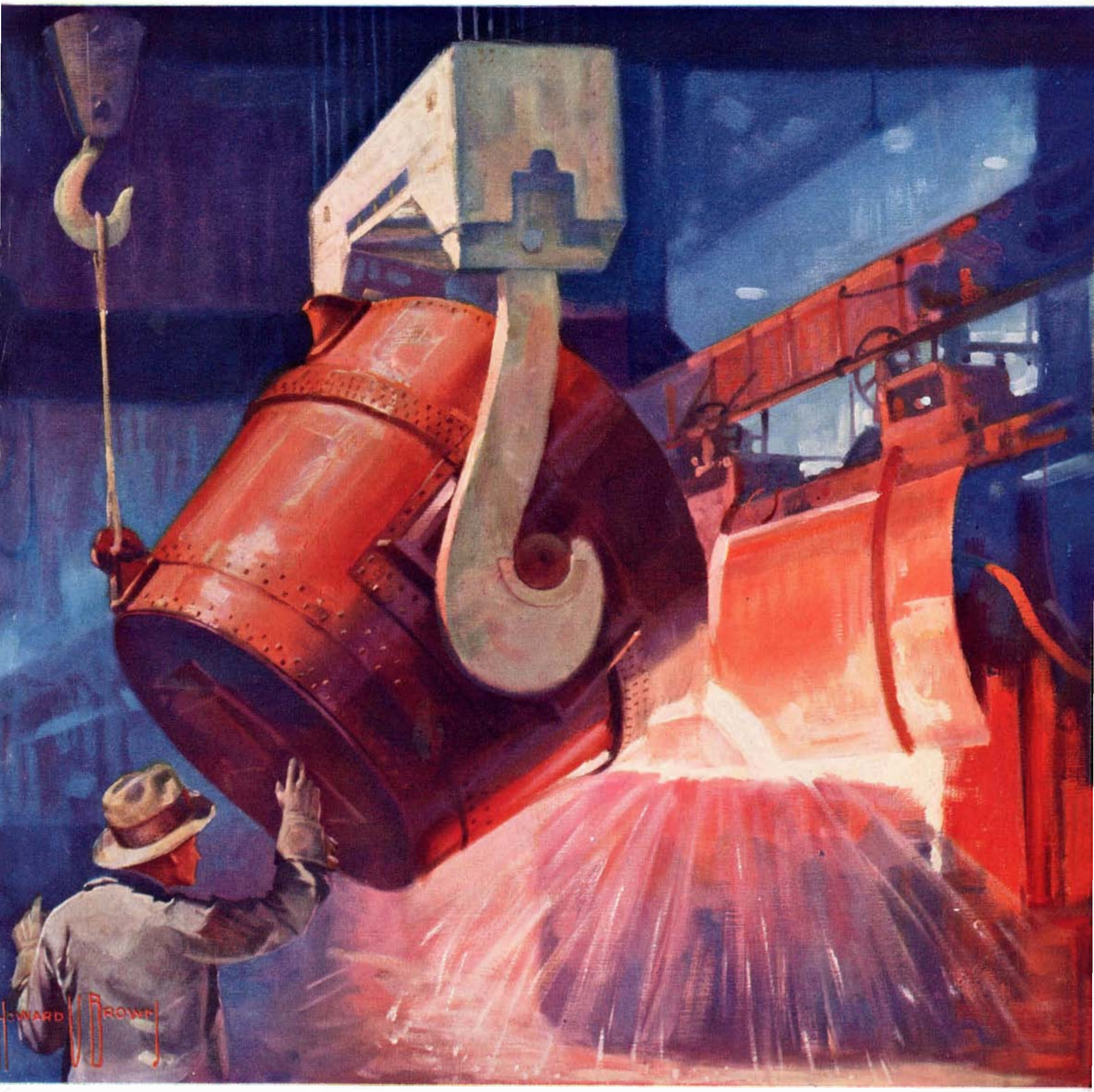
Synthetic Life From Chemicals—A New Advance

Why the Space Rocket? • • X Rays and Alloys

SCIENTIFIC AMERICAN

January • 1931 ★ 35c A Copy



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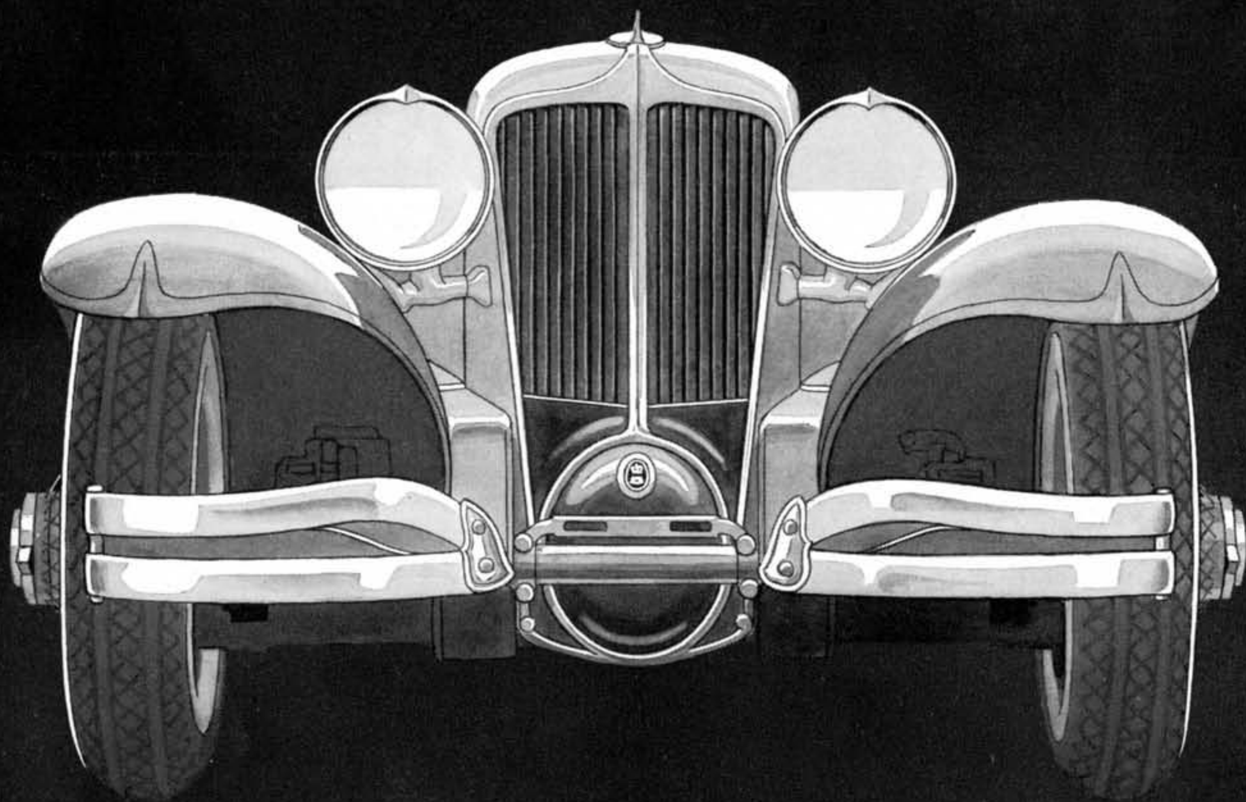

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EIGHTY-SEVENTH YEAR • ORSON D. MUNN, Editor

CONTENTS · JANUARY · 1931

THIS MONTH'S COVER

Relating to the article on page 26, our cover painting this month, by our artist Howard V. Brown, colorfully depicts a time-saving and fuel-saving method adopted by the American Rolling Mill Company. Molten metal is charged directly into the open hearth furnace. This modern practice materially reduces the time required to make a heat in the open hearth furnace and also effects quite a saving in fuel over the old method of charging cold pig iron.

ACROSS THE EDITOR'S DESK

WITH the present issue the SCIENTIFIC AMERICAN enters its 87th year of recording the progress of the world of science for an international audience. And since this issue will reach our readers during the holiday season, we take the opportunity to extend our best wishes for A Merry Christmas and A Prosperous New Year to all.

●

Among the advance proofs of the articles in this issue we find one set which is most intriguing. These proofs are of the article which deals with the subject of the X-ray analysis of crystalline structures. A scientific curiosity only a generation ago, the uses of the X ray have multiplied rapidly. Now as the result of a new technique, the same ray that is of such great assistance to the surgeon promises to become an invaluable asset to the engineer. The author of the article, Dr. Pullin, is well known in England for his scientific researches.

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The artificial production of life is still a moot question among men of science. Down in Mexico, however, there is an earnest research worker who has produced what is at least very much akin in appearance to simple low forms of life. Just what will come of this work only time will tell; for the present we record his results without further comment.

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Many of our older readers will probably remember, back in the early eighties, when the island of Krakatoa in the Sunda Straits burst its volcanic shell with a boom that was heard for thousands of miles; the huge wave that was formed inundated many villages and towns and took a vast toll of lives. Now old Krakatoa's "offspring," Anak Krakatoa, has been following in its forerunner's footsteps; to date the pyrotechnics have been stupendous but no harm has been done. A series of aerial pictures of Anak in action appear in this issue.

●

Only a few years ago the man who drove an automobile at 40 miles per hour on a public highway was looked upon as at least reckless if not an absolute menace to the lives of others. Today, however, so great have been the improvements in automobile and highway construction, 40 is considered only a moderate cruising speed and 50 and 60 are commonly attained in the ordinary course of driving. In fact one well-known car, equipped with a four-speed transmission, is reputed to do 65 miles per hour in third gear. All of which is a prelude to the announcement that February will be our annual Automobile Number and that it will contain advance information on the developments in motor cars for 1931.

●

While it is quite possible to put a new car or a new part or accessory on the market and let the public find its weak points, that is no longer the way in which the reputable manufacturer works. Instead, he does his own testing, his own fault finding. On his proving grounds he puts new cars or new parts through tests more gruelling than they will ever receive in ordinary service, and redesigns and rebuilds until the resulting product is as perfect as present knowledge can make it. An article on this testing work, different from anything that we have published heretofore, is scheduled for our February issue.

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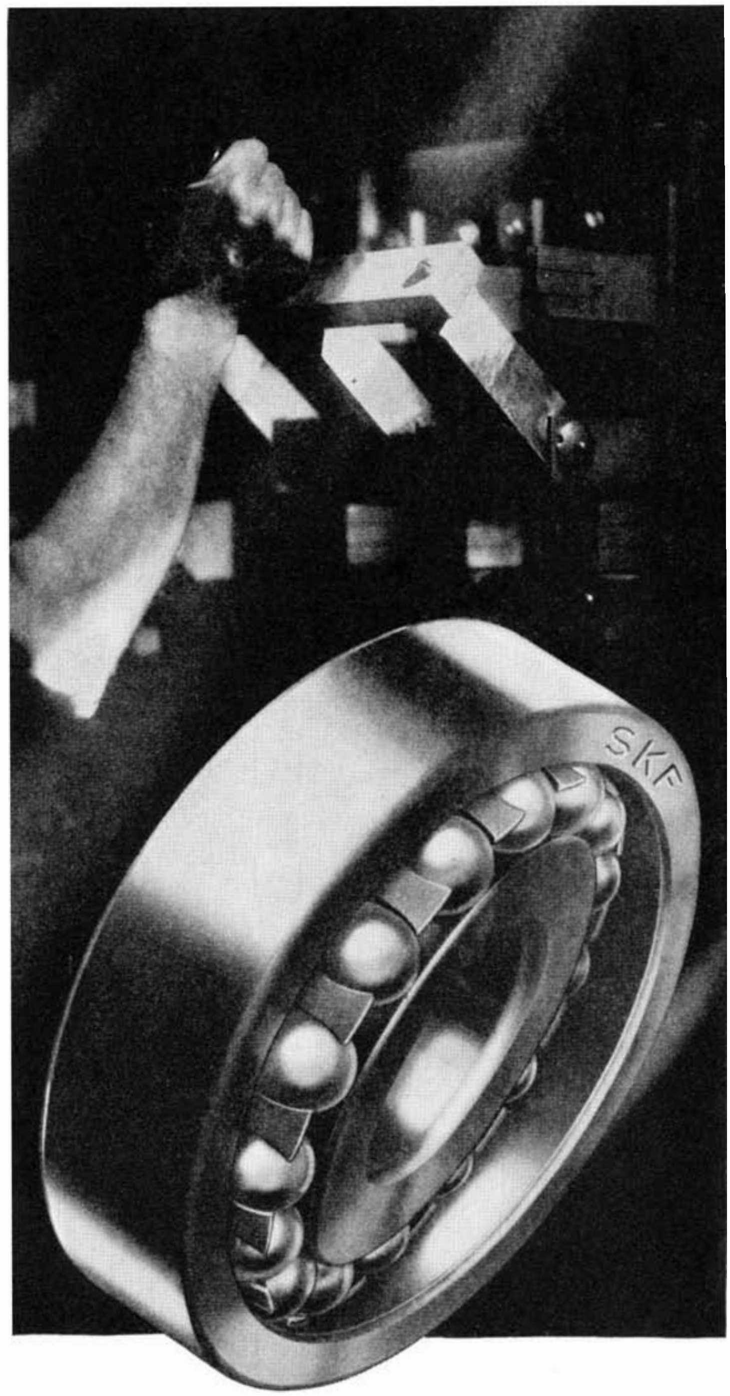
We are also collecting material for an article on up-to-date motor camping trailers which may give you an idea for a vacation next summer that will provide a freedom far greater than is possible when your travels must be governed by hotel reservations.

●

One of our editors was a guest at a recent demonstration of ordnance at Aberdeen Proving Ground, Maryland, and the article which he has written on the subject contains some amazing information as to the applications of science to our ordnance problems. Concerning guns primarily, this article also describes developments in our mechanized military forces, motorized gun mounts, tanks, and so on.

●

Although automotive articles will predominate in our February issue, they will not make up the entire content of the magazine. Features on other subjects will cover engineering, building construction, pure science, industry, and aviation. Grouped under the heading of The SCIENTIFIC AMERICAN Digest there will be a carefully selected series of short items that will reflect tersely yet accurately the latest developments in every branch of industry and science.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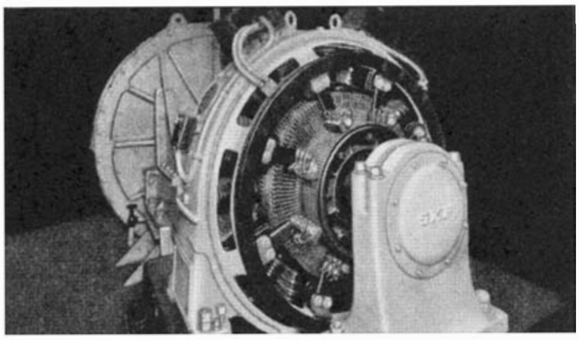
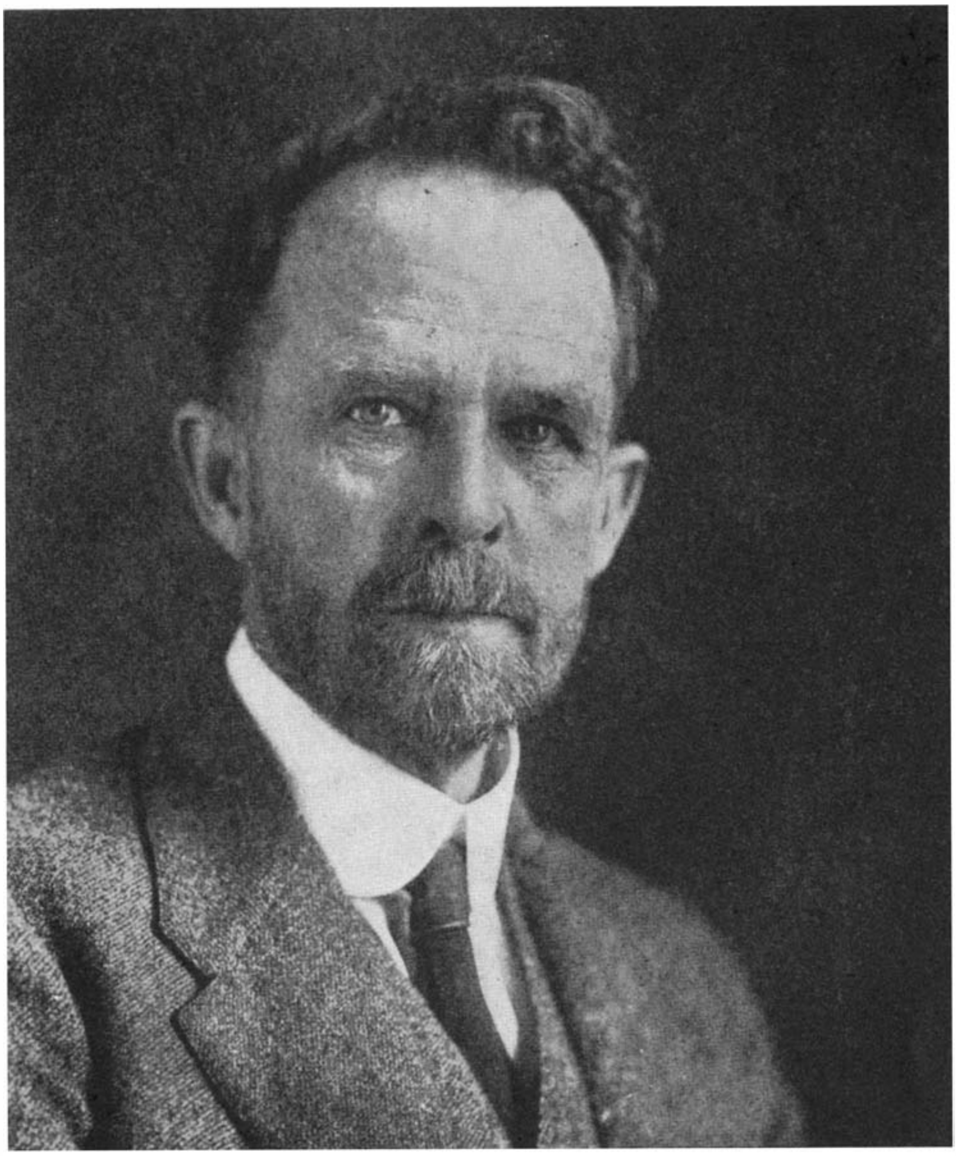


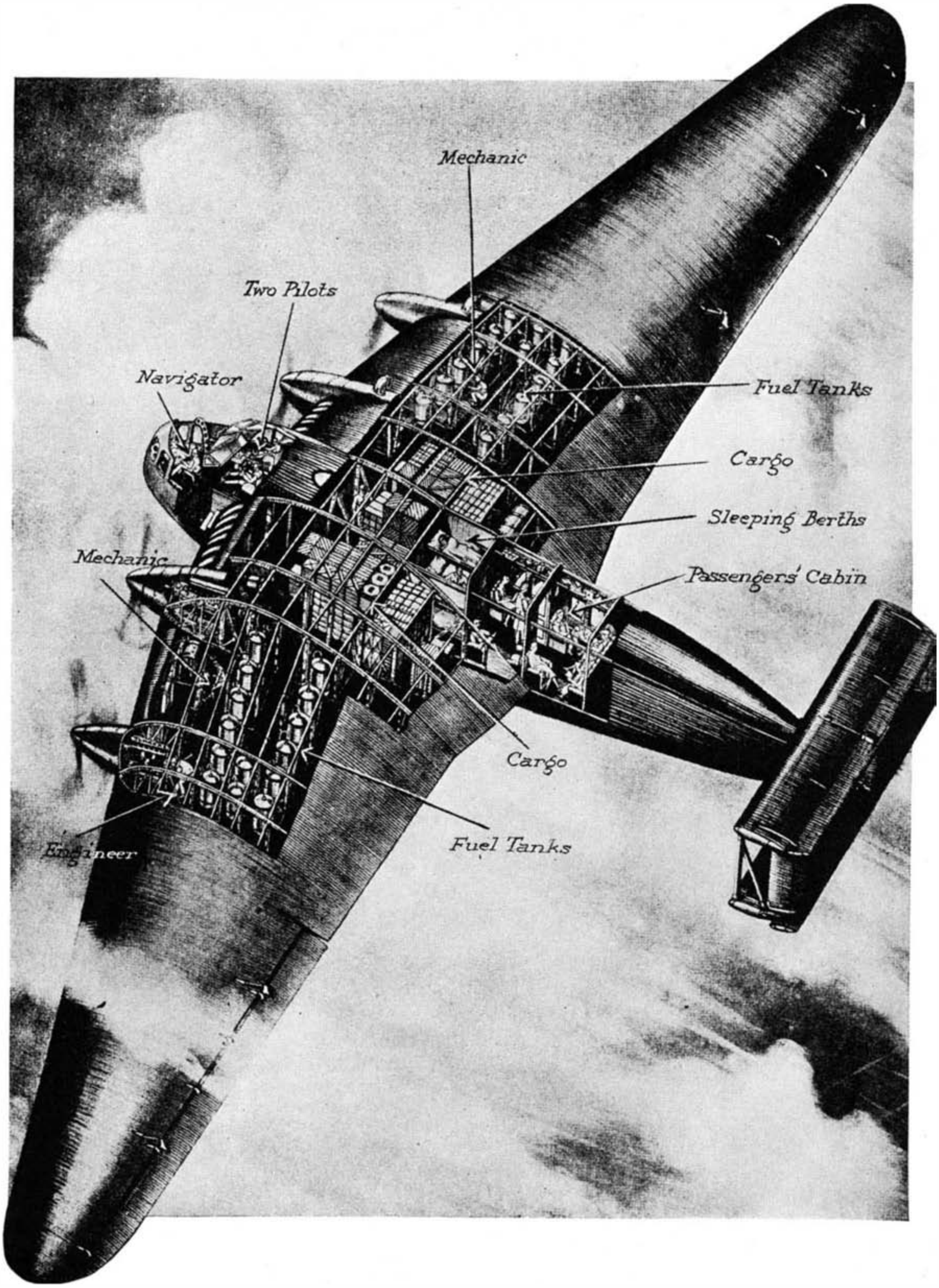


T. H. MORGAN

DR. T. H. Morgan, Director of the Kerckhoff Laboratories of the Biological Sciences at the California Institute of Technology, whose Presidential Address at the annual meeting of the American Association for the Advancement of Science held this year at Cleveland during the Christmas holidays no doubt will receive widespread notice, is the foremost living investigator of genetics and is also regarded by many other scientists as America's ablest man of science. In addition he is President of the National Academy of Sciences, the highest honor any American scientist may receive. Thus he is at the same time head of both the most select and the largest of our scientific bodies.

Professor Morgan's contribution to human knowledge is an understanding of much of the problem of heredity, and the isolation of principles which underlie and guide the practical work of plant and animal breeders. Therefore he is a key man to civilization in a large way. "The reader may never have seen this man," says Scott, "yet this great work whose successful solution he has chiefly led has inevitably touched often on your life. The discovery of the mechanism of heredity, the mechanism of the genes of the germ cells, has enabled other workers to breed cows that give more milk, hens that lay more eggs, wheat of higher yield and better quality, corn with more sugar, sheep with more wool and better meat. In sheer economic value alone Morgan has literally been worth billions."

The mechanism of heredity has been explained perhaps best by Professor H. S. Jennings in his recent semi-popular work "The Biological Basis of Human Nature." Morgan's own writings are more technical.



