITS is a new 32-page bulletin, profusely illustrated, intended as an aid in applying electric welding to the design of machines and machinery structures. Of particular interest are illustrations of products as they were formerly built by some other method and of their modern arc-welded counterparts. *Write for Bulletin 338D, Scientific American, 24 West 40th Street, New York City.—3 cents.*

WHAT AN INVESTOR SHOULD KNOW is a pocket-size booklet containing 32 pages which covers briefly elementary points which are not often understood by inexperienced investors. It further describes the methods which swindlers have frequently used to defraud unsuspecting investors. The keynote of the discussion is: "Before you invest—investigate." *National Better Business Bureau, Inc., 405 Lexington Avenue, New York City.—8 cents.*

HIGH-SPEED VULCANIZATION OF RUBBER, by A. R. Kemp and J. H. Ingmanson, is a technical bulletin describing the factors involved in the continuous vulcanizing process now employed by the rubber-covered-wire industry. Monograph B-1019, *Bell Telephone Laboratories, 463 West Street, New York City. Limited free distribution.*

ANTHRACITE INDUSTRIES MANUAL OF ANTHRACITE AS A DOMESTIC FUEL is a 115-page book which presents in compact form much of the experience and knowledge which has been gleaned by a number of well-known combustion engineers. It covers a description of anthracite and its proper combustion, heating systems and equipment, and methods which should be used for obtaining a maximum of satisfaction from anthracite. *Anthracite Industries Laboratory, Primos, Del. Co., Pennsylvania.—50 cents.*

WHY AIR WRECKS? is a discussion of the causes of airplane accidents and corrective measures which have been advanced by various authorities. It includes a summary of crashes of scheduled airplane flights in the United States from August 7, 1934 to March 25, 1937 inclusive. The Commonwealth—Part II, November 6, 1937. *The Commonwealth Club of California, Hotel St. Francis, San Francisco, California.—35 cents.*

FIRES ON FARMS, Leaflet No. 44, United States Department of Agriculture, deals with the various causes of farm fires and how fire hazards may be and should be removed. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

EYE HAZARDS IN INDUSTRIAL OCCUPATIONS is a handbook for safety engineers, safety committee-men, industrial physicians and nurses, and for those responsible for any industrial operations. The volume contains 247 pages and includes 59 illustrations dealing with the safeguarding of eyesight in factories, mines, shops, and offices. This handbook formerly sold for $1.50. As long as the supply lasts it is available at the special price mentioned. *The National Society for the Prevention of Blindness, 50 West 50th Street, New York City.—50 cents.*

# LEGAL HIGH-LIGHTS

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

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

### Corporation Licenses

At the present time there is pending before Congress a Bill which has received surprisingly little publicity in view of its far-reaching effect upon American business. The Bill is being sponsored by two senators of more than ordinary ability in parliamentary tactics, and accordingly, it deserves careful watching.

The purpose of the Bill is to accomplish certain social reforms which have heretofore been regarded as outside the province of the Federal Government, by requiring corporations engaged in interstate commerce to be licensed by the Federal Trade Commission. The Federal Trade Commission is given extraordinary powers to grant, modify, or revoke such licenses. Thus, the Bill provides that: "It shall be unlawful for any corporation to engage directly or indirectly in commerce without first having obtained a license therefor from the Commission." The Bill also provides "that such license shall contain such terms and conditions as the Commission shall prescribe as necessary and appropriate to carry out the purposes of this Act, shall be effective from the date specified therein, and shall continue in effect until suspended or revoked."

In order to receive a license from the Federal Trade Commission a corporation must submit detailed information as to its financial structure and must certify to the Commission that it intends to comply with the provisions of the Bill and any requirements that may be imposed by Congress as a condition to its right to engage in commerce. In addition to this the licensee must comply with certain labor and fair trade practices. Thus, no person under 16 years of age may be employed by the licensee; female employees must be paid at the same rates of pay as male employees doing similar work; and the right of employees to self-organization and to join labor unions must be guaranteed.