THE "INHABITED WING" PLANE OF THE GERMANS

CARRYING a useful load of two tons, this gigantic new Junkers monoplane *G-38* has, it is claimed, a flight range of almost 3000 miles. Due to its peculiar construction, as shown in this diagrammatic drawing, passengers will have spacious accommodations; and a great quantity of freight or mail can be carried in the thick wings which also contain fuel tanks, the four motors, and has wide passageways for the convenience of the mechanics who will attend the motors. The principal use to which such planes will be put will no doubt be in carrying perishable or fast freight for long distances rather than large numbers of passengers.

Loading ivory at Zanzibar, the old Arab capital on the East African coast. The tusks are first carried on the porters' shoulders to the small boats, then transferred to the lighters which are towed alongside the ship at anchor in the roadstead

IVORY, THE PEARL OF THE FOREST

By ERNST D. MOORE

IVORY, for its grace and beauty, its use for the purposes of art and adornment in all lands for many centuries, for the intensity and persistency of the quest for it and the bloodshed and suffering attendant on its acquisition, may well be classed with gold and precious stones. It has ever been a material associated with the history, romance, art, development, and industry of the world from the earliest times of which mankind has left a record; it is a synonym for luxury and beauty in civilization and of barbaric splendor in the savage countries of the world.

The work of one of the earliest artists of whose product we have any example is scratched on a few broken bits of prehistoric ivory: pieced together they show the picture of a hairy mammoth, sketched by a human contemporary of the animal.

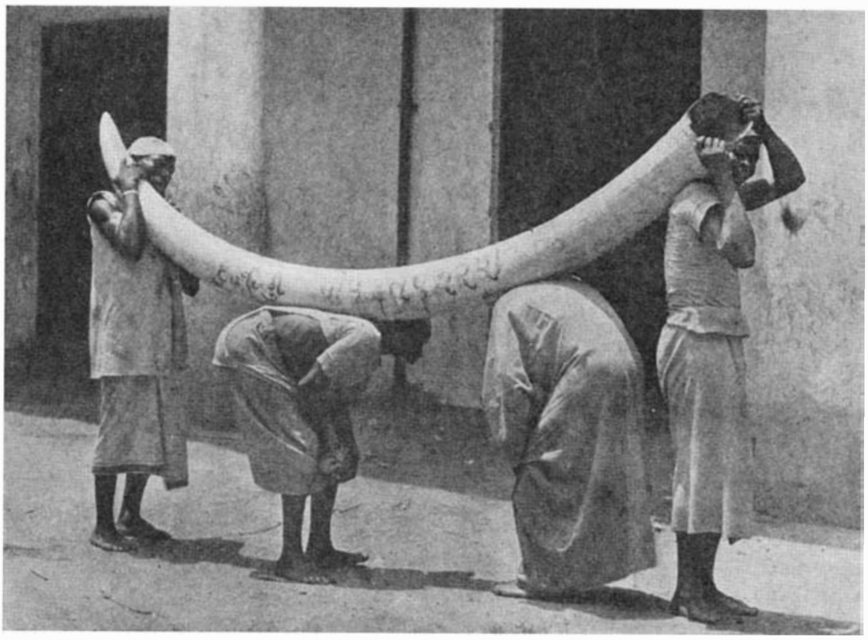
Solomon, so *Kings* and *Chronicles* tell us, had "a great throne of ivory," and to him came "the ships of Tarshish, bringing gold and silver, ivory, and apes and peacocks." Ezekiel pictures the craftsmanship of ancient Tyre in telling of its "benches of ivory inlaid in boxwood," and Pliny said the galleys of Tyre had benches made of ivory. The ancient Hebrews trafficked in ivory with Assyria; and in the days of Thothmes III, 14 centuries before Christ, cargoes of ivory from Abyssinia drifted down the Nile. The *Iliad* speaks of ivory studding on the trappings of horses, and the *Odyssey* of the bosses of shields and the handles of keys being made of ivory, and of roofs inlaid with "the spoils of elephants." The statue to Jupiter Olympus, wrought by Phidias of ivory and beaten gold, was among the seven wonders of the world.

Hundreds of similar examples might be cited; it has truthfully been said that the use of ivory has been so constant and universal as to involve the world's art and history in all ages.

THE supply of ivory has had some curious fluctuations. The Romans put it to such reckless use that by the beginning of the Christian era the then-known sources of the precious material were almost completely drained, whereas only a few centuries before, according to Polybius, it was so plentiful in Ethiopia that tusks were used for stockades in the fields. After the fall of Rome and through the Middle Ages the demand subsided greatly; then as the art and culture of the Renaissance revived it, the Portuguese discovered new fountain heads of ivory tusks in their voyages along the central and southern coasts of Africa. The Portuguese in turn drew such immense quantities of ivory that by the middle of the 17th Century the available supply was almost exhausted again; but a little later the Dutch began to collect ivory in their South African settlements, and the supply rose again. Since then, with the exploration and opening up of the central portion of the continent by the Arabs, British, Belgians, and Germans particularly, ivory has fairly held its own with the demand for it.

There are various types of ivory, notably that of the elephant, its predecessor the mammoth, the hippopotamus, and the walrus, but in this article we use the word to describe the substance generally understood by the term—elephant ivory: the qualities, the quantities available, and the use of other kinds other than that supplied by the elephant have always been negligible in comparison.

The tusks of the elephant are, in the ivory trade, known as "teeth," and this designation is a correct one, for they are the upper incisors of the animal. They grow during the entire lifetime of the elephant, both outwardly, so that the solid portion protruding from the head becomes increasingly longer and thicker, and inwardly, as the part which is set in the skull, about one third the length of the average tusk, contains a pulp chamber which gradually becomes shortened and constricted as the beast ages. A nerve runs the length of the tusk, the canal of which usually is visible as a black speck at the pointed end of the tusk. It is this same nerve canal that is visible on opposite sides, in the exact center, of an ivory billiard ball. Along this nerve, abnormal growths known in the trade as "beans," and other

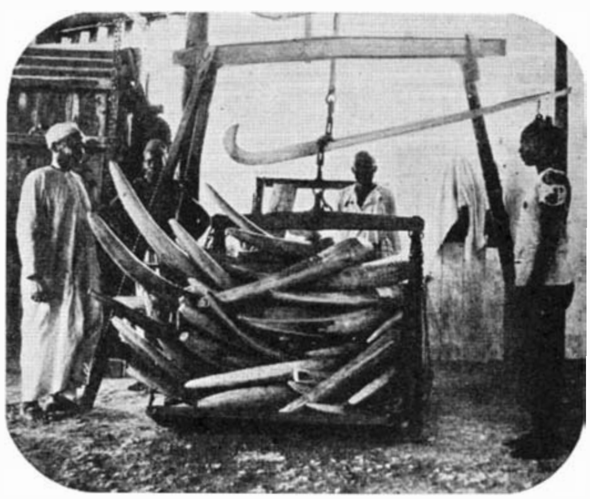


One tooth of the largest pair of elephant's tusks on record. This great tusk is now in the British Museum of Natural History at South Kensington, in London

evidences of disease which must cause the animals excruciating pain, are often found; so if we have jibed at the giraffe with a sore throat, let us pity the elephant with a toothache!

There are many varieties of elephant ivory—"descriptions," as the ivory buyers and workers know them—Asiatic ivory such as Indian and Siamese; the African kinds known by names of their geographical origin such as Abyssinian, Sudanese, Zanzibar, Uganda, Congo, Mozambique, Angolo, Egyptian, Senegal, Niger, and Ambriz; others named for the uses to which they are put, such as ball and bangle; and others with such odd names as Cutch, Gendi, scrivelloes, and so on. All ivory is divided into two great classes, "hard" and "soft." By far the greater portion of the world's ivory, from ancient times to our own, has come from Africa. The supply of African ivory has not only been many times greater than that of Asiatic ivory, but African tusks run larger and are of superior quality. There are large deposits of fossil or mammoth ivory in the tundra surrounding the mouth of the Lena River in Siberia and on the islands nearby, and though the tusks are much larger than the run of elephant ivory, they are largely defective, and of little commercial value so long as a good supply of African ivory may be had. Very little Asiatic ivory is exported from that continent; most of it is used in India for bracelets and bangles for native brides.

So ivory, as we generally know it, comes from the African elephant. Literally millions of those noble animals have died at the hands of those whose only object was to seize the ivory they carried, for the elephant must be killed to secure its jewels, as the tusks poetically have been called. The elephant does not shed them; it requires hours of careful chopping in a fresh kill to free them from the bony sockets which terminate almost on a line with and between the eyes, or the carcass must be left several days until decomposition has advanced sufficiently to permit them to be "drawn" without recourse to chopping.



***Above:* Weighing ivory in the compound of an American trader's establishment in Zanzibar. *Right:* An ivory poacher's caravan crossing a stream in the Belgian Congo with their stolen tusks. The ivory in both illustrations was shipped to America and there fabricated into ivory piano keys**

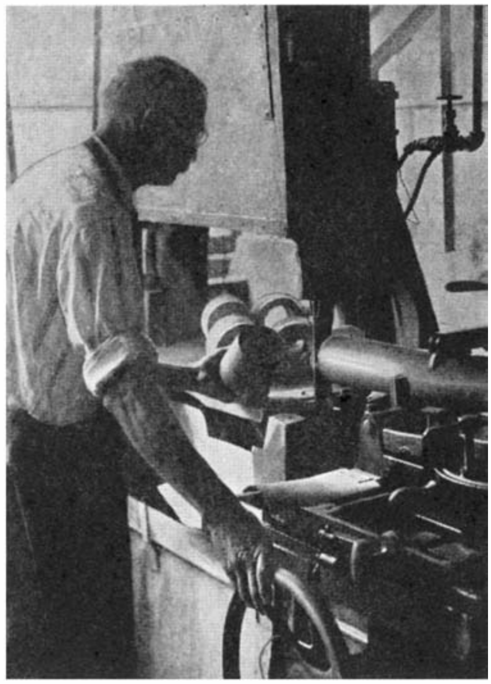
Various estimates, running from 40,000 to 100,000, of the numbers of elephants killed annually for their ivory, have been made. These estimates, it should be added, were for the years from 1850 to 1900. It is the judgment of the writer, who spent several years in Africa as an ivory buyer, that around his time, from 1900 to 1915, not more than 25,000 African elephants were killed each year; probably the number has been less since then. Any figure of this kind, however, is at best a guess, for not only are complete and reliable export statistics of the *number* of tusks not available in the many ivory outlets of Africa, but no records whatever are kept of the age of the ivory—that is, whether the tusks come from long dead or freshly killed animals. From recollection alone, in Aden, Arabia, where the writer bought tons of ivory gathered as tributes and taxes by Ras Menelik of Abyssinia, very little of it showed signs of having recently been in a living head. On the other hand, in Mombasa and Zanzibar, the two greatest ivory marts on the East Coast, by far the greater proportion of large tusks—those weighing 40 pounds and over, the writer buying none smaller—undoubtedly came from freshly killed elephants, as recently dried bloodstains and tissue attested.

The largest pair of tusks of which there is any definite record weighed 228 and 232 pounds, and came from Tanganyika, then German East Africa, in 1898. Fifty years ago it was not uncommon for a lot of "prime" tusks to average 90 pounds in weight; 20 years ago the average ran about 70 pounds; and now an average of 55 pounds is considered good.

Not only, in the old days, were the tusks stained with the gore of the fallen elephants, but with the life-blood of countless humans besides. The story of the acquisition of ivory in the 19th Century is also that of Africa in the most cruel aspect of all its tragic history. The slave trade and the ivory trade were one, interlocking and interdependent. Probably never in any other land or age did the natural treasure of a continent bring upon it so cruel a fate, over so immense a territory, as was Africa's in the years of the domination of the Arab ivory raiders. They pressed into the deep interior of the continent long before the first European explorers, and with their guns and powder terrorized and conquered, burned, enslaved and stole, throughout a country nearly as large as the United States east of the Mississippi, for decades.

THEY forced the natives, in every conceivable cruel manner, to deliver their accumulations of ivory, enslaved them when they could produce no more, and sold them for more ivory as human meat tó the cannibal tribes about; then, since the only means of transporting the ivory was by human carriers—the tsetse fly making the use of beasts of burden impracticable—enslaved still more to carry the ivory to the coast. There the captive survivors of the slave march—it was estimated that not more than one in five slaves lived to reach the coast—were sold along with the ivory tusks they had carried. Without the ivory, so Livingstone and others were told by the Arabs, the slave trade could not pay. Livingstone proposed the placing of armed steamers on the African lakes to enforce a legitimate trade in ivory and thus kill the slave trade at its source.

Today most of the ivory comes from the Congo, the upper Sudan, Tanganyika Territory, and Portuguese Africa. The white traders and British Indians get most of it from the natives, from whom they buy it legitimately or surreptitiously, as suits the market best. In the former case the ivory tax is paid and the tusks follow the regular trade routes, whereas in the latter, they are taken across the line of an adjacent colonial sovereignty and the import duty paid, thus legitimizing the ivory. The natives find a great deal of ivory in scattered tusks and small hoards which the governments take at a fixed nominal sum and then sell to the traders.

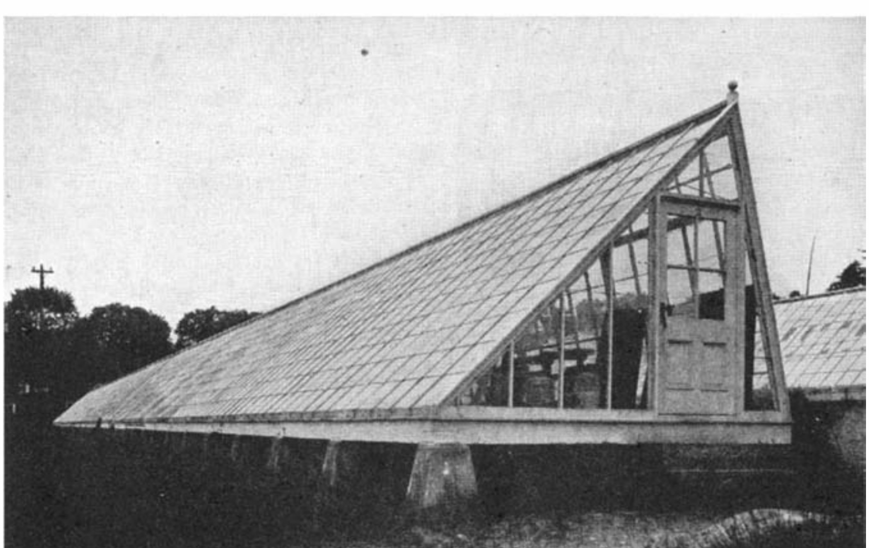


Cutting into blocks across the grain; the first operation in making ivory piano keys

In almost all jurisdictions the natives are allowed, within the confines of the district in which they were born and have lived a requisite number of years, to kill elephants and sell the ivory thus obtained. Sportsmen often sell their ivory to help defray their *safari* costs; government hunters often are despatched to kill troublesome or destructive elephants. Special ivory licenses are often easy to obtain if one is of the right nationality and has a little influence. A great deal of ivory is poached by elephant hunters in the Belgian Congo and Portuguese East Africa and brought over the British line, where, if necessary duty is at hand, there are no questions asked. Thus in many ways, straightforward or devious, the ivory is gathered, and started on its long journey to the working tools of the artisans of civilization.

Shipment of ivory will seem to many to be very carelessly attended to, for despite its great value and its easy susceptibility to damage, the tusks are shipped from Africa without any protective covering of any kind, the bare ivory being stencilled with the shipper's mark, number, and the port of destination. It has been found through long and costly experience that the appeal of the unprotected ivory itself is more potent in ensuring safe handling than any of the forms of covering that have been used.

One knows, of course, that ivory is used for carvings, for cutlery and other handles, for billiard balls, miniatures, and other objects; but, if we except the Indian bangle trade, more ivory is used for piano keys than for all other purposes combined. Ivory, not alone because of the exquisiteness of its contact to the human hand, is the ideal material for the piano keyboard. It is yielding to the touch, yet firm; cool, yet never cold or warm, whatever the temperature; smooth to the point of slipperiness, so that the fingers may glide from key to key instantly, yet presenting just enough friction for the slightest touch of the finger to catch and depress the key and to keep the hardest blow from sliding and losing its power.



The ivory wafers are left several weeks in glass houses to whiten in the sun. When one side is bleached the trays of ivory are inverted and the operation is repeated

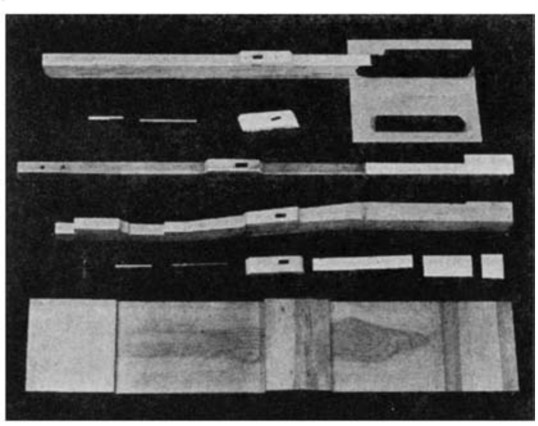
THE largest individual users of ivory in the world are the American companies who manufacture keyboards for the piano makers of this country, Canada, and Australia. The center of the ivory industry in the United States lies in two small adjacent towns in Connecticut, on the river which gives the state its name. There is a large ivory cutting company in Buffalo, also. One of the Connecticut ivory cutters, Pratt, Read & Company, of Deep River, is among the oldest surviving manufacturers of any kind in this country, its ivory business having been established in 1806, during the term of Thomas Jefferson, on the same spot where the present factories stand. The photographs of piano key manufacturing were taken in their factories. The few American piano key companies—there are only three—influence almost to a dominating

Matching the ivory into sets of similar grain for piano keyboards

The board with the ivories glued thereon is separated by saws to form the individual keys

extent the price of ivory even in the remotest depths of Africa. At present the cost of a good quality of Congo ivory is about $2.25 per pound at New York.

On arrival at the factories of the key makers, the tusks are stored in vaults, well protected from the light and any extreme changes of temperature and humidity. In the first manufacturing operation they are "junked," or cut across the tusk, to make blocks corresponding to the length of the pieces required for the piano keys. These blocks are then marked by a planner who is expert in the art of getting as many blocks of the broad pieces for the "heads" or front part of the piano key, and the "tails" which are the narrow pieces which run alongside the sharps or black keys, as is possible out of them, leaving at the same time as few wedges of scrap between the head and tail blocks as can be managed. These pieces are then sawed out, and the resulting small oblong blocks are sliced into the ivory wafers that finally cover the piano keys. Each of the sawing operations is done under a stream of water to prevent burning the ivory; the condition of the saws is of vital importance and is watched carefully.



Piano keys and their components: frame, ivories, buttons, sharps, guide pins, capstans

The ivory wafers are then bleached in jars containing peroxide of hydrogen, in the endeavor to make them as uniform in color as possible, for there are many shades and imperfections in a single tusk of ivory. After the immersion is over, the pieces are placed in glass houses which to the passerby seem to be the hot-houses of some horticulturist, and there left to whiten in the sun. From the sun bath the ivory pieces go to a department where, in the north light, they are graded according to their grain and matched into sets for the keyboards.

Meanwhile the wooden board which forms the major portion of the keyboard is being made from sugar pine from the Pacific slope or basswood from the middle West and marked, drilled, and bushed to the particular spacing or "scale" of the piano in which the completed keyboard is to be used. A frame or bed for the keyboard is also made and drilled correspondingly.

At the proper time the ivory and the board meet; a strip of white backing cloth is first glued on the board, and then on the cloth the ivory is glued with a light gray gelatinous adhesive made in France, and set firmly, but with extreme nicety, in a heavy press. Afterward the ivory on the board is planed, sometimes only one or two thousandths of an inch, by rapidly rotating cutters. Then the ivory is polished on buffers.

The next step is the separating of the keys, thus far all together in a single board. Gang saws spaced to the width of the keys in front and band saws for cutting the rearward portion of the keys that swing to right or left to meet the spacing of the piano strings, which is different than that of the front of the keys, are used for this work. Then the pieces which form the bases for the black keys are sent to another department to have the black tops or sharps glued on.

The sharps are made of various materials. They may be of ebony from Madagascar or boxwood from the West Indies, or of native birch. These pieces are stained a deep black in such a thorough manner that if you should cut one of them in two you would find that the wood was stained not merely on the surface but all the way through. This is done by forcing the stain into the wood under pressure in a chamber in which a partial vacuum has first been created. A very fine sharp is made, also, by forming a piece of black celluloid, first rendered plastic by heating, over a core of birch.

After the sharps are glued on, the black keys must find their way back to their own positions in the identical set of ivory keys from which they were parted, and they always do, though the thing appears as mystifying to the outsider as the process by which one finally gets one's own washing out of the steam-laundry's common tub.

THE final steps may be passed over quickly. The sharps and naturals are reunited, the frame is brought up, with its rows of shining pins firmly and accurately set, and on them the keys are fitted and regulated. Then with the final inspection done, the keyboards are shipped off in piano boxes, so that the piano maker who receives them can use the container again in shipping a piano. Soon all manner of human hands, from those which bear the stumbling fingers of practicing childhood to others tipped by the accomplished digits of the virtuoso, are at work on them with varying effects on our peace and happiness.

The making of piano keys is not quite as simple an affair as the foregoing may make it seem to be. Because of the never-uniform quality, texture, and susceptibility of the ivory it is in reality a tremendously difficult, tricky business, to which few set formulas apply, and one which necessarily requires constant expert, individual judgment to overcome the peculiarities of each tusk of ivory used.

If only the elephants would standardize their production, the ivory workers would be happy to do the same with theirs. Since, however, there is no way of inducing the elephant to co-operate, the skill of the workmen must be relied upon for the production of high quality articles from the pearl of the forest.

OUR POINT OF VIEW

Blindness and False Shame

ONE thing that has long irked all men of science is the false sense of delicacy that surrounds the subject of syphilis, the ravager which blinds and kills thousands. This dread disease is not something to be looked upon as the result of sin, a subject to be tabooed; it is rather a powerful enemy that should be treated as such and attacked with all the weapons of science—in the open.

Estimates of a prevalence of syphilis up to 12 to 18 percent have been made for cities such as New York, Paris, and Berlin, but Professor Edward H. Cary, M.D., LL.D., of Baylor University, said, in a paper read before a conference of the Society for the Prevention of Blindness, that he believes this is too high. He estimates that if our total population were examined, 6 to 7 percent would show a positive Wassermann test. This means that that percentage may suffer blindness, may transmit the disease to unsuspecting loved ones, and may bring into the world children that are blinded by syphilis at birth or later in life. Moreover, as every one knows, the mortality in syphilitic cases is high.

Professor C. S. O'Brien, M.D., of the State University of Iowa, said before the same conference that if the disease is recognized in the child during infancy, proper treatment may prevent its effect on the eyes; if not, then very little can be done to stop the process. If it is detected in the mother before marriage or even during early pregnancy, proper treatment of her case will give the child a chance to be born with normal eyes.

Professor O'Brien suggests that a law be passed to compel all persons to submit to blood tests and, further, that all women should have blood tests as soon as they become aware of pregnancy. Of the efficacy of the first, we have our doubts; laws seem nowadays made to be broken. Education of the mass of our population is what we need and that will never be achieved while the present hush-hush attitude prevails. Syphilitic eye defects must be prevented by active educational propaganda.

We believe with Professor O'Brien that syphilitics should not be allowed to marry and that all pregnant women should have blood tests. The stark truth is that no prospective mother knows that she is free of a dormant syphilis; it may be hereditary or she may have contracted it in ways for which she should suffer no reproach nor feel any personal shame. Once it is discovered, immediate and prolonged treatment is necessary.

We have spoken frankly but not indelicately; we have simply stated unalterable facts. The more others speak as frankly, the more chance will scientists have to combat the blindness which occurs as the result of metasyphilitic disease. But while prudery or a false sense of shame covers up the facts, the great destroyer may, like lightning, strike anywhere.

YOUR AID IS NEEDED

INDIVIDUALS, committees, city and state governments, and even certain branches of the Federal Government itself, have, during the past few weeks, worked out praiseworthy plans for the relief of unemployment. Some jobs have literally been created out of nothingness and others are simply jobs that should have been done long ago but were postponed for one reason or another. All in all, the work along this line has been splendid and we commend all those who now have or have had a hand in it.

The problem of unemployment, however, assumes a more serious aspect with the coming of cold weather. If our winter is severe, there is bound to be a great deal of suffering, especially in our cities, for many thousands will lack sufficient fuel, warm clothing, and warm, nourishing foods.

The work of making jobs must, therefore, go on—not half-heartedly but with well-directed vigor. But there is something more which is especially important at this Christmas season. We millions of well-fed, well-clothed ones who have been touched only superficially by the depression—we who have grumbled because we have had to keep last year's cars—must open up our purses as we haven't since the war and must give to the Red Cross, the Salvation Army, the Volunteers of America, and other organizations of a like nature in our communities. And for those people who cannot be classed among the poor that receive charity, we must make more and more jobs.

Too Fat?

BY continuing the "slim silhouette" in women's fashions, dress designers are salting the gold mine which already has enriched purveyors of fat-reducing remedies, most of which are wholly worthless, some, indeed, being harmful.

The Food, Drug, and Insecticide Administration of the Department of Agriculture states that "No drug or mixture of drugs known to the medical profession can be offered for the promiscuous use of the public for reducing weight without introducing an element of danger." In fact, the Administration has record of a case in which death resulted from an overdose of a widely sold anti-fat concoction.

Therefore, whatever your reasons for reducing, do not allow your reason to be seduced by lurid advertisements. Consult your physician and let him prescribe the remedy, if there is one for your particular case, and then follow his instructions conscientiously. It's safer!

International Affairs

Our Peacemaker

WHEN Mr. Hoover was elected it was predicted in some quarters that his long residence abroad would cause him to take a lively interest in foreign affairs; and so it has come to pass. Not content with the results of the London Naval Conference the President is now undertaking through Mr. Hugh Gibson, American Minister to Belgium, to reconcile the conflicting claims for naval tonnage of France and Italy.

The purported reason of our interest in this problem is the fear that England will insist upon increasing her naval program if France and Italy continue to add to their navies, and England's building will cause us to increase our navy or fall farther behind. In short, we must either persuade these two states to decrease their naval programs or spend some more money on our fleet.

The reason given these two states for our gratuitous but friendly advice is that jointly with England we were instrumental in calling the Naval Conference, which has unfortunately caused increased tension in the French-Italian relations and therefore we feel it our duty to assist them in finding a formula for their two navies that will remove this friction.

(Please turn to page 67)

TESTING THE ASTRONOMICAL YARDSTICK

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

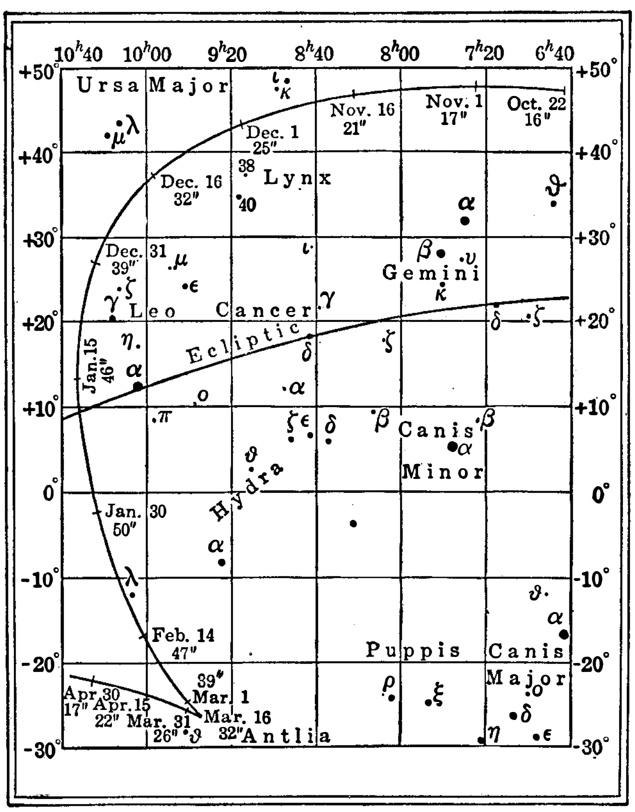
THE earth's distance from the sun has sometimes been called "the astronomer's yardstick," since it is the unit which he uses in describing other distances. Our best methods for measuring the distances of the planets—and, for that matter, of the nearer stars—do not give an answer directly in miles or kilometers; they tell us how many times the sun's distance or what fraction of it we have to deal with. Hence the accurate measurement of the sun's distance (or to be accurate ourselves, of the mean value of this distance, which varies in different parts of the earth's orbit) is one of the major problems of observational astronomy. Many ways of measuring it have been devised and put in practice. The results agree so well that it is unlikely that the accepted value, 92,870,000 miles, is in error by as much as one-fiftieth of 1 percent.

But even this small margin of uncertainty amounts to more than 18,000 miles, and it would be worth while to diminish it. The best chance of doing so by direct observation that will fall to the lot of any astronomer now living comes at the present time, and an extensive and carefully planned series of observations are already under way at many observatories.

TO find the sun's distance we begin by measuring that of a planet—for the ratio of the two can be calculated with all the accuracy we need if once we know the planet's orbit. The nearer the planet is to us the more accurate our measurements will be; for they depend upon the convergence of the lines of sight from various parts of the earth, on the familiar principle of the range finder.

Of all the planets the little asteroid Eros comes closest to the earth and it will be nearer late in January than it has been since its discovery in 1898, or than it will be again until 1975. Why this happens appears clearly from Figure 2. Eros moves in a decidedly eccentric orbit. At aphelion its path is more than 70,000,000 miles outside the earth's orbit but at perihelion the distance is only 13,840,000 miles—which is but a little more than half the distance of Venus.

Such close approaches are rare, for the orbital velocity of Eros at perihelion is almost equal to that of the earth (though in other parts of its orbit it is smaller). If the earth is behind the planet as the two approach the region where the two orbits are nearest it has a "stern chase" and can not catch up with Eros until the favorable region has been passed. On the other hand, if the two planets are abreast of one another at perihelion they will remain so for a good while. This is happening at the present time. Eros comes to perihelion on January 17th. At this time the earth is not quite in line between it and the sun, but we are only five days' motion behind. It takes us a whole month to catch up far enough to get between Eros and the sun, so that opposition does not occur until February 17th. The distance reaches its maximum on January 30th, 16,200,000 miles, and is less than 20,000,000 miles for almost two months.



From Russell Dugan and Stewart's Astronomy, courtesy Ginn and Co.

Figure 1: **The path of Eros. The figure below each date indicates the parallax, which is explained in the text**

A still more favorable approach happened in 1894 when the earth was only a day and a half ahead of Eros, but unfortunately this happened four years before the planet was discovered. In 1900-01 the earth was 17½ days ahead and the least distance was a little less than 30,000,000 miles. Hundreds of observations were made on the planet that winter, and the resulting value for the sun's parallax and distance is the best that has yet been obtained by the geometrical method. The planet is so much nearer this time that one night's work should be as valuable as three nights then (with instruments of equal power).

FOUR revolutions of Eros take 16 days longer than seven of the earth. In 1938, therefore, the earth will be 11 days ahead of Eros at perihelion and conditions will be better than in 1901. Reckoning ahead, it appears that in 1968 the earth will be 11½ days behind, and in 1975, 4¾ days ahead; which will give the observers another chance substantially as good as the present, but little better. In the year 2012 the earth will be less than two days behind Eros and only then will the lost opportunity of 1894 be repeated.

The planet's track in the heavens at a favorable opposition is unusual and curious (Figure 1). Its orbit is inclined nearly 11 degrees to the ecliptic, and the node nearly coincides with the perihelion, as is shown in Figure 2. In consequence the planet at this time is moving eastward around the sun at very nearly the same rate as the earth, but is also moving southward or, in the figure, downward through the plane of the paper. For us who watch from the earth the eastward motion is almost neutralized while the southward motion is apparently rapid. Before opposition Eros is far north in Ursa Major (Figure 1). It sweeps southward in a wide curve, crosses the ecliptic about at right angles, and is almost stationary in March in the southern constellation Antlia, almost 40 degrees from the ecliptic and with the declination differing by 74 degrees from what it was in November. The planet's distance decreases from 51,000,000 miles on October 25 to 16,200,000 on January 30, and increases to 50,000,000 before the end of April. It will be nearly three magnitudes brighter at the middle date than on the others. Recent observations show that it is fainter than was anticipated, and at best it will be between the eighth and ninth magnitudes and quite invisible without telescopic aid.

To identify Eros the observer should have a good star chart. It will then be fairly easy to pick the planet out by its rapid motion, which amounts to a degree per day. For the benefit of those who may care to try, this brief ephemeris is given:

	R.A.	Dec.
Jan. 5	10h 28.0m	+23°7′
17	10 31.4	+11°12′
29	10 23.4	— 2°8′
Feb. 10	10 7.2	—13°57′

THE precise observations of the planet which are made to determine the sun's distance, present interesting complications. What we must measure is the planet's parallax—that is, the difference of its direction as seen from the point where each observer happens to be, and from the earth's center (which is adopted as a standard). We can not of course observe it from the latter point, but since we already know the planet's distance very closely we may proceed as follows.

Starting with the present accepted distance of the sun we may calculate that of the planet at any time, and then by straightforward geometry compute just how much the apparent position of the planet as seen from the point of observation at the given instant should differ from the position seen by the hypothetical observer at the earth's center. Applying these corrections for parallax to all the observations we obtain a series of results which, *if our adopted value of the sun's distance was exactly right*, would agree perfectly with the value calculated from the theory of the planet's orbital motion (except for the very small errors which are unavoidable in even the best observations). If, however, our adopted distance from the sun is a little out, this agreement will be disturbed and can be improved by increasing or diminishing the corrections for parallax by a small fraction of 1 percent. Just what alteration is required is found by the method of least squares, familiar to the computer, which makes the outstanding discordances as small as possible.

In this way all the observations made at observatories throughout the world can be combined in a single investigation. The computer will have plenty to do, for in a question of such delicacy he can not put trust in even the best previous calculations of the elements of the planet's orbit. He must determine them anew and find what corrections to them as well as to the parallax will give the best possible representation of the observations of the "campaign." Incidentally, of course, we must verify that the perturbations of the planet's motion by the attraction of all the other planets have been correctly computed.

All this is very laborious, but the methods to be employed are well known and it is really only a question of bookkeeping, so to speak. Still more care and forethought are required in order that the observations themselves shall be free from all avoidable errors. Observers for stellar parallax need not bother themselves with a precise determination of the actual right ascension and declination of their stars—the *relative* positions of the stars in the photographed field tell them all they seek. But in the present case, where the planet wanders far over the heavens, the stars around it will be quite different from day to day and it becomes necessary to know their places with great precision. A long series of "reference stars" distributed all along the apparent path of Eros was therefore picked out years ago, and these have been carefully observed at many places so that their positions are now among the most accurately known in the heavens. Photographic methods will add many fainter stars to this list. If the astronomer who photographs Eros can find four or five of these stars on his plate he can measure the planet's position, using these as standards, and have full confidence in his results. It may be possible to guide on the planet, which will then show a round image while the stars appear in trails. Which of these methods will give the most accurate results can be found only by trial.

FINALLY there is a subtle error arising from the colors of the stars. Refraction of light in the earth's atmosphere shifts the stars' apparent place in the sky and shifts a blue star more than a red one. If the planet's light is redder than the average for the stars there will be a resulting average shift which, though small, is very troublesome since it acts always in the same direction as an increase in the parallax. The spectra and hence the colors of the reference stars have therefore been observed so that observers can avoid stars of extreme color, or perhaps balance a red one with a blue one.

One other thing besides the sun's distance should be very accurately determined by this campaign and this is the mass of the moon. As the moon circles about the earth every month the earth's own center swings in a small orbit about the center of gravity of the two bodies. The distances of the two from the center of gravity are inversely proportioned to their masses.

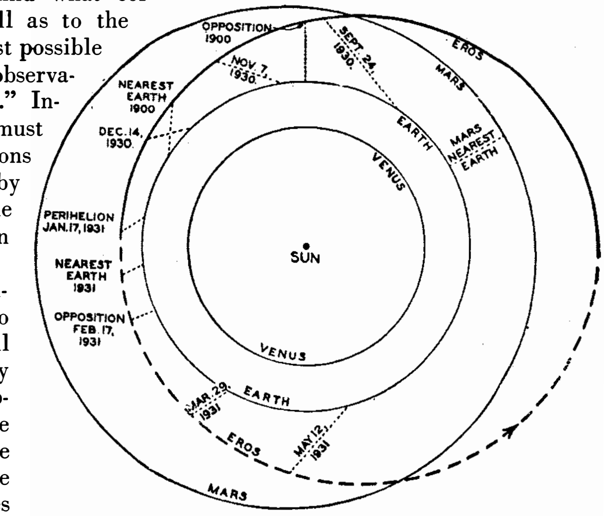
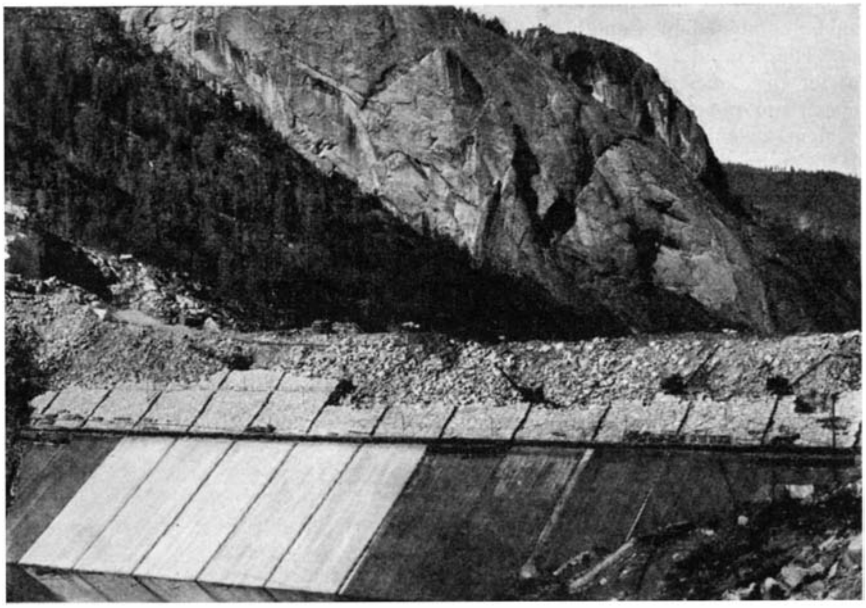


Figure 2: **Orbit of Eros. From a special leaflet issued by the *Astronomical Society of the Pacific***

This motion of the earth's center is of course allowed for when predictions are made of the apparent motions of the sun or the planets. If the value at present adopted requires any alteration its amount can be found from the observations of Eros by introducing this correction also into the solution, like the correction to the parallax. To get a good determination the observations must be continued for some three months, so that the "lunar equation" may swing from positive to negative and back again several times.

Many observatories throughout the world will engage in this campaign and, indeed, are now actively at work upon it, taking all the precautions here described and various others which we have not space to tell of. Most of the work will be photographic, as is always the case nowadays. Before spring comes thousands of plates will doubtless have been exposed. Measuring them will be a long job and discussing the results a longer one, so that it may be fully ten years before the final result is announced.

After this sketch of what is involved in the present Eros campaign it may be hoped that the reader will not reproach astronomers for the delay. Numerous other astronomical problems have involved longer periods of application, even, than this.—*Princeton.*



Three stages of construction of the Salt Springs Dam—the dumped stone, the hand-placed stone, and the concrete slab of the upstream face

A STONE DAM GREATER THAN CHEOPS' PYRAMID

By P. M. DOWNING

Vice-President and General Manager, Pacific Gas and Electric Company

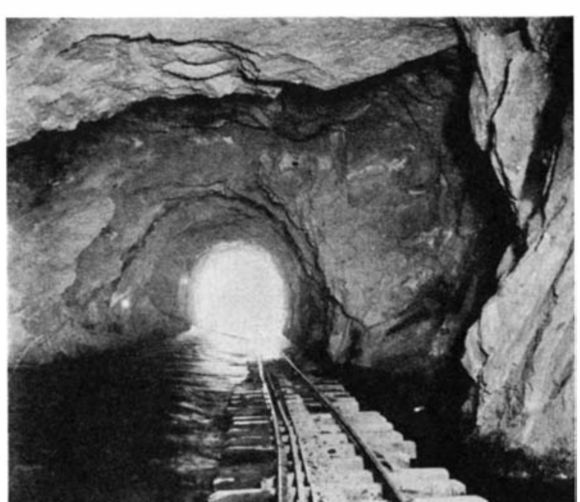
A DAM as large as the pyramid of Cheops, wonder of the world for thousands of years, is the modern miracle of industry which features California's latest great hydro-electric project.

Literally moving mountains for its purposes, the Pacific Gas and Electric Company is constructing at Salt Springs high on the Mokelumne River in the Sierra Nevada, the largest rockfill dam in the world. Nearly 3,000,000 cubic yards of granite are being massed across the canyon of the Mokelumne River, in a mighty structure which rises 330 feet from the river bed, extends 1300 feet at its crest from one canyon wall to the other, and measures 900 feet through at the base.

The Pharaohs spent a lifetime in constructing their pyramids. The California power company is spending two years in constructing its dam.

Two years to move 3,000,000 cubic feet of mountain means that 125,000 cubic yards of granite must be quarried and dumped each month. Moreover, this tremendous task, involving the blasting of mountain sides, transportation of mighty rocks weighing as much as 25 tons, and settling these stones in their places on the mammoth structure, is being carried on in the remote fastnesses of unbroken mountain country, 50 miles from the nearest railway, where not even crude roads had penetrated before the power company surveyors.

Preceding the actual period of construction on the dam, the builders carved roads, extended power lines, constructed camps, and in other ways made provision for the use of modern machines, for the transportation of supplies, and for the housing of the small city of men required to carry on the work.



A portion of the tunnel built to divert the river. It was excavated through a mountain of solid granite

The character of the high Sierra country in which the work is taking place adds to the difficulties of the builders. It is a country of solid granite, rising in bluffs which have been compared to the famous walls of the Yosemite Valley, and descending precipitously into the canyons of its many water courses. Two years, with enforced halts during the winter period of heavy snow, were required in the building of a 30-mile road in that granite country. This road had to be carefully constructed to stand the wear and tear of three years' constant traffic, during which more than 50,000 tons of cement, steel, machinery, and other supplies were to be hauled to the construction site.

ONE supply does not have to be hauled in—the stone for the dam. An abundance of excellent quality granite for quarrying is right at hand. In the building of an ordinary gravity type concrete dam, about 150,000 tons of cement would have had to be brought in to do the work of this stone. Granite cliffs at the dam site provide the rock supply and it is from these cliffs that the stone is blasted away and poured down into the river's chasm.

Every modern construction convenience is available to the 1600 men who are now working on the project here in this isolated region. Electricity is available for all power operations, lines having been extended to this location from the nearest point on the power company's system, 40 miles away. This line was used even for road construction.

Machinery which has been developed during the course of many years' experience in the west is available for this newest project. Additional equipment has been worked out to meet the peculiar problems of this job, which is new and unusual in many of its features.

Construction at the dam site itself began in 1928, and is to be completed during the summer of 1931. Most important of the preliminary tasks were the excavation of a tunnel, 19 feet in diameter, through the granite mountain on one side of the proposed structure to permit the diversion of the river during the period of construction in the river bed; and clearing away the river bed to the solid foundation. About 310,000 cubic yards of loose rock and other debris were removed in stripping the dam site to bed rock.

Then began the two-year

process of pouring rock into the fill. Stone was dumped from both abutments, gradually blocking up the canyon. On the downstream face the rock was allowed to roll to a natural angle. The upstream face, which must withstand the pressure of 130,000 acre-feet of water in the gigantic reservoir to extend four miles back of it, is being faced and sealed with placed stone and concrete.

Three main quarries are located on the north side of the dam. On the south side, excavations for a spillway provide about 500,000 cubic yards of rock. An average haul of about 1500 feet is required between quarries and the fill. This transportation is carried on by tractor-drawn trailers of nine cubic yards capacity, from the spillway quarry. Thirty-cubic-yard railroad cars, drawn by electric locomotives, haul the rock from the north quarries. Both side-dump and end-dump cars are used, the latter being one of the innovations which have been worked out on this job. The cars are loaded by electric shovels.

QUARRYING here is spectacular. The first step in the process is to break off a great slice of mountain. To accomplish this, a line of vertical holes is drilled 60 to 180 feet deep, 20 feet apart, and 30 to 45 feet back from the face of the cliff. Across the base of the ledge, horizontal toe holes are drilled about 24 feet back and approximately eight feet apart. These holes are loaded with explosive, the blast is touched off, and a section of the mountain crumples.

The largest of these blasts was set off last November, when a granite face 160 feet high, 45 feet deep, and 750 feet long was shattered into 231,700 cubic yards of broken stone in a single explosion. In preparation for this blast, 44 vertical holes 158 feet deep, and 99 toe holes 24 feet deep, were loaded with 116,250 pounds of Hercules dynamite. Products of big shots such as this are further broken up by blasting into sizes convenient for handling.

Facing the dam on its upstream slope makes up a large part of the construction task. A layer of placed rock, 15 feet thick, covers the entire slope, and each stone in this facing must be handled separately. Five crawler cranes, which have been converted from power shovels, are used for this work. With wire rope slings, these cranes handle rocks weighing as much as 10 tons.

One of two four-yard electric shovels used on the job. Operated by a single man, this shovel loads rocks weighing up to 25 tons on the cars

The large rocks are chinked with smaller stones, the whole making a solid face for the concrete slab which is later poured over the surface. At 60-foot intervals, grooves are left in the placed rock sections, which allow for concrete ribs under the edges.

Thickness of the concrete slab varies from 36 inches at the bottom of the dam to 12 inches at the crest. One of the new construction methods of this project was developed for the pouring of this slab. This is the use of a sliding steel form instead of a stationary form. The slab is poured in sections 60 feet square, the edges of the panels resting on the concrete ribs provided for when the grooves were left in the placed rock section. The entire section is completed in one continuous pour taking about 12 hours.

Completion of Salt Springs Dam will be the first step in a great hydro development project which is to provide electric generating capacity of 228,000 horsepower on the Mokelumne River. The reservoir to be formed by this dam is to be the main storage body for four generating plants at lower levels.

The entire development will not be completed for a number of years, but the first units will go into operation in the summer of 1931. Construction of two power houses and auxiliary facilities is going on simultaneously with the building of the dam. Salt Springs power house, at the foot of the dam, is to have a capacity of 15,000 horsepower when it first goes into operation. Twenty miles down the River is Tiger Creek Power House, an 80,000-horsepower plant which will be completed at the same time. Concrete canal and tunnel will carry the water from Salt Springs to Tiger Creek.