The Bill also contains provisions intended to protect investors. Thus, a licensee is required to have the principal place of business and executive offices in the state of incorporation. The right of a corporation to hold stocks of other corporations is greatly restricted, and the right to vote the shares of stock of a subsidiary corporation is vested in the stockholders of the parent corporation rather than in the parent corporation itself. Also, rather rigid restrictions are placed upon the financial set-up of licensees. One of the most important of these restrictions provides that the surplus of a corporation shall not exceed 50 percent of the value of its capital stock.

One provision of the Bill would introduce an entirely new element into the relations between business and government. Under this provision a stockholder of a corporation can deliver a proxy to vote his shares of stock only to a person who has been certified by the Federal Trade Commission and the Civil Service Commission as a duly accredited corporation representative. The compensation of the corporation representatives is fixed by the Federal Trade Commission but is paid one half by the corporation and one half by the Federal Trade Commission.

At the present writing the Bill is 31 pages long and it is difficult to summarize all of its provisions. However, in addition to the high-lights of the Bill as outlined above there are many other provisions which have a far-reaching effect upon every corporation engaged in interstate commerce.

One further provision that is worthy of note is that the Federal Trade Commission is given extraordinary powers of investigation, interrogation, and subpoena in connection with its duty of supervising and enforcing the Bill.

### Caveat Vendor

THE United States Supreme Court has recently held that laws are made to protect the trusting as well as the suspicious and that the Federal Trade Commission has the power to restrain misrepresentations even though they are palpably and obviously false and would not deceive a cautious person.

The publishers of an encyclopedia had represented to customers that they were distributing the encyclopedias as gifts and that the customer only had to pay $69.50 for a loose-leaf supplement or extension service. The Federal Trade Commission found that these representations were false; that the encyclopedias were not given away; and that as a matter of fact the publisher was selling the encyclopedia and the supplement for the price of $69.50. The Commission accordingly ordered the publishers to cease and desist from making false representations of this character. The order of the Federal Trade Commission was subsequently reviewed by one of the circuit courts of appeal and the court overruled the Commission on the rather interesting theory that the representation that the encyclopedia was given away was so obviously false that no one would be misled by it. The case was then taken to the United States Supreme Court, which overruled the circuit court of appeals and sustained the Commission on the theory that the laws are intended to protect the trusting as well as the suspicious. In this connection the Court stated:

"The fact that a false statement may be obviously false to those who are trained and experienced does not change its character, nor take away its power to deceive others less experienced. * * * Laws are made to protect the trusting as well as the suspicious. The best element of business has long since decided that honesty should govern competitive enterprise, and that the rule of *caveat emptor* should not be relied upon to reward fraud and deception."

### Private Fight

THE owners of the exclusive right to broadcast over the radio a description of a prize fight can restrain a competitor from interfering with that right and from appropriating news of the fight from the exclusive broadcast and furnishing it to other broadcasting stations.

The promoters of the fight between Joe Louis and Tommy Farr gave the exclusive broadcasting rights to the fight to one of the large broadcasting companies. A news agency engaged in the business of supplying news to broadcasting stations announced that it would supply its customers with a running account of the fight while it was in progress. The promoters of the fight and the owners of the exclusive broadcasting rights brought suit against the news agency to restrain it from interfering with its exclusive broadcasting rights. The court found that the purchasers of tickets to the fight were bound by agreement not to take motion pictures and not to broadcast the fight. The news agency advised the court that it intended to "obtain tips from the ringside broadcast as to the facts of the progress of the fight, and to authenticate them by independent investigation by newsgathering representatives of defendants located at vantage points outside of the stadium but within view of the bout." The court found, however, that the running account of the fight to be furnished by the news agency would necessarily be based to a substantial degree upon the exclusive broadcast, and that accordingly the plan of the news agency could not be utilized without an unlawful appropriation of plaintiff's broadcast. An injunction was accordingly granted.

### 8 O'Clock—on Land and Sea

A PROMINENT grocery company owning the well-known trademark "8 O'Clock" for coffee has been awarded an injunction restraining a competitor from using "8 Bells" to designate his coffee.

The plaintiff has used the trademark "8 O'Clock" for coffee since 1869 and the mark has been extensively advertised and is well known throughout the United States and Canada, while the defendant did not adopt the name "8 Bells" until the year 1932. The court found that "8 Bells" was deceptively similar to "8 O'Clock" and that its use by defendant constituted trademark infringement and unfair competition. In reaching this conclusion the court stated:

"We judicially notice the fact that the word 'Bells' is a nautical term for 'O'Clock' and so used eight bells after midnight means eight o'clock in the morning. * * * The use of the designation '8 Bells' by defendant constitutes unfair trade practice and infringes plaintiff's trademark of 'Eight O'Clock' and '8 O'Clock'."

# Books SELECTED BY THE EDITORS

## ALCOHOL, ONE MAN'S MEAT—

*By Edward A. Strecker and Francis T. Chambers, Jr.*

"ANOTHER man's poison" fittingly describes this volume, which is neither for nor against the use of alcoholic beverages. As a matter of fact, the authors believe that alcohol may be a source of normal enjoyment, but at the same time they know that there are psychological factors involved which are as important for the individual to know as for the medical man who may later be called upon to treat that man's alcoholism. Parts of the book are "The Psychology of Alcoholism" and "The Treatment of Alcoholism," these two being broken down into a number of chapters each. For the layman the first part is, of course, the more interesting, some of its chapters being "Alcohol, The Camouflaged Narcotic," "The Identification of the Alcoholic," "The Alcohol Saturated Personality," "Alcohol and Sex," and "The Alcoholic Breakdown."—$2.65 postpaid.—*F. D. M.*

## THE CHEMISTRY OF PETROLEUM DERIVATIVES—Volume II

*By Carleton Ellis*

PETROLEUM serves as a raw material for an ever-growing number of valuable chemical synthetics. New industries are continually growing to importance in this field and development proceeds at a rapidly accelerating rate, as Volume II of Ellis clearly demonstrates. In 1934 the first volume, covering with remarkable thoroughness all the research up to that time on chemical derivatives of petroleum, contained some 1285 pages. So swift has been progress in the subsequent years that the second volume, designed to bring the first up to date after only three years, appeared in 1937 with a total of 1464 pages. The two volumes together form the standard work on the subject. Lest there be misunderstanding, let it be clearly stated here that neither volume deals with petroleum refining of itself but rather with the multitudes of products derived from crude oil and natural gas by chemical treatment.—$20.50 postpaid. —*D. H. K.*

## UNIVERSAL PHOTO ALMANAC AND MARKET GUIDE—1938

AMATEUR photographers who feel that they should be able to make money with their cameras will find in this book many hints that will be of value. A series of articles tells what, when, and how to photograph, how to sell your photographs profitably, how to handle your equipment, what picture journalism consists of and how to make contacts with editors, and many other things that the would-be photo journalist will want to know. A pictorial section presents some of the work of this country's foremost photographers; a 34-page formulary gives in compact form most of the standard formulas. The market guide section tells who purchases what kind of photographs, approximately the price paid, and gives other pertinent data regarding hundreds of publications that are in the market for photographs. —$1.00 postpaid.—*A. P. P.*

## FORTY YEARS OF AMERICAN-JAPANESE RELATIONS

*By Foster Rhea Dulles*

READERS who desire to be well-informed concerning the international background of our relations with Japan will find in this book a period-by-period history, beginning with our Spanish War days and tracing through in a clear sequence periods of the Open Door, the Boxers, the Russo-Japanese War, dollar diplomacy, and the European War, also the more familiar recent periods.—$3.15 postpaid.—*A. G. I.*

## THE RADIO AMATEUR'S HANDBOOK—1938 Edition

EVERY year there is published a new edition of the Radio Amateur's Handbook—the present one is the fifteenth. It covers the entire story of amateur radio from its beginnings up to the present day. Then it presents elementary radio principles, fundamental circuits, vacuum tube facts, equipment design and construction, amateur radio telephony, ultra high frequency apparatus, and so on throughout the whole gamut of amateur radio. There are 446 pages (including an index) of accurate facts that will be of value to everyone interested in short wave communication. As could have been said for every previous edition, this one is "the biggest and best yet."—$1.00 postpaid.—*A. P. P.*