Two other power houses are to be built below Tiger Creek eventually, and an additional capacity of approximately 35,000 horsepower is to be added at the Salt Springs Power House later.

Approximately 40,000,000 dollars is being spent on this great hydro-electric development, which is the newest project of the Pacific Gas and Electric Company, California's largest power utility and third largest service company in the United States. Increased electrical facilities being developed by this company will benefit a territory of approximately 75,000 square miles extent and upwards of 1,200,000 households, factories, farms, and shops.

Previous shots have already torn away much stone from this cliff. Holes have been drilled and loaded for another

The same cliff "erupting." When this blast was made, stone totalling 231,700 cubic yards crumpled from its face

HAS LIVING MATTER BEEN PRODUCED IN THE LABORATORY?

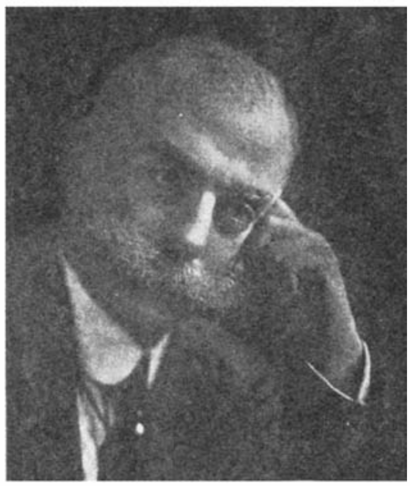
By MAYNARD SHIPLEY
President, The Science League of America

IF the "discovery" announced and discussed in this article is confirmed by other men of science than the one who has made it, its date of publication will mark the beginning of an epoch, not only in biochemistry but in biology, and may be the beginning of the end of certain schools of thought and philosophy. It will signify that in the summer of 1930, possibly protoplasm was produced from inorganic matter by aid of photosynthesis, or solar chemistry, in the laboratory of a Mexican biochemist—one whose intensive labors in the provinces of biochemistry, biophysics, and related subjects, extend over a period of a quarter of a century or more. Even if—as seems more probable—only the first close approach to this great discovery has as yet been made, the announcement is an important one.

In January 1929, readers of the SCIENTIFIC AMERICAN were made acquainted with the remarkable success attained by Dr. Alfonso L. Herrera, then Director of the Biological Institute of Mexico, in the production of certain inorganic bodies closely resembling living organisms, not only in form, but in behavior.

The likeness pertained not only to forms and structures but also to lifelike cell phenomena: for example, the imitation of cell division, the formation of "nuclear bodies," spindle formation (the "mitotic" figure), extension and retraction of pseudopodia or temporary feet (in amoeba-like forms), and so on. In order to distinguish these purely chemical structures from living forms, Dr. Herrera gave them the name of "protobios," and, later, of "colpoids."

PHOTOSYNTHESIS—chemical synthesis due to the effects of sunshine—played no part in the production of these more or less lifelike inorganic structures. More recently, however, Dr. Herrera has given increasing attention to experiments in photochemistry. During the past five years, the present writer has been in constant touch with the progress of this brilliant and indefatigable biologist and biochemist; and on August 22, 1930 (which may some day be a memorable date), Herrera wrote that he felt justified at last in announcing that he had produced protoplasm from inorganic materials—or, at least, a substance which he could not distinguish from protoplasm. The forms incidentally produced include bacteria,



Dr. Alfonso L. Herrera and three able laboratory assistants, his wife and daughters. *Left:* Lucia Herrera. *Below:* Maria Estrada y Herrera. *Right:* Maria Amalia Herrera

fungi, "connective tissue," and what appear to be simple protozoa.

While these apparently living forms may be merely lifeless bodies with a startling resemblance to certain typical, though low, forms of life, Dr. Herrera is confident that he has seen evolve before his very eyes that complex of organic compounds called protoplasm, upon which all life is dependent. He is, however, careful to say that he does not care to assert, as yet, that his protoplasm is "complete and living." It suffices for the present to say that a great step forward is believed to have been made in physical chemistry, through the synthesis of a product not readily distinguishable from protoplasm.

ON the face of his reports, as made to me in August and September, it certainly would be imprudent to jump to any definite conclusion, either for or against. One's first impulse naturally is one of incredulity, considering the apparently insuperable difficulties involved. But few who are conversant with the progress made during the past five years or so toward the production of living matter from so-called dead elements and compounds doubt that science is very near one of its goals—the production of living matter by the chemist in his laboratory.

I shall attempt to show in the discussion which follows that Herrera's results are not isolated, but may be taken as representing the logical next stage in work that has been going forward during the past 60 or more years.

How close to actual living organisms are the forms produced by Herrera? It is the very perfection, structurally, of the vegetal (?) and animal (?) forms and tissues revealed by his powerful microscope that gives us pause. They are a bit too far advanced, one would think, to be representative of primitive life forms, and unless we are prepared to go back to the innumerable experiments of Dr. Charles Bastian and his heterogenetic findings, and, in a sense, begin all over again, we are all but compelled to assume that the forms and phenomena observed by Herrera do not represent primitive forms of life—or even of near life—but are due merely to accidental resemblances to living organisms. However, this may be a mistaken view of the subject. It is unfortunate that the photomicrographs reveal so little of the delicate structures seen directly under the microscope. (Dr. Herrera was good enough to send me some actual specimens for microscopic study.)

A brief resumė of some of the work accomplished by his predecessors will aid in an intelligent evaluation of Herrera's present results.

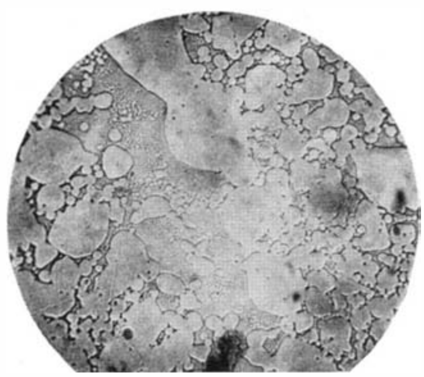
Speaking of his astonishing products, Herrera says: "It is confirmation of von Baeyer's theory which you quote in one of your published works." It was von Baeyer who first suggested that the initial stage in the synthesis of organic matter from inorganic, by the green leaf (when exposed to radiant energy), consisted of a reaction in which a molecule of carbon dioxide of the air was "seized" and the oxygen removed, forming, in the presence of a molecule of water, formaldehyde, the simplest possible of the carbohydrates. The oxygen thus produced is merely a by-product, as suggested by Priestley and Ingenhausz a century earlier.

These chemists noted that when the green substance of the leaf, "chlorophyll," was exposed to sunlight, it gave off oxygen from plants containing it. About 1865, Sachs, professor of botany at Würzburg, came to the erroneous conclusion that the first organic product formed in the leaf was starch, and that the production of this carbohydrate took place most vigorously when the leaves were exposed to the yellow-red rays of sunlight. Later research led to the conviction that cane sugar ($C_{12}H_{22}O_{11}$) was the first product. Then von Baeyer, professor of organic chemistry first at Munich and later at Berlin, put forward his formaldehyde theory, which still holds the field, though not without criticism at the hands of that eminent American biochemist, Dr. H. A. Spoehr. However, most workers, for example, Benjamin Moore, Daniel Berthelot, E. C. C. Baly, Webster, Heilbron, Barker, and others, accept the theory of von Baeyer.

VON BAEYER explained the production of carbohydrates (starches, sugars, cellulose) by a primary formation of formaldehyde. Carbon dioxide plus water forms formaldehyde plus oxygen, by means of light rays, in the presence of the green pigment, chlorophyll, found in the leaf of the plant. Note that only three elements are present—carbon, hydrogen, and oxygen. But formaldehyde has a strong tendency to add to itself, or combine with itself, more of the same species of atoms or elements. In the green leaf of the plant, under the influence of radiant energy acting on the chlorophyll, it multiplies its original formaldehyde molecule by six, but adds no new element, thus changing from formaldehyde (familiar as the disinfectant and preservative called "formalin") to grape sugar. Cane sugar can be formed synthetically from a mixture of glucose and fructose by eliminating a molecule of water. Starch is produced by the plant from glucose, direct, also by condensation.

But what of protoplasm, which Herrera thinks he has produced photosynthetically? The formation of living matter, as the physiologist knows it, consists in the synthesis of the proteins, nucleins, fats, and carbohydrates of the cells, from the "split products," of which I shall speak presently. Of the three classes of organic compounds, the most complex are the proteins. Their chemical structure is based principally upon nitrogen. The proteins are readily broken down or "split" into a number of constituents or units, known as "amino-acids," containing hydrogen and nitrogen. The amino-acids all possess the properties of both acids and bases, and the different proteins found in different kinds of living tissue are made up of amino-acids combined in different proportions.

In 1883 Curtius was able to synthesize certain elements which yielded a substance whose chemical reaction was characteristic of protein products. The proteins, or proteids, form the essential basis of protoplasm, and consist, as said, of nitrogen, hydrogen, carbon, and oxygen; some of them also contain phosphorus and sulfur. They form a thick, viscous solution in water, what is known to the chemist as a colloid solution, or "sol," which on very slight provocation passes into a gelatinous solid, or "gel." This complex mixture of sol and gel, together with the compounds mentioned above, is what is meant by the term "protoplasm"; and it is this substance, or something much akin to it, which Dr. Herrera has produced from a few simple inorganic elements, by photosynthesis.



Resembling alveolar structures

Soon after Curtius built up in the laboratory his protein products, Emil Fischer showed that both plant and animal proteins could be split up into amino-acids; and he devised methods of combining these substances, linking them together into complex bodies—polypeptides—resembling the peptones which are produced by the action of digestive ferments on proteins. These bodies are regarded as probable stages in the construction of the complex which we call proteins, bodies essential to the formation of protoplasm.

Forms suggesting division of amoeba

Skillful biochemist as he was, Fischer could not, by synthetic methods, produce protoplasm; nor, for that matter, starch or cellulose. The most he succeeded in doing was to produce the polypeptides. But radiant energy can—and does—do what no chemist in his laboratory can accomplish by his limited methods. In some manner light vibrations transform the molecular complexes and produce the chemical energy requisite for the changes brought about.

The late Dr. Benjamin Moore demonstrated conclusively that dilute solutions of nitrates exposed either to sunlight or to an artificial source of light rich in light energy of short wavelength, undergo conversion of nitrate into nitrite. This reaction, like that of the formation of formaldehyde by transformation of the energy of sunlight into chemical energy, involves an uptake of chemical energy similar to that which takes place in green leaves when organic carbon compounds are formed. Dr. Moore's results show that, while rainwater which has been held for a considerable time contains no nitrites (all having been oxidized to nitrates), if this same water be exposed to bright sunlight or ultra-violet rays for a few hours, a strong reaction for nitrites is always obtained. Not only do the nitrites contain a greater storage of chemical energy than the nitrates, but the nitrites react more readily than the nitrates, and many changes occur between living organisms and nitrites which are not given directly by nitrates.

BALY, Heilbron, and Hudson have succeeded in producing complex nitrogenous products from inorganic substances under the influence of ultra-violet light alone. Baudisch long ago (1911) obtained evidence of the formation of amino-acids by the action of ultra-violet light on a potassium nitrite solution in the presence of carbon dioxide with ferric chloride as a catalyst; and in solutions of potassium nitrite and formaldehyde exposed to ultra-violet light, of an alkaloidal compound similar to nicotine. Baly, Heilbron, and Hudson not only obtained similar results, but also obtained from inorganic materials two different complex organic substances, "one a volatile oil and the other a low-melting solid, both of which give crystalline salts with acids and positive tests with the usual reagents for alkaloids."

As is well known, hundreds of thousands of organic compounds have been built up in chemical laboratories since

Bearing resemblance to mitotic forms

the days of Liebig and Wöhler—the latter (1828) was first to synthesize an organic compound, thus disproving the old doctrine of "vital force." The problem today of the artificial production of living matter does not consist, however, of the synthesis, atom by atom, or molecule by molecule, of inorganic elements into living cells at the hands of the biochemist. The work of Moore and Webster, of Barker, Hudson, Baudisch, von Baeyer, Butlerow, Stoklasa, and other researchers, goes far to show that the "creation" of living matter, now or in primordial days, is a function of radiant energy acting on suitable materials, wherever and whenever found. It has been discovered that while all the rays of light, from infra-red to ultra-violet, are of biological importance, the ultra-violet radiation is the chemical radiation *par excellence*, while the relatively long waves, such as the infra-red, are especially concerned with assimilative problems, both in plants and in animals.

IT has been fully demonstrated that the high-frequency rays, for example ultra-violet rays, are analogous in their effects to high temperatures in the chemical laboratory. This explains the fact that living organisms produce without high temperature chemical products which, synthesized in laboratories, would require thousands of degrees of heat.

In France, M. Daniel Berthelot, in co-operation with M. Gaudechon, conducted valuable researches concerning the effects of ultra-violet light on various materials. These experiments succeeded, by the aid of photochemistry at high frequency, in "reproducing the fundamental mechanism of the restoration of chemical energy which we find in nature, that is, the mechanism of chlorophyllian assimilation."

In England, endothermic synthesis, that is, synthesis involving heat absorption, was carried out by means of the quartz mercury-vapor lamp, resulting in the production of carbohydrates from carbon dioxide and water-vapor. By this means Berthelot succeeded in synthesizing a new compound, CO(CN). Decompositions also were effected, and the principal types of fermentation reactions were carried out.

Using, as a basis, inorganic gases of the simplest character, for example, carbonic acid gas and ammonia, the high-frequency rays give rise to formamide.

The syntheses mentioned bring us up to the starting point of the proteins and albumins, the basis of living matter.

Now comes Dr. Herrera with the announcement of the next step in photosynthesis; the apparent production of protoplasm itself. It may be, of course, as said previously, that what Dr. Herrera interprets as protoplasm is something else. But what? To repeat one or more of his experiments would be a simple matter for any chemist. The materials and the procedure, in a typical instance, are as follows as stated by Dr. Herrera:

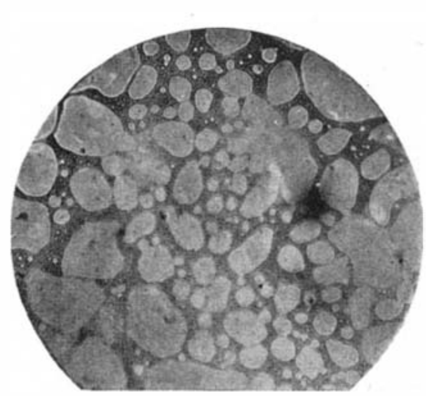
PLACE a plate of glass moistened with formaldehyde on a closed glass dish or Petri dish enclosing 20 cubic centimeters of sulfide of ammonia dissolved in five percent of water. Place in strong sunshine from 8 A.M. to 6 P.M. Microscopic examination will reveal the transformation of the solution into what appear to be vegetable tissues, cells with two nuclei (some of which may be blue), an abundance of structures resembling microbes, amoebae, yeast, alveolar appearances, parenchyma, and, in short, all the marvelous, in some cases lace-like, structures characteristic of indubitable protoplasm. Formaldehyde, or monose of Fischer, precipitates "sulfide of sulfur" (?—"*soufre de sulfure*") in a remarkable state of division. Herrera is inclined to believe that "sulfur is, rather than silicon, iron, or the amino-acids, the base of life." At least, that is his impression "deduced from weeks of experimentation" with the materials here mentioned.

The successive reactions that occurred in the case of Herrera's materials, under the influence of sunlight, lacked the vegetable (leaf) substance known as chlorophyll, which in the plant acts as transformer of solar energy, producing sugar and finally starch and cellulose. Herrera's product was not sugar but apparently protoplasm. He writes:

"It is no longer a question of *imitations* of protoplasm, but of protoplasm prepared with reagents uniting with already complicated combinations of molecules, producing, probably, sulfaldehyde, nitrosilicon, hexamethylin, formhydroxamic acid [*sic*], and what not?"

And here is another phenomenon which seems to be unprecedented in the work of his predecessors: the organic structures produced are volatilized by calcining, being formed particularly from sulfur; but between two glasses the calcining leaves a carbon residue. A repulsive odor of organic substances, not yet identified, arises. With iodine added, black or perhaps intense blue globules appear.

WHILE it is true that we may, for the time being at least, place the recently produced photosynthetic "organic" forms among this investigator's "colpoids" (which were produced without the aid of sunshine), it is not so easy to dispose summarily of the assumed protoplasmic substance. If it is not protoplasm as we have heretofore identified this living substance, it may possibly represent an intermediate stage in the evolution or synthesis of what Huxley so long ago called, quite correctly, "the physical basis of life." The *forms* may be accidental, chance resemblances to living organisms, as were the colpoids. But Dr. Herrera was not for a moment deceived by their appearance or their physico-chemical activities. His new forms are quite different, in some respects at least, and his new substance is distinct from any obtained otherwise than by his recent photosynthetic methods—new materials and methods, and



Like protoplasm, vacuole granules

novel results, but wholly consistent with the less sensational results of his predecessors.

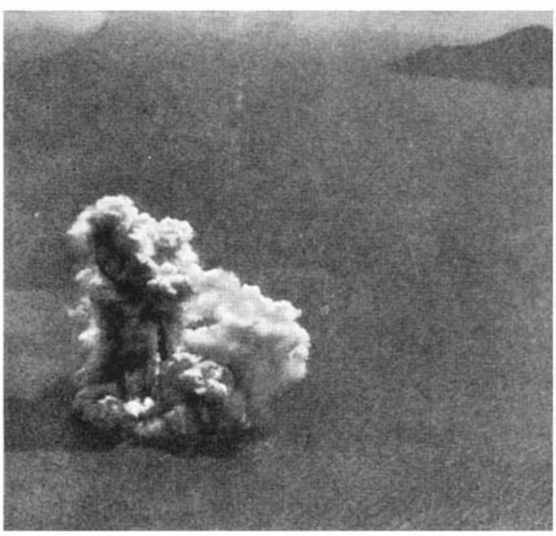
All this may seem, superficially, not very convincing as to the photosynthetic production of veritable protoplasm. Nevertheless, so far as I can learn, no similar phenomena have ever been produced by any other worker in this field.

Perhaps enough has been said to bring home to the reader how far the age-old gap between inorganic, non-living compounds and living protoplasm appears to have been narrowed or even obliterated.

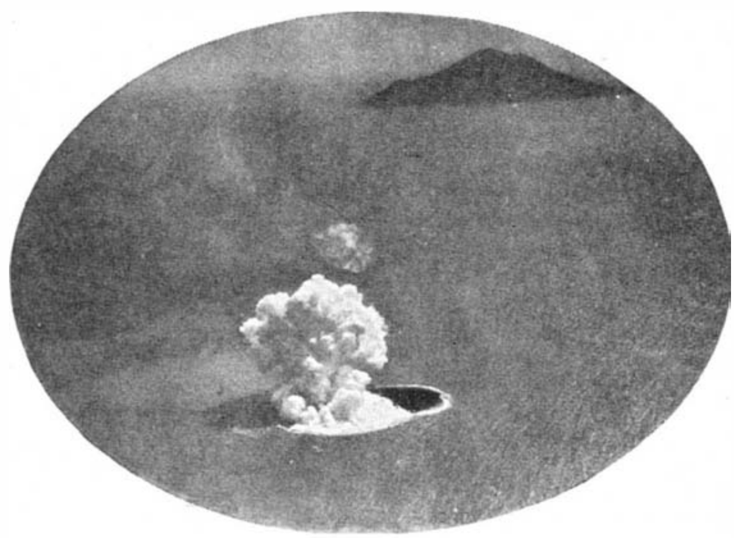
THE VOLCANIC BIRTH OF A NEW ISLAND

The low island crater on the former site of Krakatoa hurls aloft a column of steam and black cinders to a height of 1000 feet

Little "wisps" of steam (actually 300 feet high) where the sea has broken over the crater's rim



Another distant airplane view, showing a cloud of steam and cinders hundreds of feet high



In the background is one of the island fragments of the edge, or ring, of the crater left after Krakatoa's explosion of 1883

WILL the volcano of Krakatoa repeat the great explosion of 1883? Millions who live within reach of its ever-threatening long arm in the Far East would be thankful for a dependable answer to this question. Science, too, would like an answer.

In the great event of 1883, this volcano, lying in Sunda Straits between Sumatra and Java, suddenly blew into fragments and hurled into the air a cubic mile of comminuted matter. The original volcanic island, five miles in length, three miles in width and 6600 feet high, was replaced by a vast submarine trench eight miles long and more than 1000 feet in depth. The explosion was heard 3000 miles away and its air wave traveled several times around the earth, while the great seismic sea wave devastated the islands in the vicinity, drowning 36,000 people. This wave traveled across the Indian Ocean at the rate of 371 miles per hour and was recorded even at Cape Horn and in France. No record of an explosion as vast as Krakatoa's exists in human history.

Then Krakatoa slept for 44 years. In 1927 signs of a reawakening commenced. An eruption occurred in the deep trench 1000 feet below the water, volcanic bombs were hurled to the surface and 4000 feet into the air. Those who dwell in the vicinity were apprehensive.

Last summer, as shown above in the group of photographs here reproduced by courtesy of the *Illustrated London News*, old Krakatoa's youthful offspring "Anak Krakatoa," at present a small island crater, growled, scowled, and menaced its neighbors once more. Alternately the new crater, comparatively small but promising, raised itself above the sea and sank beneath the waters.

What eventually will happen? Who knows? Those who believe the explosion of '83 was due merely to sea water leaking in on hot rock maintain that a similar event can not happen again, for the rock was all blown away. Others hold that the real cause was the explosion of superheated steam absorbed in and *all through* the molten magma in the earth's crust. A cubic mile of matter "popped" like popcorn, and may pop again. The people who live near Krakatoa wonder.

MINING THE SKY FOR SCIENTIFIC KNOWLEDGE

The Author

By W. J. HUMPHREYS, C.E., Ph.D.
Meteorological Physicist, United States Weather Bureau

NEARLY every one thinks of the rocket as something new under the sun. Well, it isn't, except in details of construction, for it has been in the air, so to speak, a long while, and written about for centuries. One could even collect a rocket library, for there are two or three dozen books on the subject, and a much greater number of papers, both ranging in dates from several hundred years ago to the very present.

The start of the rocket idea may not be recorded, but it is quite certain that any boy who happens to be bowled over by the kick of a musket might well have a rocket half invented by the time he gets up again. At any rate, the rebound of the old-fashioned blunderbuss doubtless suggested to many an observant victim the idea of turning the butt end of the thing toward the enemy for real effectiveness, or of standing it muzzle down that it might kick itself over the moon. Surely, at least, it was the action of reaction that led to the invention of the first crude rocket, for reaction is the very soul and essence of all rockets.

THUS far, everything was nice and promising, but right there Newton's law that reaction can not exceed action put a very finite limit to rocket attainments. So long as the gun weighs more than the bullet, it is the latter, and not the former, that goes the farthest—contrive as one may to obtain the opposite result. Furthermore, the going of either varies with the kind and quantity of the "powder" used.

And so it happened, owing to one handicap or another, that until very recently the only gun any one succeeded in making that would really kick itself heavenward was the familiar sky-rocket, a sort of 4th-of-July jazz toy for filling the air with booms and bangs and a lot of sparkles. But earnest efforts to attain more serious ends were not abandoned. Time and again a sort of rocket boat was invented, one that obviously would work, too, after a fashion, consisting of a pump of some sort amidships that sucked water in at the front of the vessel and drove it out at the rear. This method of propelling boats, however, does not seem to have come into commercial use, though it is conceivable that there might be places where, and circumstances under which, it would be just the thing.

Another contrivance that every one who thinks of rockets is sure to invent is a rocket torpedo; whether driven by the direct escape of compressed air or by some explosive is only a detail. And from this to the giant air torpedo that could carry the compliments of one enemy admiral to another by way of the clouds is only a seven-leagued stride of the imagination—a stride none too great to take, however, for visionary as it may seem, it nevertheless is within the range of the plodding steps of reality.

THE automobile, too, has been much in the thoughts of the rocket enthusiast who seemed to think, and with good reason, that a machine could be so constructed that by the time it had shot half its weight away the pilot gunner, riding the rest of it, might have won the race. The rocket automobile has not yet gotten beyond the dangerously experimental stage, but as at least a sporting machine it may be rather near ahead and coming fast. It has been proposed also to run the airplane on the rocket principle, in short to make it a giant rocket, so as to get there, wherever that may be, in no time. This, too, may be ahead of us, but somehow we are not looking for it to appear the first thing tomorrow morning. But, for all that, our fancy is caught by the wonderful stream-line shape such a device could be given all over, as long as its velocity was less than that of sound in the air.

The chief difficulty encountered in the operation of every sort of rocket is that of finding a substance that will blow out of its container with such terrific velocity as to produce a very great back pressure, and at the same time to be under control. Of course, there are other desirable features also, such as minimum weight of the device apart from its load of fuel, but all these, however valuable, obviously are secondary to the means for getting the thing to go at all. The solution of this fundamental problem of getting it to go, and to go well, has been the object of years of investigation, much theory and calculation and many experiments by different people, each after his own method, in different parts of the world.

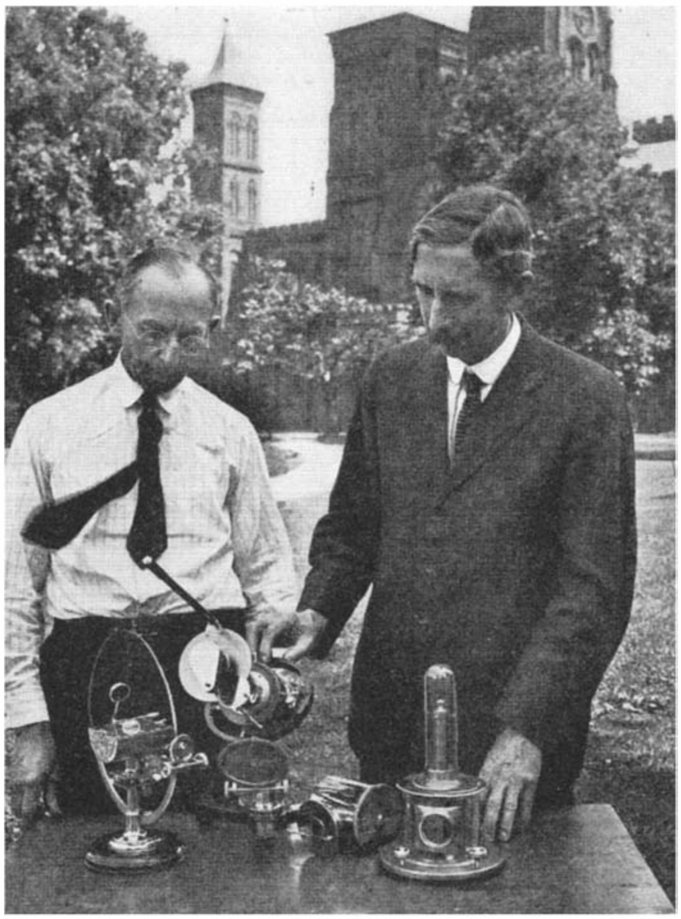
In this country the most persistent and effective investigator of that problem is Professor Robert H. Goddard of Clark University. Just now he is at work on it harder than ever before, having both financial backing and the counsel and moral support of many eminent men of science. Of course, none of these conservative savants is envisaging an early Jules Verne trip to the moon in this super sky rocket—at least not for himself. He does envisage, however, the acquisition through it of much new information of both the solar and the terrestrial atmospheres, matters of very great scientific interest—answers to many questions which for decades we have been vainly asking. For every "good sport" this is game enough for the quest.

BUT who, then, are these good sports? That requires and deserves an explanation. The arts are developed, knowledge is attained, and civilization acquired when and only when there can be some surcease from toil, some rest from the daily grind of winning one's daily bread, some opportunity to stalk the game from mere choice and not from necessity, time to decorate one's clothing and ornament one's shelter, leisure to observe and experiment. But not all that have these opportunities use them. Most of us just eat and sleep and desire only better food and a softer bed. However, there always have been a few who were not wholly self-centered, who saw more in the universe than just themselves, and who still retained enough of the child's curiosity to try to find out something about that universe. These are the "good sports." They work when they don't have to. They have striven mightily in their efforts to discover the secrets of Nature, not with a bread-and-butter aim in view, but for the very love of the quest and under the urge of a compelling desire to know and to understand. Thus they gained knowledge, the knowledge that has given us our mastery, so far as we have it, over the world and all that is in it. To them chiefly we owe our civilization.

To all such as these explorers in the infinite realm of the unknown it would be useless to explain how any additional knowledge of our atmosphere and of the sun might be of practical use. To them, the mental satisfaction of knowing is of itself alone ample reward for almost any amount of labor expended in acquiring that knowledge, and especially so if it be new knowledge. They also know, though they don't bother about it, and we who do bother about it likewise know, that practical uses have been found for almost every scrap of information we possess of Nature and her ways, and therefore that it is virtually certain that abundant use will be found for substantially all additional information we yet may acquire of this kind. They may not know, and we may not know, immediately each discovery is made, nor be able even to surmise, what its applications will be, but everybody does know that use follows knowledge as surely as day follows night—follows, never precedes.

BUT, despite all this philosophical calm, and assurance born of invariable past experience, it does seem reasonable to ask what sort of information could be obtained by means of a sky rocket of whatever supersize and power, and what possible use could be made of that information if we had it. Well, even that oldest of all sciences, astronomy, would be benefited, because, although as long as the astronomer confines his attention to the kinds of light the eye can perceive, red, yellow, green, and the rest of the spectrum colors, his troubles are not serious, or at least not insuperable, nevertheless when he pushes far beyond this limited region in either direction, whether into the ultra-violet, or exceedingly far out in the direction of the ultra-red, his apparatus fails wholly to function, and can not be made to function at the bottom of the atmosphere.

By far out in the long wavelength direction is meant the radio region of vast but indefinite extent. We know nothing of static from the sun or other celestial body, and could not, or at best, know but little, however full of such strays interplanetary space might happen to be, because the very high atmosphere is so good a conductor as to be opaque, or nearly so, to radio of every wavelength. Possibly we some day may be able to send a rocket, with a radio-recording attachment, beyond the conducting limits of our own envelope, and thus know definitely whether static of appreciable intensity is or is not knocking at our outer door. If it is, and it well may be, great will be our curiosity to know where it is from and what it means.



Dr. C. G. Abbot (at right), head of the Smithsonian Institution, with his invention, the silver disk pyrheliometer for measuring the intensity of the sun's radiation. Similar measurements made outside the atmosphere with a rocket would eliminate an uncertainty existing in some men's minds

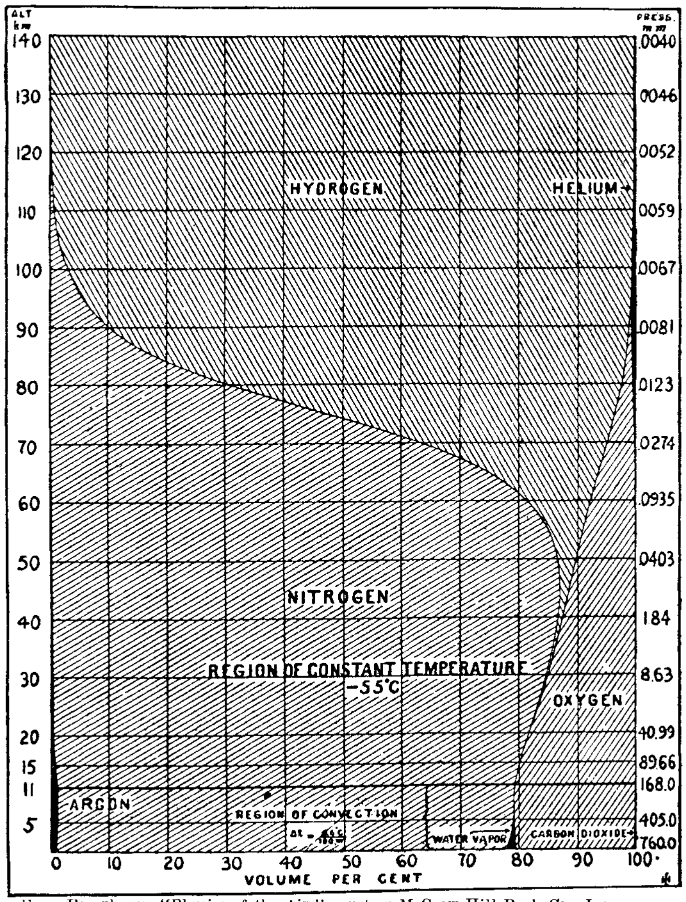
At the other end of the spectrum also, as just stated, we are helpless even in the highest balloons and on the tops of the loftiest mountains. Long before we have gotten half way down the spectrum from the limit of visibility the atmosphere has become opaque, and remains so to the very end. And it is through the photograms of this invisible region that Nature, in respect to the little things of the laboratory, has confided to us many of her innermost secrets. How we long for like confidences about the sun and the stars, and how fretfully impatient we become over the tantalizing fact that we can have them in abundance for the mere asking if only we will go a little way, merely to the confines of our own atmosphere, for them. Whether we ever get there ourselves or not, this much we can do: we can send a messenger in the form of a rocket equipped to receive these facts in code and return them safely to us.

We should like also to have direct measurements of the intensity of the total solar radiation just outside our atmosphere. Of course, this value can be computed very approximately from measurements made at the surface of the earth, but always there are residual uncertainties owing to the inconstancy of the atmosphere, and to the unknown value of the totally absorbed portion of the ultra-violet. It is to eliminate these uncertainties as far as possible that we need to have a few measurements of the solar constant quite outside any appreciable portion of this atmosphere, measurements that at present only the rocket promises to make possible.

THE rocket also can give us much information about the upper air, concerning which many more questions are asked than as yet can be answered. We know very accurately the composition of the atmosphere up to the greatest height reached by clouds (about seven miles in middle latitudes), or throughout the troposphere, the region in which there is constant stirring by vertical convection, hence the same proportions throughout of the several gases, except water vapor. At higher levels, however, where vertical convection is either absent or at most quite feeble, the exact composition of the air is unknown and the greater the height the greater this uncertainty. We know that there is lots more ozone in the upper atmosphere than there is anywhere below the tops of the highest mountains. We also believe from indirect observations that it is most concentrated about 25 miles above the surface. We should greatly like to know just where it does occur and why.

Auroras are nearly all stopped at approximately 60 miles above the earth. Again we ask why, and get no answer. What is the electrical state of the high atmosphere, how does it vary, and how is it maintained? Fair questions, all of them, but we can not answer them.

What is the temperature of the upper atmosphere? We know something about this. We know that, on the average, the air gets colder and colder with increase of height, up to around seven miles above sea level where its temperature is —67 degrees, Fahrenheit, or thereabouts. We know, too, that through at least the next seven miles the temperature is substantially constant with height. What it is much beyond that height, beyond the levels to which automatic-recording instruments have been carried by sounding balloons, is largely conjecture. It is true that the strange phenomenon of zones or rings of sound and silence around centers of terrific explosions has led to the conjecture that 25 to 40 miles above the earth the air is quite as warm as it is at the surface, if not even very much warmer. Many hold that the shooting stars, or meteors, strongly support the idea that the very high atmosphere is warm to hot. Indeed, it was a study of meteors that first led to that idea. Well, maybe so, but many a conservative scientist has his doubts about it and longs for direct observations such as, so far as we now see, only a rocket adequately equipped can supply.



From Humphreys, "Physics of the Air," courtesy McGraw-Hill Book Co., Inc.

Composition of the atmosphere at different levels. This is partly based on assumptions, because direct experimental observations are lacking above about 30 kilometers height

OBVIOUSLY the first thing to do in preparing for this investigation of the upper atmosphere is so to construct a rocket that it will attain very great heights, 25 miles at least, 100 miles, if possible. The next task will be so to equip the rocket as to secure the information desired. It would be only a useless stunt to send a rocket, however high, if it brought back no record of its journey. It therefore is a matter of business-like prudence and not a show of timidity to consider carefully before venturing on so difficult an enterprise whether a possible way to accomplish the desired results can be envisaged. This need not be the actual method followed but it is tremendously heartening to all concerned to know that results can be had, one way or another. To this end it will be interesting to outline a plan, however crude, whereby much knowledge of the upper atmosphere could be obtained by means of a rocket.

If the rocket is to reach great heights, say 50 miles above the earth, it seems unlikely that it could carry along unharmed any sort of delicate recording apparatus. It seems practically certain, too, that the unavoidable time-lag in response to the condition of the air passed through, of any device sturdy enough to withstand the stress upon it due to such a flight, would render every record so obtained wholly worthless. Presumably, therefore, we must try to obtain the desired data with exceedingly simple apparatus.

We possibly (and that is all the encouragement we need to go ahead) might obtain samples of the air under known conditions and at known heights and get our information from an examination of them in the laboratory. We must have these samples anyhow if we would know the composition of the air at great altitudes and its change with height, so while about that we might as well obtain them in such manner as to furnish the rest of the desired knowledge.

A possible method is as follows—a mere combination of well-known schemes that work. Let the rocket carry a highly exhausted thin-walled vessel of suitable size surrounded by a mixture of ice and water. This will maintain the vessel at a constant temperature, 32 degrees Fahrenheit or 0 degrees Centigrade, whatever the outside temperature may be. It has been tested under circumstances similar to those proposed here, and it worked. Let this vessel terminate at one end in a drawn-out and sealed-off tube wound at the proper place with a few turns of platinum wire that may be short-circuited to an ample but minute electric cell. Then provide that as the last of the propelling charge leaves the rocket (the time when the rocket has reached its greatest height and is moving slowest) the tip of the glass tube shall be broken, admitting air to the exhausted vessel, and at the same time the wire short-circuited so as to seal the tube again with its sample of air securely bottled up. All this, too, is an old trick that works.

We now have secured a sample of the upper air at a known temperature, not the temperature it had before capture, but that of the walls of the containing vessel, 0 degrees Centigrade, to which it necessarily came immediately on admission and before being sealed in. The little vessel containing this sample of air is eased back to earth by means of a suitable parachute, and further protected from injury on landing by a shock-absorbing device—all old and familiar tricks.

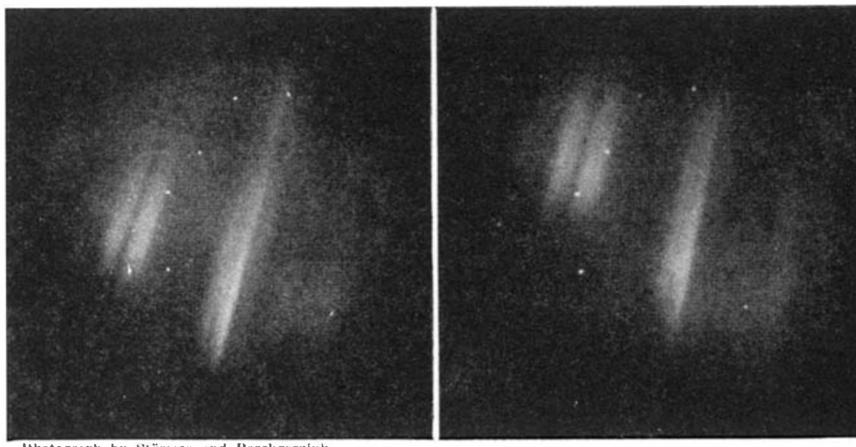
IN the laboratory the capture tube with its sample of upper air could be brought to the temperature it had when filled, 0 degrees Centigrade, and the pressure quite accurately determined at which this air just fills the tube at that temperature. This obviously would be the pressure of the atmosphere at the time and level of filling. After this, the sample could be analyzed and thus the composition of the free air at the level in question determined to any reasonable degree of accuracy.

Thus far well and good, but one important factor still is missing, namely, the height at which the sample was obtained. On very clear days the rocket might perhaps be followed by two theodolities some distance apart, the pointing of each noted at the time of filling —that is, when the rocket ceased to discharge, or when at its maximum altitude—and the actual height then calculated from these theodolite readings by simple triangulation, just as the heights of pilot balloons frequently have been determined.

Again, if the propelling discharge is luminous (it could be made so), the rocket could be followed and its height at the time of filling similarly determined by theodolities on cloudless dark nights.

Finally, a bright flash might be produced on the rocket at the time of sampling, and this flash photographed on suitable nights from two stations and the height of the flash determined from the positions of its images on the two photographs among the star images obtained at the same time. This is the simple "parallax method" used for finding the heights of the auroras.

We now have, let us suppose, the exact composition of the atmosphere and its pressure at numerous different known heights up to, say, 50 miles above sea level. From these data in turn we can readily compute the temperature distribution, for there is just one distribution of temperature that can give the observed pressures with the particular gases in question and at the specified heights.



Photograph by Störmer and Borchgrevink

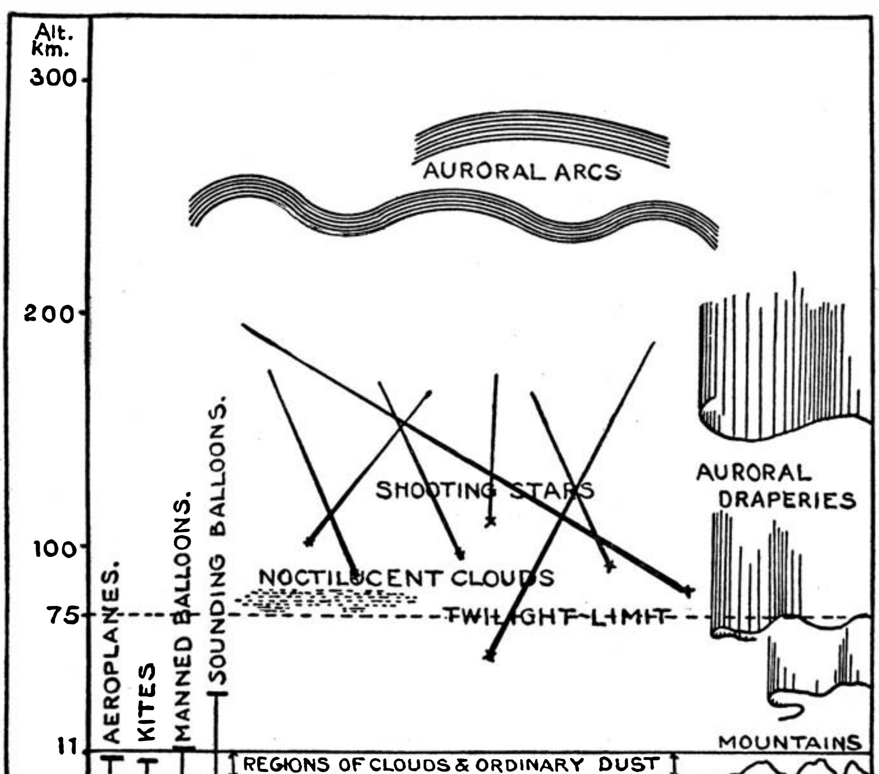
How the height of the aurora is determined photographically. (See text at left.) The same auroral curtain photographed at the same instant from opposite ends of a known baseline against the same background of stars (note Big Dipper)

CLEARLY, then, it is possible to obtain much information about the upper atmosphere by means of the rocket. This alone is enough to justify great effort in its development. Besides, as stated before, this knowledge once obtained is certain to have practical applications. Indeed we already see how it frequently might be used to great advantage in weather forecasting, for there is evidence that some of our least-expected general storms originate from conditions in the upper atmosphere, conditions of which only the rocket can inform us in time for our forecasts. Besides, this upper air may be the ideal medium in which to fly, especially on long trips. It is wholly free from the ice hazard, from all danger of lightning and from bumps of every kind. Also, piloting in it would be perfect, for there never is a cloud here to blot out the sun by day or hide the stars at night. But before we can fly in this region to best advantage we must know more about it than we know now.

In addition to its use in the important study of the upper air and its use also in several investigations of the sun and its radiation there is one practical need in sight—in fact, upon us—for the rocket in the lower atmosphere. That need is for it to take the place of the kite in getting the temperature, pressure, and humidity of the free air through the first two or three miles above the surface —information of great importance in weather forecasting. Kites can not be flown every day, and when they are flown it takes a good while to get them up and back again and, finally, they are being driven out of the air by the airplane. A kite wire is too great a hazard to the aviator to be tolerated where aviation is active. Of course, an airplane can be sent up for the sort of information that is gotten by kites, and some planes are used for that purpose, but it seems practically certain that the desired data could be obtained with a rocket (letting the recording instruments down slowly with a parachute) much quicker and at less cost than they can be with a plane. At any rate, this is one immediate practical application of the rocket well worth trying out fully and thoroughly.

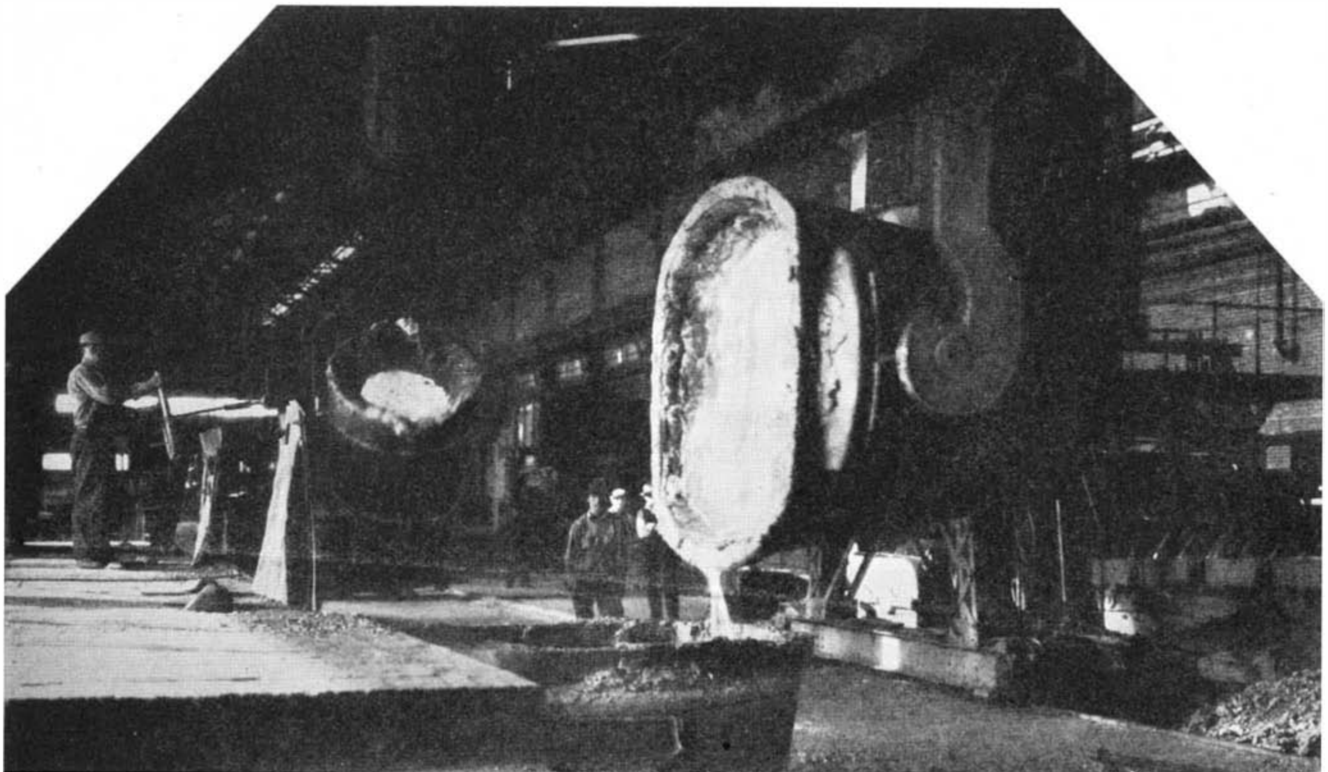
Now and again the forecaster is "up against it," as we say. The surface conditions may leave him wholly in doubt as to whether or not there will be local showers, perhaps, and yet the public insists on being told. For the moment this is discouraging, but there is buoyant hope in the fact that in most such cases the sounding of the air to the height of only two or three miles would change perplexing doubts to reasonable assurances. Nor would the occurrence of local showers alone be more certainly heralded in this way, but occasionally, disturbances even of great extent clearly indicated hours before there is available any sure surface evidence of their coming. We need the weather rocket for these practical purposes and must have it.