## AMERICA'S YESTERDAY

*By F. Martin Brown*

NO previous book has covered so much territory as this new work, which is an account of our present knowledge of the early Indians, Pueblos, Mayas, and other middle Americans, the early Peruvians, Incas, and the Moundbuilders. In fact it is a full compendium of New World anthropology. It may err a little in one respect which, however, is equally characteristic of popular presentation of other branches of science: the popularizers are often more certain that the scientists are correct than are the scientists themselves. This, however, is a minor matter in connection with so valuable a survey as the present one.—$3.65 postpaid.—*A. G. I.*

## PHOTOGRAPHY OF THE NUDE

*By Marcel Natkin, D.Sc.*

ESTHETIC photography is the essence of the present book. The author first discusses the nude in classical paintings and sculpture and then presents 32 plates showing various treatments of the nude from expressive through phantasmagoria and stylized to realistic treatment. The book is supplemented by a series of notes on technique and by a discussion of soft-focus photography and its application to the main subject. This is in every respect a serious treatment of a legitimate phase of the art of photography.—$2.65 postpaid. —*A. P. P.*

## GOVERNMENT OWNERSHIP AND OPERATION OF RAILWAYS FOR THE UNITED STATES

*By Lewis C. Sorrell*

THERE are many arguments pro and con on the question of whether railways of this country should be under government ownership and operation. Professor Sorrell, who has been professional advisor to the Transportation Conference and to the Railway Business Association, gives us in this volume the essence of all these arguments. He shows that we have had very little experience in such operation and, on the basis of this fact, outlines the problem from the standpoint of public interest. One chapter is devoted to the subject of whether government ownership is at present imminent. A short but rather complete bibliography concludes the volume.—$3.20 postpaid.—*F. D. M.*

## RAILWAYS OF THIRTY NATIONS

*By P. Harvey Middleton*

AS a companion piece to the volume mentioned immediately above, this

study gives the background and present status of the railway systems of the more important countries of the world. In this study must of necessity be included a considerable amount of discussion of the historical aspects and the sociological and economic factors which differ greatly from nation to nation. There are few statistics as such, though the text itself contains many figures relating to mileages, construction costs, and the like. A four-page bibliography is included.—$3.20 postpaid.—*F. D. M.*

## THE BOOK OF WILD PETS

*By Clifford B. Moore*

A DISCUSSION on the care and feeding of our native wildlife in captivity, with notes on their identification and life habits. The author is biologist in charge of the Trailside Museum at Springfield, Massachusetts, and he appears to have a large fund of *practical*, not merely general, advice in building and maintaining quarters for a wide variety of aquatic life, insects and pet spiders, also mammals and birds, as well as in their care and feeding. This large illustrated volume is a reference book. —$5.20 postpaid.—*A. G. I.*

## THE STORY OF GEMS

*By Herbert P. Whitlock*

A POPULAR handbook on precious and semi-precious stones—diamonds, opals, quartz gems, ornamental stones—the antique use of gems, the lapidary art, the forms in which gems are cut, and other general gem lore.—$3.65 postpaid.—*A. G. I.*

## WILD ANIMAL WORLD

*By Raymond L. Ditmars and William Bridges*

SUPPOSE you could sit down 18 times with the men who conduct the big Zoo in New York and listen each time for an hour while they related their choicest tales of exciting happenings among the many animals that have been kept there. Doctoring under difficulties, animal myths and superstitions, the unexpected always happens, a pea-green lion, midnight in the zoo, adventures with elephants, a nose for zoo news—these are some of the subjects of the 18 informal narratives in this most readable book.—$3.15 postpaid.—*A. G. I.*