JULES VERNE'S trip to the moon was visionary, but mining the strata of the upper atmosphere for treasures of knowledge—knowledge that will have application in our daily affairs—is not visionary. This mining needs to be done. It can be done, and it will be done.



From Humphreys, "Physics of the Air," courtesy McGraw-Hill Book Co., Inc.

Existing sources of meteorological information. Above the bottom eighth of the diagram our information at present must be obtained by indirect and comparatively unsatisfactory methods. Here the rocket would help immensely



Courtesy The A. M. Byers Company

Pure wrought iron of fixed quality produced by the ton. The "shotting" process is depicted above

MODERN "ALCHEMY" IN IRON AND STEEL

By F. D. McHUGH

VERY often we hear it said that man cannot today duplicate the quality of steel that made the smiths and forgers of Damascus famous throughout the medieval world. According to widely current belief no such steel as that in the blades of the Saracens can be made in this era of mass production. Why such an impression should persist it is difficult to understand. Some people seem to think that those Oriental iron masters had some secret which we, even with our greater advantages and experience, have not been able to find out for ourselves; or that to produce a Damascus steel requires artisans which we now lack. The fact is, however, that these opinions are fallacies born of ignorance.

Modern skill has not only equalled Damascus steel but has improved upon it. Scientific research within comparatively recent years has given man a mass of information which has widened the latitude with which he works with iron and the steels and alloys he derives from it; and has made this more truly an iron age than would have been considered possible only a few decades ago. The scientist, without whom ferrous metals would never have come fully into their own, has played with iron and steel, worked with them, made new and amazing alloys of them, has discovered new ways of working them, smelting them, refining, rolling, molding, and shaping them.

Most iron and steel manufacturers and makers of ferrous metal products today maintain large staffs of research scientists who study the idiosyncrasies of the metal from the time it is an oxidered ore to the finished product. By them, new ferrous alloys are constantly being produced—alloys that fill some particular need or open the way to the manufacture of products previously impossible to make; or new schemes are devised for treating iron at various stages of its preparation.

THERE comes to mind offhand a notable instance of plant laboratory work of this nature. The A. O. Smith Corporation, of Milwaukee, which first commanded the attention of industry by building a huge automobile frame plant which is practically 100 percent automatic (see SCIENTIFIC AMERICAN, October, 1928), is now building a laboratory which will cost 1,500,000 dollars and eventually will have a staff of 1000 engineers and scientists. This staff will be built up by the addition of hundreds of specialists to the present force of hundreds—a force that already records among its achievements the development of the revolutionary pipe mills (of which more will be said later), the automatic frame plant, and many contributions to the scientific information and working principles of the industries that the company serves.

The problem of modifying the characteristics of iron by the addition of other metals to obtain greater strength, less weight, longer life, greater resistance to heat, greater cutting power—one or more of these qualities in a single ferrous metal—has been worked upon for over a century. Chromium, nickel, molybdenum, manganese, tungsten, and other metals have been used as alloying metals, but only the 20th Century may truly be called the era of alloy steels. Armor plate of nickel steel was one of the first successful alloys of this kind but now they run into the hundreds.

Of all the steel alloys in use, however, perhaps none is better known than stainless, or chromium steel. This silvery steel which first became known to the general public in the form of kitchen cutlery is now cutting the country's immense rust bills greatly, and it has been predicted that it may save industry a billion dollars annually. It may be said to be partly of British nativity and partly German. An English metallurgist, by the name of Brearly, while experimenting with gun lining metals, found that, by raising the chromium content, he could make the steel stainless. At about that time Dr. Benno Strauss, of Germany, was working on the same problem. He added nickel to the chromium steel and obtained a stainless steel, non-corroding, non-rusting, and of greater ductibility than the British steel, his proportions for the principal alloying metals being 18 percent of chromium and 8 percent nickel. Harry E. Sheldon, president of the Allegheny Steel Company—who was the first American manufacturer to make silicon steel and thus released our electrical industry from dependence upon Wales—was largely responsible for the manufacture of the first American stainless steel. Other manufacturers now make similar alloys.

THE chrome-nickel stainless steels, sometimes called "18 and 8" alloys because of the percentages of their principal alloying metals and to differentiate them from the stainless steels and rust-resisting irons having no nickel, now find a wide use in industry where resistance to fruit, vegetable, and meat acids is desired. Dairy equipment, chemical plant apparatus, and kitchen utensils, tables, and so forth, for large hotels and restaurants now account for much of the production of the "18 and 8" steels. The Model A Ford uses Allegheny metal for its bright parts and this same metal is being used in great vertical strips for trim on the exterior of the 85-story Empire State Building in New York City. A similar alloy, Nirosta, made at the Central Alloy plant of the Republic Steel Corporation was used on the beautiful tower of the Chrysler Building.

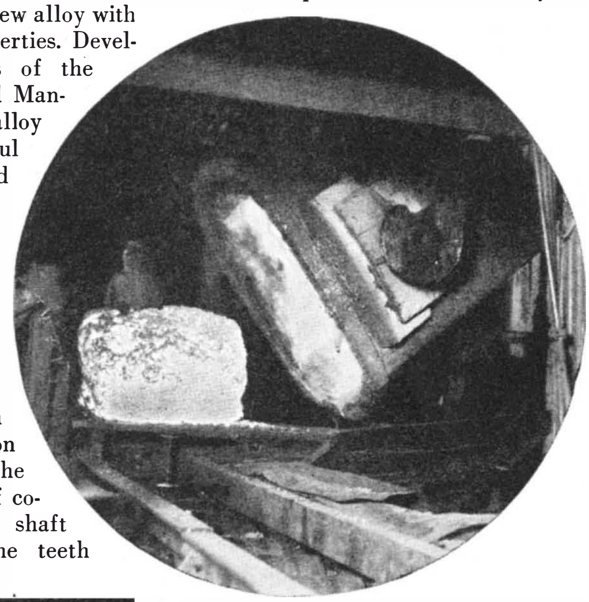
Another alloy with which many are more or less familiar, since it has been used for several years, is Permalloy. This is a nickel steel which was developed after the discovery, in the laboratories of the American Telephone and Telegraph Company and the Western Electric Company, that remarkable magnetic properties were possessed by nickel iron in which the proportion of nickel exceeded 30 percent. Best results were obtained when the percentage of nickel was as high as 80. This metal, called Permalloy, has since been largely used for the loading of telephone and telegraph cables, and in the construction of instrument and audio-frequency transformers, relays, and measuring instruments. Recently the British laboratories of the International Telephone and Telegraph Company developed a new alloy in this series which is to be called "Permalloy C" and which will replace the original Permalloy A, and will largely replace a second member, Permalloy B. Permalloy C is the softest magnetic material available.

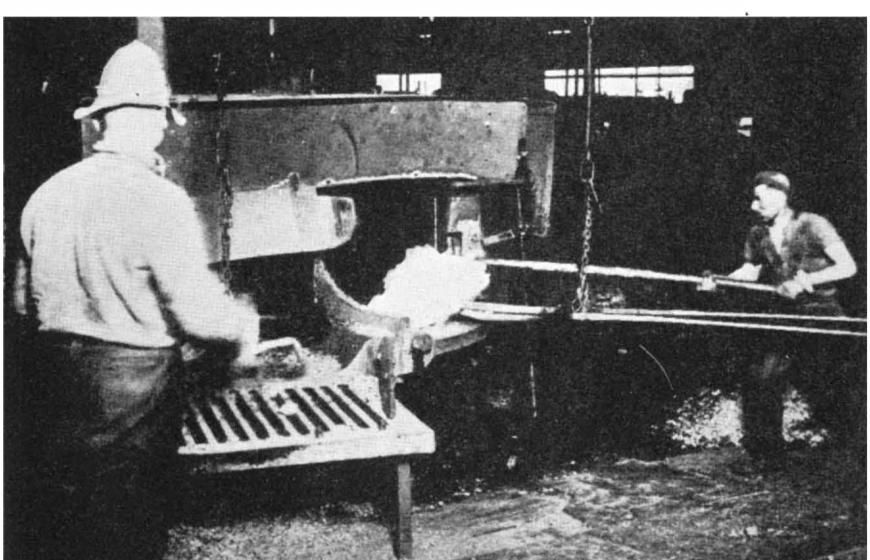
Cobalt steel is another new alloy with remarkable magnetic properties. Developed in the laboratories of the Westinghouse Electric and Manufacturing Company, this alloy can be given a powerful magnetic "charge" and made a permanent magnet. One of the first important uses to which it has been put is in the drive from an electric motor that is totally enclosed to exclude dust, fumes, moisture, et cetera, to the external shaft which has no physical connection with the motor itself. The magnetic lines of force of cobalt steel on the motor shaft are "enmeshed," like the teeth of a gear, with the magnetic lines of force of cobalt steel on the external shaft, thus providing a positive, cushioned drive.

The Westinghouse laboratories have also developed an alloy called Konel which is credited with being much stronger and tougher than other metals at high temperatures and can, therefore, be used extensively in the moving parts of internal combustion engines and in other extremely hot places. Its constituents are cobalt, nickel, and ferrotitanium. It was originally developed for use in the manufacture of radio tube filaments, and in that use is said to result in the saving of 250,000 dollars monthly at present. Konel filaments last 10 times as long as other filaments.

Other alloys or kinds of steel or iron are perhaps as important in their own particular applications as those already mentioned, but the list is entirely too long to be reviewed here. We might mention Promal, however, for it may in time be adapted to a wide variety of uses. Originally developed by the Link-Belt Company as a metal to be cast into drive chains, it is not an alloy but a specially treated iron. Experimentation with cast chain metals, begun four years ago, led to the discovery of a new method of processing malleable iron which so altered its characteristics as to make of it a distinctly new metal. Compared with malleable iron, Promal has a much higher yield point, an ultimate average strength about 22 percent higher, a lower average elongation, and a 40 to 45 percent higher Brinell hardness. It is claimed that the new metal therefore has surprising durability.

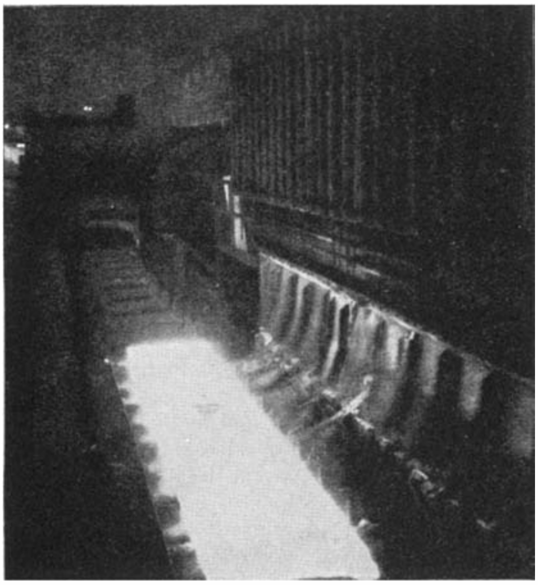
Probably the outstanding metallurgical development of recent years, for certain special applications, is that of nitriding. This process, preferable to case-hardening—especially for Diesel engines where surface toughness, resistance to wear, and freedom from dis-

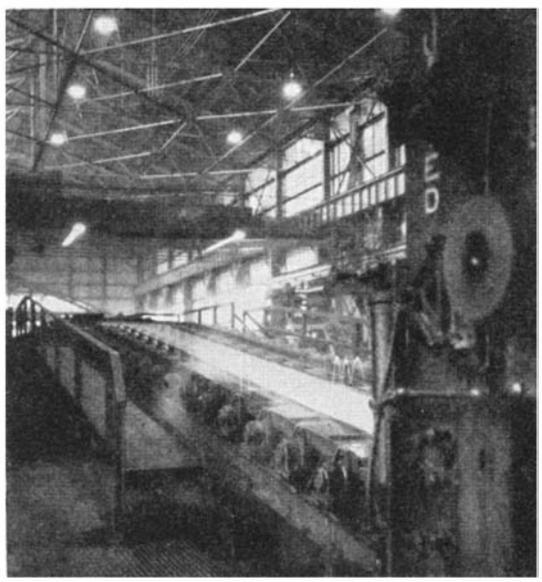




Courtesy The A. M. Byers Company

The "little red ball" being taken from the puddler's furnace. *Above:* The "big red ball," weighing ten times as much, as produced by the Byers New Process





tortion are required—resulted from the studies of Dr. Adolf Fry of the Krupp works in Germany. Several French investigators and Dr. V. O. Homerberg, of the Massachusetts Institute of Technology have also carried out extensive researches in the process.

In nitriding, any one of a series of steel alloys, known generally to the trade as Nitralloy, is heated to temperatures varying between 900 and 1000 degrees, Fahrenheit, in an atmosphere of anhydrous ammonia for from two to 90 hours depending upon the depth of the case required. The low temperature used prevents the core from being affected during the process. After its completion, no further machining may be done on the nitrided material since it is extremely hard—its Brinell hardness being 900 to 1100 contrasted to 650 for case-hardening; hence proper annealing and finish-machining must be done previously. The treated metal has, besides surface hardness and resistance to wear, a good resistance to scoring and abrasion, resistance to corrosion—it is therefore a stainless steel—no distortion in hardening, and hardness maintained up to high temperatures. Furthermore the case has no tendency to peel off, as the transition from core to surface takes place gradually.

THE metals of the Nitralloy series used in the nitriding process all possess a definite amount of aluminum because of the hardness this metal imparts to the surface of the steel when subjected to the action of the nitrogen in the ammonia and because of the desirable physical properties it induces in the core. The other constituents of the alloy vary in proportion according to the strength of core desired—that is, according to the specific application of the article being produced.

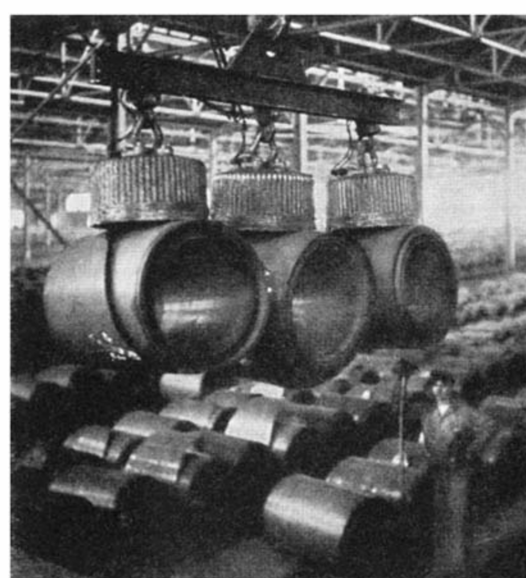
For many centuries man has made and used quantities of wrought iron. It is notable for its fine working qualities, its toughness, and its resistance to rust. One of the oldest and most useful of metals, it was known and valued by the ancient civilizations of India and Egypt. As recently as 70 years ago it was a very much larger industry than that of steel but the invention of the Bessemer process in 1856 caused wrought iron to be eclipsed by its cheaper but harder and stronger cousin, steel, even for uses in which it is unquestionably superior. Up until the 14th Century wrought iron was made in a very pure form in the Catalan forge, but for the past one hundred years it has been made by the laborious and expensive hand-puddling method.

Scientists long studied the problem of developing a commercially feasible and cheaper mechanical process for quantity-production of wrought iron but their efforts were attended with failure until Dr. James Aston developed, something over two years ago, a successful process of mechanical puddling. Wrought iron made by this process promises to take once more its rightful place as one of the world's most useful metals. The A. M. Byers Company will see to that, for they have just completed a new 10,000,000-dollar plant at Ambridge, Pennsylvania, with an initial capacity of 600 tons of wrought iron daily, to supplement the 200 tons daily they have been producing for over two years at their Pilot plant.

WROUGHT iron is a malleable iron shot through with slag particles, slag being essentially a ferrous silicate high in iron oxide content. In the hand-puddling process, it is made by melting together on the hearth of a reverberatory furnace certain proportions of pig iron and iron ore. Stirring of the molten mass, or puddling, by workmen, causes proper mixture of the iron and the slag, eliminates undesirable gases and elements, and results in the formation of a spongy ball of practically pure iron of a higher melting point than that of the original pig iron. This sponge, weighing only about 250 pounds, is squeezed in a press and then rolled into billets.

In the Byers New Process, as Dr. Aston's development is commercially known, Bessemer-grade pig iron is melted in a 12-foot diameter cupola of the standard steelworks type. The slag to be used is melted independently. The sources of supply of the slag are: puddling-furnace tap cinder, heating furnace cinder, roll scale, iron ore, and sand. The composition is maintained in close conformity to the slag found in good wrought iron.

The "shotting" operation—that which replaces puddling—is carried out in a set of unlined, stationary cups, or thimbles, on standards along the pouring platform. The average "heat" of blown metal is 5000 pounds and since this is usually formed into



Courtesy The American Rolling Mill Company

Upper: **A great slab starts through the continuous mills; in 20 seconds is a 200-foot sheet of red metal *(middle)* running at comparatively high speed over the rolls and is coiled automatically and then stored by electromagnets**

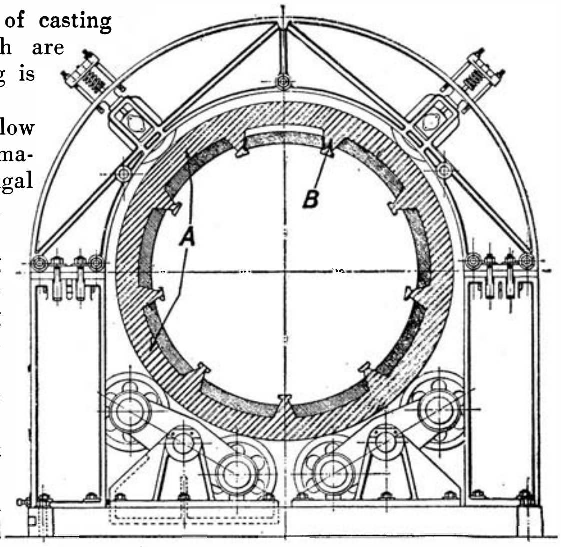
two spongy balls, two cups are used. Into one of the cups there is poured from the melting furnace enough melted slag to half fill it; and about one-half the ladle of blown metal is poured, in turn, into this slag. During the pouring of the iron, the slag boils vigorously. Cold, granulated slag is added to the mixture from time to time, largely to quiet the action and prevent its boiling over, as one adds cold water to boiling coffee.

As the pouring is completed, the boil subsides and the slag level goes down. A crane then lifts the cup and pours the excess slag into the adjoining empty vessel which is ready to receive the other 2500 pounds of the ladle metal. In the treated cup, there is now a solidified, spongy mass of metal shot through with liquid slag. This red ball, equal in all respects to the product of hand puddling, but weighing 2500 pounds compared to 250 pounds for the ball produced by the slower, more expensive, hand-puddling process, is dumped upon a carriage and taken to a press which compresses it into a bloom. It is understood that in the new Byers plant the balls will weigh about two tons each.

WHILE a review of the many new processes for working iron or steel would fill many pages, a few outstanding ones, not necessarily the most important, suffice to indicate the progress that is being made continually.

Charles Pack, a consulting engineer of New York City, reported some time ago that a machine which forms articles from cast iron continuously in the same mold, is in use in Germany. No details of the machine were divulged but if it is all it is claimed to be, it represents a distinct and industrially important advance over the old method of casting iron in sand molds which are broken up after one casting is made.

The process of casting hollow objects in rapidly spinning machines—that is, the centrifugal casting process—is over a hundred years old. Even the centrifugal process of casting iron pipe dates from before 1850 for the pipe-making method first used by Shanks in London was described in SCIENTIFIC AMERICAN in the issue of December 1, 1849. However, the long-sought process of casting steel ingots centrifugally eluded steel manufacturers until Leon Cammen, a New York consulting engineer, perfected what is known as the Cammen Process.

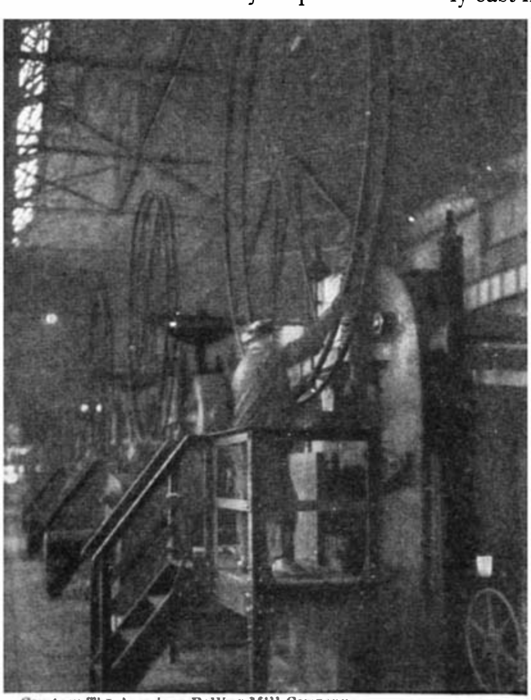


Courtesy Leon Cammen

Transverse section through the centrifugal bar-casting machine, the rapidly rotating "barrel churn." *At left:* The freezing of cast bars

As an ordinary steel ingot cools, the steel cools so rapidly that a crust is formed over the molten metal within. As this crust thickens, it contracts. This contraction sets up strains within the ingot and the resulting weakness is called "ingotism." To remedy this, the ingot must be put through a soaking pit and then a blooming mill. The Cammen Process eliminates these last two operations and produces ingots ready for bar or sheet mills. Furthermore, centrifugally cast ingots do not have to be trimmed, so that an additional saving is effected. Thus it is said that an investment of 750,000 dollars for the centrifugal casting equipment is substituted for one of 2,500,000 dollars for necessary equipment for the old process.

Essentially the Cammen centrifugal casting machine consists of a huge "barrel churn" cylinder with the inner surface of its periphery hollowed out and divided into sections to receive the liquid metal. It is supported and rotated by wheels like a huge roller bearing. As it is rotated at several hundred revolutions per minute, molten steel is poured, at a predetermined rate, into the inner rim where it is caught in the whirl, is thrown outward by centrifugal force hard against the rim, spreads to the sections, and begins to cool. It cools so rapidly, first as a very thin sheet and then as consecutive thin sheets, that the final ingot does not have "ingotism." This manner of cooling also "presses" out by centrifugal force the undesirable gases which would be imprisoned within the hard shell of the ordinary ingot. Complete solidification takes place in from 30 to 45 seconds, contrasted to the 15 to 30 minutes for ingots made according to usual practice. It is understood that the Central Alloy plant of the Republic Steel Corporation holds a license for the use of the Cammen Process.



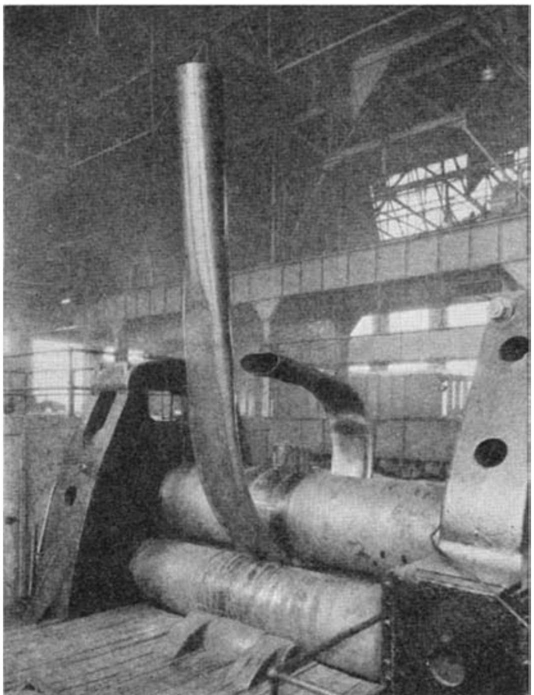
Courtesy The American Rolling Mill Company

In the continuous sheet process, rolls are accurately adjusted for proper gage by machines

IN rolling sheet iron and steel, the ordinary process has been a see-saw method of passing the metal back and forth through various sets of rolls. The future sheet has to be personally conducted—that is, an operator has to stand at the controls and reverse the direction of the moving metal after it passes each set of rolls, so that it passes through the rolls of the next smaller size, or back through the same rolls after they have been readjusted to a smaller clearance. When sheets become too long, the units are folded and rolled again to proper thickness. The sheets are then separated, squared to size, and annealed.

The American Rolling Mill Company, however, has perfected equipment for rolling a continuous sheet of metal. Prior to the time this company's engineers began their investigations in 1914, no successful way had been discovered to roll thin, wide iron and steel sheets by a continuous mechanical process. Two years ago their new continuous sheet mill began operations and greatly increased their production at lower cost.

The Armco engineers found that they had a two-fold problem. First, they had to design production and conveying machinery to carry hot ingots from the


Courtesy A. O. Smith Corporation
Striking test of Smithwelded pipe. A section is rolled until it is a flat curl as shown

blooming mill through to the finished sheets without a break in the long line of operation. Secondly, the characteristics of iron in its heated state when passing through the rolls of this continuous process, were studied. This latter question baffled them and it had to be turned over to the metallurgists. In fact, so many different details had to be worked out that it can be truthfully said that Armco pioneered in developing this continuous rolling process.

TO describe it in detail is unnecessary; it is just what its name implies. Beginning as an 11,000-pound ingot, the metal travels in a straight line for some 800 feet and is delivered at the end of the line in a continuous sheet, at the rate of more than a ton a minute. So rapid is the speed of the pieces of hot metal as they pass down the line of operation that one must move rapidly to keep pace with them. The approximate daily capacity of a continuous mill unit is 1400 tons, requiring 1700 tons of ingots.

The Sharon Steel Hoop Company, Sharon, Pennsylvania, have a continuous process for making steel strip that is so fast that one end of the strip is in the shipping room before the other end is out of the furnace. Of the many new methods and improved equipment incorporated in this mill, we have space to mention but one: the novel method of communication.

To facilitate high speed production, a modified public address system, comprising a microphone and loud speaker, has been installed By means of this equipment, the men on the rolling floor deliver instructions regarding operations and speed changes to an operator in a control "pulpit." This pulpit operator is therefore in constant, audible touch with the work he controls and which he can see through the glass sides of his elevated pulpit.

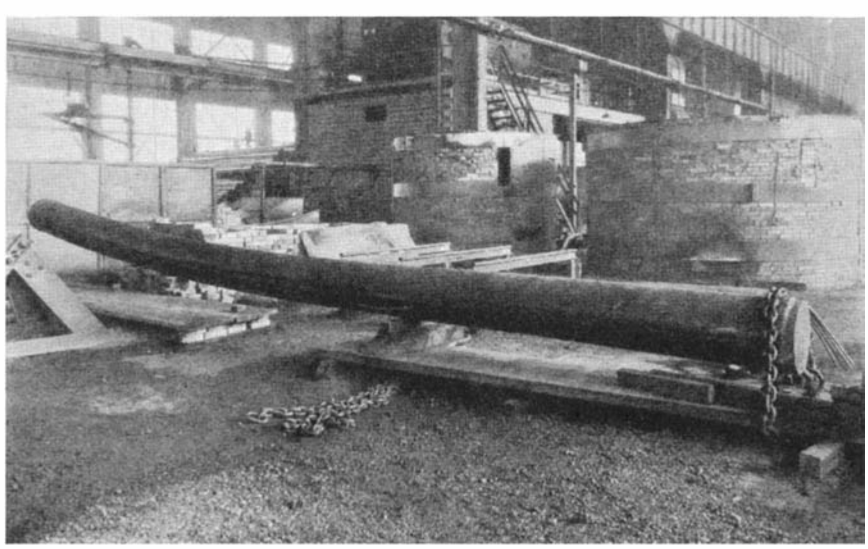
Casting about for new industrial fields to conquer, the A. O. Smith Corporation, mentioned earlier in this article, decided to make pipe. With its customary initiative and directness, the company tackled the problem as a newcomer, but as a newcomer wise in scientific research and free from the trammels of tradition. Why others had always made pipe in a standard length of 20 feet they could not discover; so they proceeded to upset that tradition by planning plants to make pipe in uniform lengths of 30, 40, and 60 feet. This apparently negligible change makes possible a great saving since it decreases by one half or two thirds the number of field joints necessary to be made. Two plants were built in short order by this company, the first with a daily capacity of eight miles of oil and gas pipe, and the second with a daily capacity of 20 miles of pipe in diameters from 12 to 26 inches.

The steel plate from which the pipe is made is received within small tolerances of the size required to make the desired diameters and lengths. Pickled, cleaned, and dried, the metal then has its edges scarfed for welding. It then goes through various press operations, is formed into tubular sections, and the longitudinal seam is electric-arc welded. The pipe is then sized to make it exactly round; its ends are squared off; and it is hydrostatically tested at double the working pressure or higher. Washing, drying, and painting complete it. The significant fact about these operations is that they *are all automatic.*

Plant scientists and engineers are working on or have perfected new methods of refining steel, of determining the presence of harmful impurities in steel, and of de-oxidizing open hearth steel whereby cleaner metal is obtained than that produced at the present time. The story of the work on the last named process is an excellent illustration of the laboratory method of working out a problem and ultimately applying it to practical operation in steel plants, but lack of space makes recitation of it here impossible.

SLAGS, which have always been, and probably always will be, one of the controlling factors in the production of good steel, have been a subject of special scrutiny by the research engineers. Experiments in the laboratory and in the plants indicate that certain properties of slag which have to date been little studied, have a decided effect upon the speed of working of the furnace and the ultimate reliability of the product. Further study of slags will, it is believed, result in great benefit to the industry.

In this review, we have not attempted to cover the entire field of metallurgical and manufacturing achievements in the iron and steel industry; there are many other advances perhaps equally as important as those mentioned. Rather have we outlined a few that seem to symbolize the initiative and scientific foresight of iron and steel men. Their research scientists and plant designers are true modern alchemists who transmute the base metal, iron, into noble metals of strength and beauty and universal usefulness.


Made airtight, the curled section shown above is subjected to high pressure. It slowly uncurls and finally ruptures at five times normal working pressure

PRESERVING NEWSPAPER FILES

By R. P. WALTON, Ph. D.
Formerly of New York Public Library

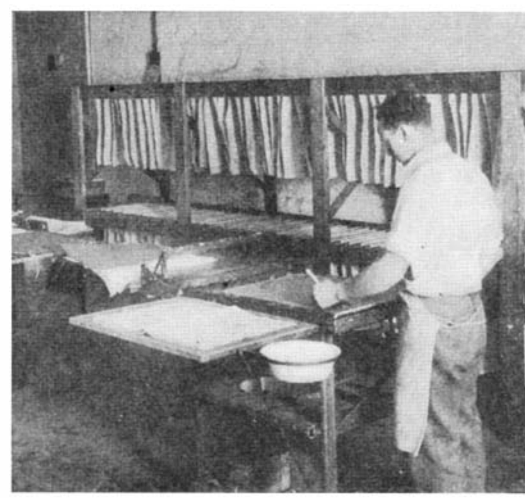
ALL records published on modern, wood pulp papers are faced with the probability of destruction within a spectacularly short time. This is particularly true of newspapers printed on paper made of ground wood. In the January 1929 issue of the SCIENTIFIC AMERICAN, the ravaged condition of recent newspaper volumes was illustrated. According to these evidences, newspaper accounts of the World War, which were printed on ground wood paper, will soon have crumbled and disappeared, while newspapers of the Colonial period, printed on paper made from rags, will still faithfully carry their stories of early American history.

Custodians and librarians have been faced with this responsibility of perpetuating records which have been printed on highly transitory and impermanent paper stock. Accordingly, some rather elaborate methods have been developed in the efforts to rescue these accounts from rapid extinction.

Princeton University, at a cost of about 20,000 dollars, has prepared clippings of the World War and has used a special process in attempting their preservation. The 81,242 pages, which make up the scrap books, were treated with a specially prepared paste which acts as a preservative. After being mounted, the loose sheets were placed between blotters and each submitted to a three-ton pressure. This pressure was maintained for five weeks with each sheet, a careful watch being kept from day to day to see that the pressure was uniform. The result was that all the moisture was taken from the paste, leaving the columns of printed matter a permanent part of the page.

After considerable experimentation, the New York Public Library has developed its own method. Essentially the process consists in covering both sides of each separate sheet with Japanese tissue. A pure wheat flour paste serves as the adhesive. To begin the process, a large glass plate is brushed with the paste. A sheet of tissue is then laid on the pasted glass and is also brushed with the paste on the upper side. The paper sheet is thereupon laid on the tissue, and this is covered in turn with another sheet of tissue, each being brushed with paste as soon as they are laid down. After the newspaper sheets are thus mounted between layers of Japanese tissue they are hung up to dry, then pressed and run through a gas heated mangle with steel rollers in order to smooth out all irregularities. The sheets are finally reassembled, sewed, and bound.

THE tissue is so thin that the size of the volume is not unduly increased. By actual measurement, an ordinary sheet of Japanese tissue has a thickness of 0.0017 inches, whereas ordinary newspaper has a thickness of about 0.0033 to 0.0040 inches. The strength of the paper is considerably increased by the additional backing and this is an item of prime importance when newspapers and books are subjected to frequent use. Recent tests by the United States Bureau of Standards demonstrate that the strength is increased from three to four times by use of the tissue. The weight of the paper is increased about 50 percent; transparency is lessened, but not enough to make reading difficult.



To Right: **Covering the perishable newspapers printed on wood pulp paper with the Japanese tissue.** ***Below:*** **Rolling or calendering the sheets on a gas-heated mangle before assembling**

The protective value of the treatment has been tested approximately by exposing treated and untreated sheets to direct sun rays for periods of 100 to 150 hours. Unprotected paper turned brittle and yellow very rapidly; the covered paper was only slightly affected and remained encouragingly flexible. The United States Bureau of Standards has recently made similar tests, in which the samples were heated in an oven at 100 degrees Centigrade, through which a stream of air was rapidly passed. After this process of accelerated aging, unprotected paper was found to have lost 20 percent of its strength, whereas, protected paper was hardly affected. Coloration, following this heating treatment, was much more pronounced in the case of unprotected paper. By the same series of tests, Japanese tissue was found to behave as an unusually high grade of paper. Copper number and alpha-cellulose content, the best known indexes of chemical change, were not substantially affected by the heat exposure.

The protective covering of Japanese tissue is now regularly applied to several important newspapers as soon as they are published, the expense being partly borne by the newspaper company. The New York *World* was the first to adopt this co-operative arrangement so that their protected file is now 13 years old. From all present evidences these files will still be in good shape after many decades of heavy service. Most encouraging is the finding that newspapers thus covered with tissue can be rebound after the covers are worn.

AN ACTOR TURNS INVENTOR

A Safety Oven Shelf Spelled Financial Success After a Lifetime on the Stage

By MILTON WRIGHT

INVENTORS are found in all walks of life; there is scarcely a calling you can think of in which men have not worked out new ideas, gone to the Patent Office with them, and eventually added to the comfort or efficiency of the rest of us and perhaps made fortunes for themselves. Nevertheless, when a well known stage and motion picture director bobs up as the inventor of a successful device for housewives to use in the kitchen, the circumstances are so unusual as to warrant looking into. We got hold of this inventor—William Parke—and asked him to tell us about it.

"The story of the safety oven shelf," he said, "is not very different from the story of pilot light. It was a fight for years before it became standard equipment on gas ranges. The same thing was true of the enameled metal stove, oven heat control, and insulated ovens. Each of them was a distinct step forward in kitchen efficiency, but the stove companies as a whole are conservative and few new inventions are put over at once."

"Yes," we interrupted, "but how is it that an actor and stage manager invented a successful piece of equipment for a kitchen stove? Such people are not supposed to have much home life, are they?"

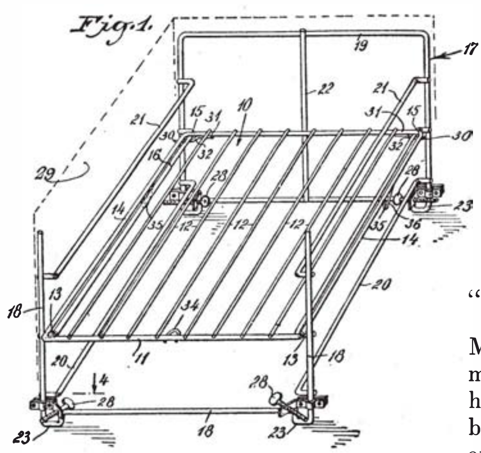
"IT was sort of forced upon me," he laughed.

"Was that the first invention that you ever made?"

"It was the first one I patented. A stage manager, you know, has to be something of an inventor, as well as a lot of other things.

"Any mechanical training I had, however, began when I started to work at the age of 14, running stamping machines in a tin factory. My job was to feed little round disks into a press. In such work it was necessary for the operator to put his fingers under the punch, and every once in a while some boy would get a finger cut off. Now I didn't want anything like that to happen to me, so I worked out a little trough to feed the disks through. It was adopted. Perhaps if I had thought to take out a patent I might have made money on it."

As a factory hand young Parke continued until he was 22 years old, when, having histrionic ambitions, he obtained a job as an actor in a Philadelphia theater. Doing small parts at first, he became assistant stage manager, and then stage director at another theater. As an actor and stage manager he went west, returning east in 1900 to become advance stage manager for E. H. Sothern. He continued in the same capacity when Sothern and Julia Marlowe toured together. He acted as stage manager for Arnold Daly for a season, and appeared in vaudeville with Daly and Helen Ware. He was stage manager for Richard Mansfield in 1907,



Oval: **William Parke, the inventor.** *Drawing:* **This safety oven shelf can be advanced or retracted for inspection or turning, enabling baking or broiling operations to be carried on safely and expeditiously**

when Peer Gynt was being produced.

In 1912, Parke began something which the theatrical profession holds is far more important than all the kitchen devices he could possibly invent. He was the pioneer of the Little Theater movement in this country. He inaugurated the William Parke Stock Company, of which Walter Pritchard Eaton said, "It is more important to the city of Pittsfield than the public library. If the public will support it, he will be producing in Pittsfield new plays and having the managers up from New York to see them. His company could go to other cities. Such a stock company can be the solution to the small town theater problem."

But Pittsfield was not a big enough city for the experiment, and in time Parke found himself 5000 dollars in debt. He closed the theater and returned to New York with 60 dollars in his pocket. He took a job as stage director for the original Potash and Perlmutter company, and within a year had paid back every cent of his indebtedness to his Pittsfield creditors, who never had expected to see their money again.

But the movies were calling, and, although Parke could not foresee it, he was now headed towards his kitchen invention. He directed pictures first for the Thannhauser studio in the east, next for Pathé, and then he went to California to direct for the Goldman studio. He directed a picture for Pauline Frederick, but it was so cut by a picture editor that Parke insisted upon his release. Then he made two independent pictures, but after that nothing was open for him in pictures. For two whole years nothing to do.

"OUR housekeeper offered of her own accord to work elsewhere," said Mr. Parke, in telling how he came to make his invention. "Mrs. Parke did our housework herself. Perhaps if she had been trained to it instead of having been on the stage she might have been a little more expert, but then we never would have had the invention. One day when she was taking a roast out of the oven to baste it, the oven rack tilted down and the roast slipped out and her hand was badly burned.

"If that happened to her, I reasoned, it probably happened to many other women. There ought to be some way of pulling out an oven rack without danger. I worked out a rack in my mind that could be pulled out and remain horizontal. Instead of having it slide on a thin shelf or runner on the oven wall, I provided a rod attached to the inside of the oven. A projection on the shelf caught and held fast when the rack was about two thirds out.

"Having figured it out, I went to a wood-working place and had a model made. Then I applied for a patent. Then I took the wood model to a machine shop, bought a stove, and had the rack made and installed. I had no means of knowing, you see, whether or not it actually would work in the heat of the oven. One day after dinner I turned the heat on full, and every fifteen minutes for three hours I opened the door and pulled out the rack. It worked perfectly. I knew I had something.

"My friends and neighbors thought it was great, so I came on to New York to start it going. One of my friends suggested that a company be formed to raise money. I did this and formed a corporation with a capitalization of 100,000 dollars. About 40,000 dollars' worth of stock was sold, mostly to friends in the theatrical profession.

"In New York I did two things: took a machine shop to perfect the invention and got in touch with the Consolidated Gas Company. The gas company put it in its laboratory to test it out and then began to recommend it to stove manufacturers. Meantime I worked out a simpler and less expensive idea and applied again for a patent. Then I saw still another means for simplifying it and once again applied for a patent. This time the gas company told me to stop where I was—that I had it fundamentally right. I went ahead, however, and devised a special handle and got a patent on that.

"THE next step was to get indorsements that would help put the invented article over. This I did by taking it up with the *Good Housekeeping* Institute, the *Herald-Tribune* Institute and *Modern Priscilla*. They tested and approved it and I was now ready for the market."

"And from then on it has just kept growing like a snowball?" we asked at this point.

"Not by any means," he replied. "The struggle was just beginning. After all, you must remember, I was just an outsider trying to break into the stove business, even if I did have the biggest gas company in the country lending me its moral support. I went to other gas companies—in Brooklyn, New Jersey, Philadelphia, Pittsburgh. They all said it was a good thing, but that if they were to sell it, it would make all the other stoves they had sold and were still selling look ridiculous. They urged that it be adopted by the stove companies."

"And then the stove manufacturers took it up?"

"Not right away. It was exhibited at the American Gas Association convention in Atlantic City in 1926, where the stove manufacturers had a chance to see it. The executives of the stove companies were discouraging, but the stove engineers all agreed that the idea was good. They predicted that when one or two of the companies should take it up, the women of the country would demand it in all stoves, and it now looks as if they were correct.

"Presently a new phase developed in the situation. Stove men began to agree on the merit of the rack, but asked why they should pay me 25 cents—the royalty I asked—when they could make a rack of their own devising. I had expected this and was ready for it. At every step of the way I had obtained patent protection. Some of the companies tried in vain to work out something to take the place of mine. One

well known stove manufacturer did succeed in making an invention, equipped stoves with it and offered it to the Consolidated Gas Company. The Consolidated pronounced it useless, and said it would take the stoves if they were equipped with *my* racks.

"The turning point had come. The gas companies, you know, are the big stove distributors of the country. It was no great while before I signed my first contract with a prominent stove manufacturer. He wanted an exclusive contract, but that of course was unthinkable. After that it was not long before I was negotiating with the largest company in the world which makes the oven racks for most of the stove companies.

"Meantime, there were the stoves which were already in use to be considered, for the stove companies were interested only in making new stoves. I devised and patented a frame of rods which could be set up in any oven for the rack to slide on. This business I have kept in my own hands, thereby getting a double hold on the business; if a woman buys a new stove with the safety oven rack, I profit by means of a royalty; if she gets only the frame and rack to make her old oven safe, I make a manufacturing profit."

The movable shelf is limited in motion but safely carries the roast out for various culinary operations

"Just one more question, Mr. Parke. Would you say that the success of the safety oven range is due to the fact that it meets a real need?"

"That is largely it, of course, but the need is really the foundation of a commercially successful invention, rather than its whole explanation. Naturally you must have a practical invention to start with, but, as I see it, two other things are necessary. First, you must see that you are protected fully, so that no one can take from you the profits which flow from your idea. Second, you must keep plugging away at it month after month and year after year in spite of every discouragement that will be thrown in your way, confident that if your idea is right, success will come if only you work hard enough and long enough."

IT might be interesting to know what the potential field is for a household device of this kind. Of course we do not mean that the rack described will be applied to every oven in the United States—this would be a Utopian dream. However, food for the families in the United States is largely prepared by gas, which has routed most of the coal and wood ranges to the scrap heap, except in rural locations. It has been found by accurate survey that there are not less than 13,000,000 gas ranges as against 8,300,000 of the coal and wood variety. Oil ranges are much used in the country, 6,000,000 being in daily operation. Evidently electricity has not come into its own yet for we find only 600,000 reliably reported as in use. It is by such figures, however, that the inventor must be guided in his efforts to introduce his product to the general public.

PRACTICAL X-RAY CRYSTAL ANALYSIS IN ENGINEERING[1]

By V. E. PULLIN

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IT was not for many years after the discovery of X rays that their nature was understood and they were identified with ordinary light. This development came about as a result of a brilliant piece of mathematical analysis by Professor von Laue in 1912. Von Laue's prediction was that if X rays had the same nature as light, but of infinitely shorter wavelength, their diffraction should be possible if a suitable—that is, fine enough—diffraction grating could be found. He suggested that a crystal, because of the regularity of its structure and the distance apart of its constituent atoms, would function perfectly in this respect as a three-dimensional transmission grating. Friedrich and Knipping carried out experimental work on these lines with conspicuous success, and the identity of X rays as an electro-magnetic phenomenon was put beyond all doubt.

This discovery, quite apart from its theoretical and historic interest, was destined to add enormously to the practical value of X rays in quite a new and hitherto unsuspected field of work.