## SOCIALIZED MEDICINE IN THE SOVIET UNION

*By Henry E. Sigerist, M. D.*

AFTER long sojourns in Russia studying his subject at first hand, the professor of the history of medicine at Johns Hopkins University describes in detail his findings concerning socialized medicine—he likes it. His account will make interesting reading to the minority who also like the same idea.—$3.65 postpaid.—*A. G. I.*

## INTRODUCING THE CONSTELLATIONS

*By Robert H. Baker, Professor of Astronomy, University of Ill.*

A VERY elementary book full of running comment on the constellations and the important stellar features in them, organized by seasons. Attractively illustrated with numerous blue half-tones of celestial features, also with simple charts of the constellations. This is a book for relatively non-serious students of the stars, readers who do not care to dip very deep, but wish to be entertained and lightly instructed while learning the constellations.—$2.65 postpaid.—*A. G. I.*

## THESE AMAZING ELECTRONS

*By Raymond F. Yates*

A POPULAR treatise dealing with the applications of electronics to medicine, surgery, music, television. The author gives us pictures of practical applications rather than the pure physics of the electron—though the latter is sufficiently explained wherever needed. A well-illustrated, well-rounded book which tells its story clearly but without frills or fanfare.—$3.90 postpaid.—*A. G. I.*

## ANIMAL TREASURE

*By Ivan T. Sanderson, B.A., F.L.S., F.Z.C., F.R.G.S.*

THE entertaining, rather racy account of a young self-taught English zoologist (later with a degree from Cambridge) who, without the orthodox ideas of the professional zoologist, went to West Africa to study the behavior of animals in their natural environment instead of in cages. As science it has been scathingly dealt with in public by a Harvard zoologist on the grounds that its many errors prove the author to be over-imaginative and not a true scientist.—$3.20 postpaid.—*A. G. I.*

## AUTOMATIC FREQUENCY CONTROL SYSTEMS

*By John F. Rider*

THE addition of automatic frequency control to the superheterodyne circuit not only permits the receiver to be tuned automatically by means of push-buttons but to be tuned more accurately than is possible by the use of a dial. The first four chapters of the book are devoted to a description of the application of basic principles; the rest of the chapters cover the different types of AFC circuits found in modern commercial receivers, their alignment, and a general discussion of their servicing. All the automatic and semi-automatic tuning systems are too numerous to be explained, but two or three, whose functioning may be considered basic and typical of many others, are covered very adequately. The explanation of what happens when a tuning push-button is depressed and how the AFC circuit compensates for the mechanical inaccuracies of automatic tuning is excellent, as is also the author's treatment of both the theoretical and the practical sides of automatic frequency control.—$1.15 postpaid.—*G. C. B. R.*

## PHOTOGRAPHIC HINTS AND GADGETS

*By Fraprie & Jordan*

WHAT advanced amateur photographer has not at some time or other yearned for some particular piece of equipment, yet could not afford to purchase it or could not acquire it at the exact time when it was needed? That many such men have gone through just this experience and have made use of their own initiative to provide the desired equipment is definitely evidenced by the content of the present book. Here is presented a vast array of data telling exactly how to make all kinds of photographic equipment from cameras to film clips, from lighting controls to enlarging easels. Space is too limited here to even attempt to list the 250 articles which tell photographers exactly how they may make many ingenious labor-saving devices to help them in their work. Out of these 250 there will be dozens that every photographer will straightway start to make. Nearly 500 illustrations.—$3.70 postpaid.—*A. P. P.*

## INORGANIC CHEMISTRY

*By Morgan and Burstall*

IN the general focusing of attention on the spectacular achievements of organic chemistry, the coordinating pattern of inorganic chemistry and the remarkable facts being learned about the 90-odd elements have been rather neglected. In this book the latest theories developed on the one hand by studies of atomic structure and on the other from complex organic compounds of metals are reviewed in some detail. It is not a book which a layman may expect to enjoy, but one likely to prove of important value to chemists by giving them a broad view of recent developments in their science.—$6.20 postpaid. —*D. H. K.*

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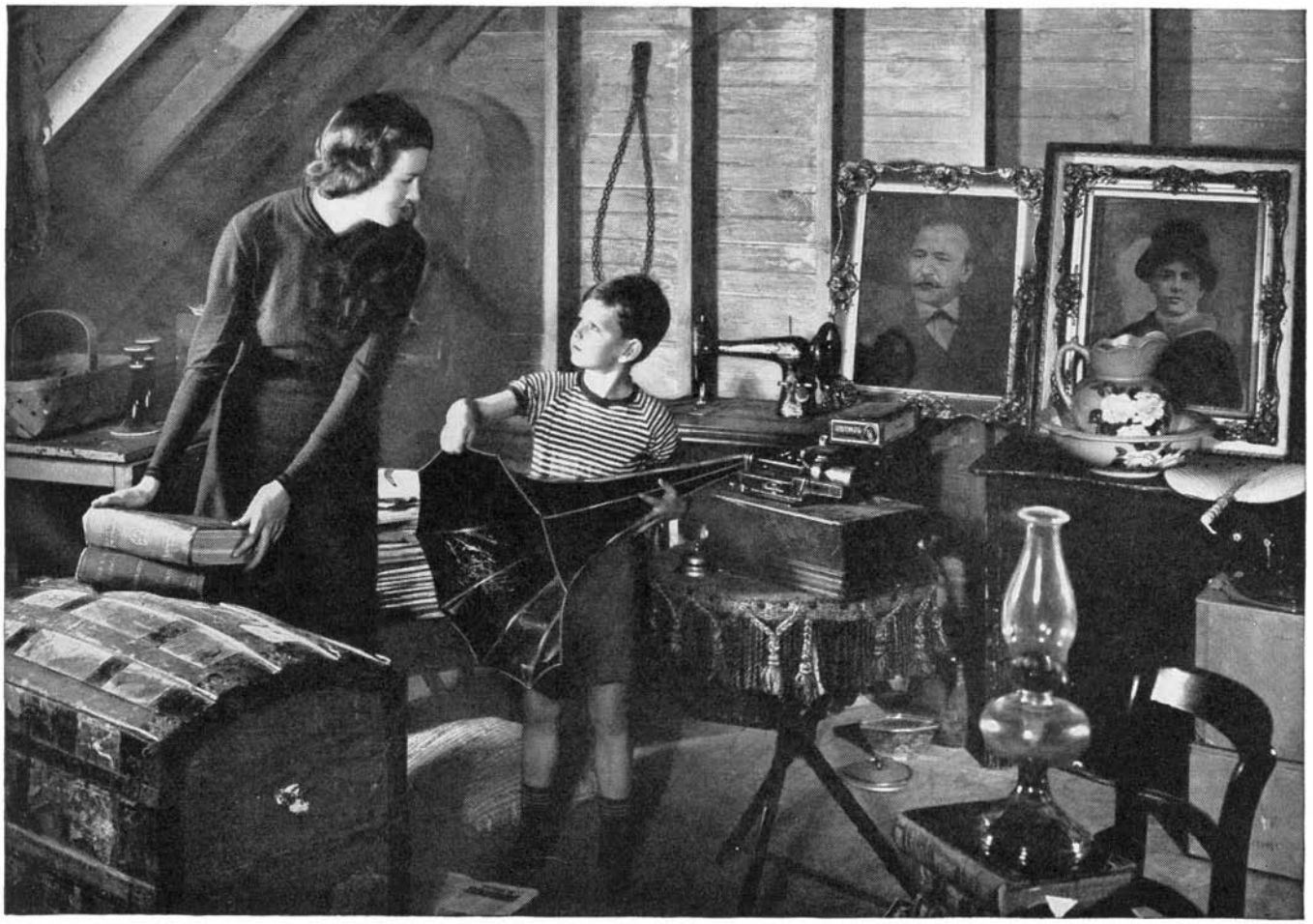

# "Gee, Mom, Were They All Poor People?"

**"Not exactly poor, Bobby. They had money. But they didn't have all the nice things that we have—such as a radio, and electric lights, and a vacuum cleaner. You see, they didn't have electricity, or automobiles, or airplanes. Most of those things hadn't even been invented."**

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