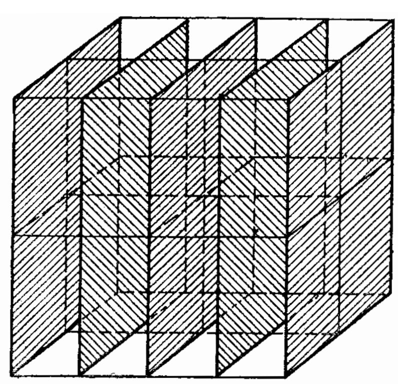
THE fine structure of materials must obviously exert a very great influence on their physical properties. By fine structure is meant something very much smaller than anything capable of detection by a microscope, and for this reason something which, prior to von Laue's discovery in 1912, had proved impossible of direct investigation. In this connection there are two highly important facts which render X-ray crystal analysis of paramount importance to engineers. First of all, metals and most engineering materials are crystalline, and, secondly, the working of metals, either by tools or heat, always tends to alter or modify the crystal structure. It is the business of X rays in this connection to provide us with pictures or diagrams from which we may, if we have the necessary knowledge, deduce the manner in which individual atoms are normally arranged, and how they are modified by mechanical or heat treatment or by alloying with other elements. The next operation is the interpretation of the X-ray story in terms of mechanical properties.

The physicist who concerns himself with X-ray analysis has really progressed quite a long way in the art of obtaining and interpreting X-ray spectra, but he is very often in considerable difficulty when he seeks to apply his results in practice. For this reason much closer collaboration is desirable between the X-ray worker and the engineer. X-ray crystal analysis is a very highly technical subject, and it is idle to suppose that it can ever reach a stage where it may be used as readily by the engineer, as, for example, the microscope. Nevertheless, a working knowledge of the subject and its limitations can be, and should be, acquired by every engineer. It is fundamental to his subject.

It is the purpose of this article to explain in general terms what crystal analysis depends upon and how it is done; and also to show from some typical spectra how their interpretation is important in general engineering practice. No attempt will be made to discuss the many applications of the subject in other spheres of activity.

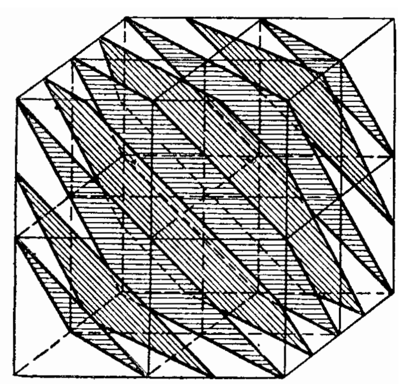
In the first place, it may be said that any crystalline material is suitable for investigation by X-ray spectrum analysis —most substances and all metals are therefore suitable. The next point for consideration is the character of a crystal and why it is that so much information may be derived from its analysis.

A crystalline substance is one characterized by the regular arrangement of its structural units. According to the material of the crystal, these units, which may be atoms or groups of atoms, are arranged in a perfectly definite pattern which is repeated over and over again in three directions. Crystals grow, and by their growth is meant that this identical pattern of units reproduces itself again and again along the three axes of the structure. A crystal, then, is



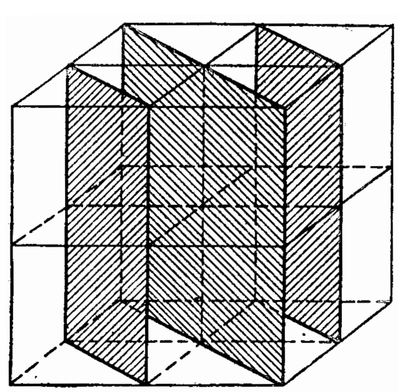
100 PLANES

FIG. 1



111 PLANES

FIG. 2



110 PLANES

"THE ENGINEER" FIG. 3

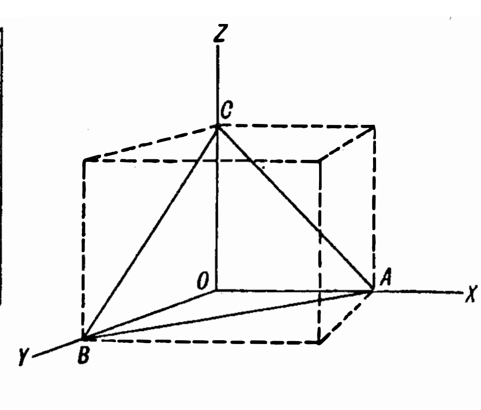


FIG. 4

Figures 1 to 4: **A little study of crystallography**

[1]Reprinted by permission from *The Engineer* (London)

simply a regular arrangement of structural units. If we could see inside and through it, which is impossible, we should find a beautiful and symmetrical honeycomb structure or lattice, presenting exactly the same appearance from any point on the lattice.

There are many different kinds of crystals, and they have been classified according to their external features into some 32 classes, of which only three types are of immediate importance to the engineer. They are called (1) face-centered cubic crystals, (2) body-centered cubic crystals, and (3) hexagonal crystals. To the first group belong metals which are ductile, such as copper, aluminum, silver, gold, lead, nickel, and that variety of iron known as the γ (gamma) type. To the second group belong α (alpha) iron and the brittle metals, such as molybdenum, tungsten, chromium, and so on; and to the third group belong zinc, osmium, and some few others.

A CRYSTAL lattice of the first type is cubic, having an atom at each corner—which, of course, it shares with adjacent cubes—and one in the center of each face; each crystal unit cell will therefore contain four atoms. The second type has an atom at each corner and one in the center of the cube; each crystal unit cell will therefore contain two atoms. The third consists of two simple hexagonal lattices, combined so that each cell contains two atoms. The atoms in a crystal unit cell are separated from each other by about an X-ray wavelength; in other words, the length of any side of such a cell is of the order of one Ångström unit (an Ångström unit is one hundred millionth of a centimeter).

Reference to Figures 1, 2, and 3 will show that we may draw various series of planes through such lattices as I have described. Crystallographers for convenience name these planes with reference to the three axes of the cube; for example, in Figure 4, OX, OY, and OZ are the three axes of the cube, and the planes in our illustrations are named in so far as they cut any of these axes. Thus, the plane A, B, C—Figure 4—cuts each axis once; therefore it is called the (111) plane. The planes shown in Figure 1 cut the OX axis only, and are therefore called (100) planes. The planes in Figure 3 cut the OX and the OY axes and are called (110) planes, and so on.

For the purpose we have in view—that is, that the engineer shall understand something of this field of work and the nature of the information yielded by this new method of investigation—it is not necessary to explain very much about crystal systems, but it is necessary that he should know that it is these symmetrical lattice planes, which obviously exist in all directions in a uniform atom lattice, that are instrumental in producing the X-ray diffraction phenomena with which we are concerned. The spots, rings, and lines which we shall find in X-ray spectra depend entirely for their position and intensity upon the disposition of these crystal planes. There will be one particular pattern for a face-centered crystal, another for a body-centered crystal, and so on. Such then is, roughly, the internal structure of a crystal.

The first business of crystal analysis is to show what this structural unit arrangement is and to give information which allows us to calculate the dimensions and the shape of the crystal units. Single crystals, as everyone knows, may sometimes be seen by the naked eye and sometimes only by the aid of a microscope, but we can never hope to see a crystal structural unit by any method; it is too small.

Now we must return for a moment to von Laue's discovery of the diffraction of X rays by a crystal lattice. Experimentally, this meant that when a beam of X rays was passed through a crystal, the component parts of the beam were deflected by the regular atom planes within, and, therefore, if a photographic plate were placed so as to catch and record the emergent beam it would show not only a central spot due to the main beam, but also a symmetrical arrangement of small spots surrounding the center spot and at varying distances from it, due to the components that are deflected by the atom planes.

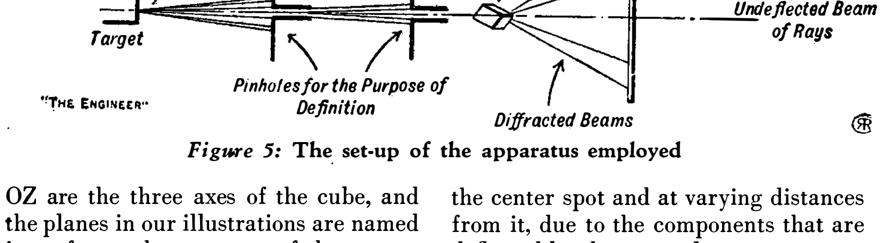


Figure 5: **The set-up of the apparatus employed**

Von Laue's prediction was correctly based upon the assumption that X rays were a form of light having a definite wavelength. Very soon after the experiments of Friedrich and Knipping, two English physicists, Sir William Bragg[2] and his son, Professor W. L. Bragg, enunciated the idea that X rays would, in a similar way, be reflected by the regular atom planes in a crystal. By the word reflection, however, we are not to understand the same phenomenon as the reflection of ordinary light by a mirror, because X-ray reflection does not take place at the surface of a crystal, but from the regularly spaced atom planes inside it. X-ray reflection really involves this assumption—that a train of X-ray waves, of appropriate wavelength impinging upon an electron, sets it into forced vibration and thereupon causes it to emit a train of waves having the same frequency as the exciting train.

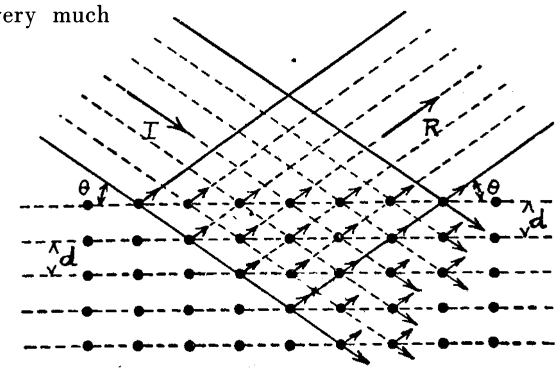


Figure 6: **How the X-ray beam is "reflected" by the regularly spaced atom planes of a crystal**

THE theoretical consideration, however, does not matter very much for our purpose. The phenomenon we are discussing may be regarded as that of reflection which, under the correct circumstances, is reinforced in intensity by the succeeding parallel atom layers beneath the crystal surface. What Professor Bragg did, which was of so much importance to practical crystal analysis —in fact, made it possible—was to show that a definite relation exists between the wavelength of the X-ray beam, the distance apart of the atom planes— this, of course, gives the clue to the dimensions and shape of the crystal unit—and the incident angle which the X-ray beam makes with the reflecting plane or planes.

If we examine a crystal of which the atomic spacing is unknown, we may find it by means of the Bragg equation— $n\ \lambda = 2\ d \sin\ \theta$, where λ is the wavelength of the X rays, d is the distance separating the atom planes and θ is the glancing angle. (See Figure 6, inserted by the Editor.)

It is very easy to arrange the experimental conditions so that the wavelength λ of the X rays is known. It will be seen from Figure 5 how the angle through which the X rays are bent may be measured, and from a knowledge of these

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[2]An article by Sir William Bragg, on the X-ray analysis, appeared in the *Scientific American* last month.—*The Editor.*

two factors we may calculate the spacing of the atom planes responsible for each deflected ray which gives rise to a spot on the photographic plate. It is very important to notice that the conditions expressed in the Bragg equation must be fulfilled before any reflected spot can appear on the plate. In other words, the atom planes must make precisely the correct angle with the particular incident wavelength before reflection can occur.

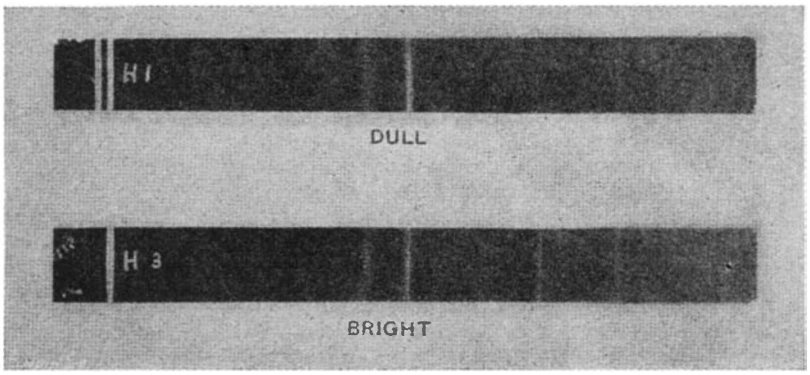


Figure 7: **X-ray line spectrum**

NOW let us see how this vitally important principle may be employed in the various practical aspects of engineering.

The chief things of importance that may be learned by the engineer from the crystal analysis of his materials are: The size of the crystals, the manner in which the crystal units are oriented, the effect on the crystal lattice of adding small quantities of foreign materials, such as carbon in iron to produce steel, the effect of cold work and annealing on the crystal units, and how far strain in a metal may be detected by X rays. Considerable work has been done on all these questions, and we shall now see what sort of results the X-ray analysis can be made to yield.

There are many different methods of technique in the application of X-ray crystal analysis, but they all depend upon the fundamental principle just explained. It is, however, very important that the most suitable method should be chosen for each particular problem. If we consider a single crystal and an incident beam of X rays made up of several different wavelengths, every set of planes which makes the correct angle with any of the component waves in the beam of X rays will produce a spot on the photographic plate, and a multitude of spots would therefore indicate a large number of participating crystal planes. Further, the arrangement or symmetry of the spots affords a guide to the crystal form.

Sometimes it is not possible to obtain our specimen in the form of a single crystal, and we have to be content with a small piece of metal containing a large number of crystals. If this is the case there is a choice of method depending upon the information we wish to acquire. We may, for example, grind up our specimen into a fine powder and put it into a small thin-walled glass tube. We shall then have, in such complete disorder, a mass of crystal planes presenting every possible angle to the incident beam. This technique is due to two independent investigators—Hull, and Debye and Scherrer. In this method it is customary to pass an X-ray beam of one particular wavelength through a system of, say, two fine line slits for the purpose of obtaining sharp definition before allowing it to fall upon the specimen. A strip of film is arranged in a circle around the specimen on the emergent side, and the results are seen as a series of lines on the film at varying distances from the zero. By applying the Bragg equation we shall find that each line corresponds to one particular set of planes, and we may thus detect any abnormality or distortion in their spacing by a comparison of the results with what is known to be the normal spectrum of the specimen. This method has value in cases where we wish to detect any lattice distortion due, perhaps, to the presence of a foreign element.

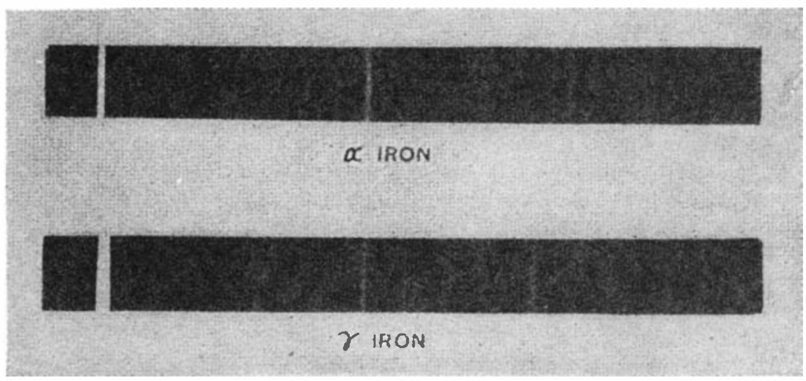


Figure 8: **"Two more line spectra"**

We may, on the other hand, use our metal fragment just as it is and reflect the X rays from it. The method is essentially the same as the previous one and the atomic plane spacing may be calculated in the same way. Care must be observed in preparing the face of the specimen to avoid introducing local lattice distortion by cutting or rough treatment. It is also highly important to remember that the examination of the planes just below the surface may be very misleading and the results by no means true of the material as a whole. X-ray spectra obtained by the reflection method have very valuable applications, but the method is by no means of universal application.

Another method which has very great value in the examination of metals is a modification of the original procedure due to von Laue. A very penetrating X-ray beam is employed, made up of a large number of wavelengths, and the rays, after having been defined by a small pin-hole aperture in the apparatus, fall upon and penetrate the specimen. This usually takes the form of a solid metal plate about one hundredth of an inch in thickness. Here we have a condition exactly the same as in the powder method, in that the specimen consists of a large number of crystals having a perfectly random arrangement. Consequently there will be sets of reflecting planes suitably placed at every conceivable angle. A photographic plate or film is mounted on the emergent side of the specimen.

The information which may be acquired by these pictures is diverse and very valuable. We may determine the crystal size of the material, we may deduce the crystal structure, and we may derive information concerning the orientation of the crystal units which may indicate cold working or strain. The analysis, if carried out subsequent to annealing, will yield important information as to partial or complete removal of orientation or strain, and also show the point at which recrystallization occurs. Characteristic diagrams obtained by this method are reproduced on page 39. They are concentric circles in some cases—Figure 11—and spokes in others. Sometimes the spokes are not very symmetrical, as in Figure 12, and sometimes they have a highly symmetrical appearance, as in Figure 13. In other cases there are no rings, but only a conglomeration of spots. Then, again, in some instances the rings are clear and well defined, and in others they present a somewhat hazy appearance. All these pictures have different meanings, which we will now describe.

FIGURE 11 is the effect produced when the specimen consists of a mass of small crystals with no preferential orientation at all. Here each ring is referable to a particular plane in the crystal which may always be identified.

Figure 14 is the effect produced by a specimen still with its crystal units unoriented, but having much larger crystals.

Figure 15 is typical of a specimen having very large crystals. The rings have entirely disappeared, and each crystal independently reflects the X rays to a spot. There is no preferred orientation.

Figure 12. This picture is quite different. Here we have some suggestion of rings indicating fairly small crystals, but there is an appearance of spokiness or, as it is technically called, "asterism." This appearance is thought to indicate that the crystals are in a state of strain—it shows itself when a metal test piece is pulled in a tensile testing machine, as we shall see later on. It indicates a tendency for the crystal units to orient themselves in a definite direction. This asterism would disappear if the specimen were thoroughly annealed.

Figure 13 illustrates preferred orientation of crystal units. It will be noticed that it is a perfectly well defined and symmetrical pattern. It is, in fact, the characteristic pattern due to the preferred orientation, viewed perpendicularly to the direction of rolling, of a metal having a face-centered cubic lattice. The actual specimen in this case was copper.

Figure 16 is another specimen which has also been rolled and therefore exhibits preferred orientation. Although it is equally well defined, it will be noticed that the pattern is different; this is because they are different crystals. In this case it is a body-centered cubic lattice. The specimen was α iron.

Figure 17 is the same specimen as Figure 15; after having been strained, the crystals have been elongated similar to those in Figure 12.

These few examples will illustrate the sort of information that can be obtained from the X-ray crystal analysis of metals. It would be possible to quote many other examples, but we will content ourselves with a few more illustrations showing the results obtained in some practical investigations. As I said in the beginning of this article, my chief desire is to convey to the engineer a working familiarity with the results of this new method of investigation. For this reason the physical aspect of the subject has been neglected in order that more emphasis might be laid upon the character of the information he is likely to acquire. The technique and its development may be left to the physicist who at the present moment is devoting both skill and time to this work, but if it is to be quickly fruitful the engineer must understand what is being "got at" in order that he may take cognizance of the subject and participate in the interpretation of results from the point of view of the development of his own research.

Questions concerned with carbide in steel; the crystal structure of alloys generally and particularly the brasses; the effect of the alloy elements in modern complicated steels; the differences between good and bad transformer iron; and the structure and properties of electro-deposited metals—all are suitable subjects for X-ray spectra investigation.

My first series of examples are concerned with iron. The specimen was progressively rolled and X-ray spectra were obtained at various stages of the rolling process. Figure 18 is a spectrogram of the original specimen. It shows that the iron had moderately large crystals without any orientation whatever. After rolling to 90 percent of its thickness, a small specimen was cut and X-ray spectra were obtained in three directions: (1) By passing the X rays through it in a direction perpendicular to the direction of rolling—this is the N (normal) spectrogram, Figure 19. (2) By passing the X rays through in a direction parallel to the direction of rolling P (parallel), Figure 19. (3) By passing the X rays through at right angles to the direction of rolling T (transverse), Figure 19. It will be observed that these pictures differ considerably from Figure 18. Some suggestion of rings make their appearance, indicating that the rolling process is beginning to break up the crystals. Further, a general spokiness appears. This indicates a strained condition in the crystals. All three views yield approximately the same pictures.

THE specimen was then rolled to 60 percent of its thickness and three similar spectrograms obtained—Figure 20. We now see a further change making its appearance. The rings are more clearly defined, hence the crystals are much smaller and the general spokiness is beginning to resolve itself into clumps. In the T spectrogram it will be observed that a definite orientation pattern is present. This particular pattern is characteristic of α iron. It is a very curious thing that when iron is rolled, preferential orientation, as indicated by this characteristic pattern, first appears in a direction viewed at right angles to the direction of rolling.

The specimen was then rolled to five percent of its thickness and three more spectra obtained—Figure 21. Here, again, the appearance is different. The crystals are now very small and preferential orientation is apparent in each direction. The rolling has induced the crystal units to take up a definite and oriented position. It is probable that this fully orientated condition is accompanied by a relief of strain which existed in the first two sets of pictures.

Having rolled the specimen to five percent of its thickness, we will now observe the effect of heat treatment on a reverse series of spectrograms. Figure 22 shows the three spectra obtained after annealing the specimen for half an hour at 450 degrees C. (842°F.); it will be observed that no change whatever has taken place. The crystals are still small and the full orientation is present. Figure 23 shows spectrograms obtained after annealing at 500 degrees C. (932°F.); this marks a change point. The general fuzziness of the rings indicates that recrystallization is occurring, and the orientation tends to disappear except in the direction at right angles to direction of rolling—Figure 24. These were obtained after annealing at 850 degrees C. (1562°F.). Recrystallization is now very marked, and the preferential

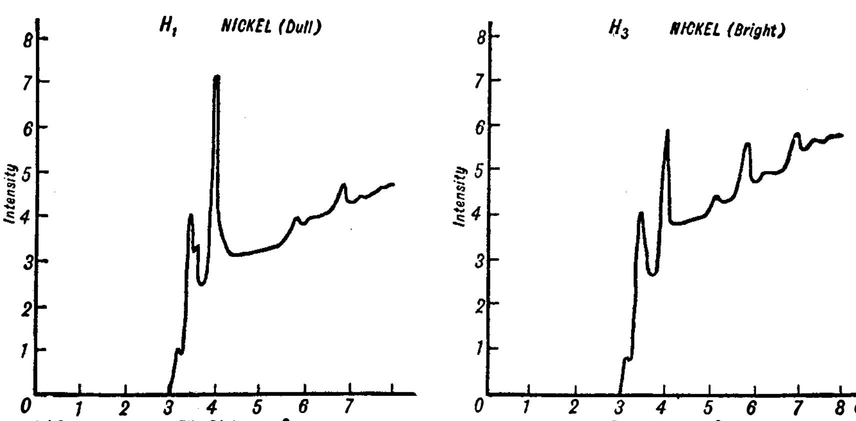


Figure 9: **Graphs obtained from the spectra in Figure 7. The peaks in the curves correspond to the spacing of the lines in the right hand parts of the spectra**

orientation has almost disappeared in the N and P views, although it is still very strong in the T view—Figure 25. After annealing at 1050 degrees C. (1922°F.) all the pictures now indicate very large crystals, and the orientation is absent except for a small suggestion in the T view, where the crystals exhibit a suggestion of a strained condition. These pictures suggest that until the temperature of 1050 degrees C. was reached, the annealing process was insufficient to remove the orientation from this specimen. A point worthy of notice is that it is in the transverse direction that orientation of the crystallites first makes its appearance, and it is retained in the same direction after it has disappeared in the other two. This series also indicates that this particular method of analysis affords a very sensitive method of determining the effect of heat treatment.

The next series refers to a specimen of manganese steel—face-centered cubic lattice. Figure 26 are the three spectra obtained after rolling. Figure 27 after annealing for half an hour at 600 degrees C. (1112°F.). General fuzziness indicates crystal growth, and the orientation is becoming less definite. Figure 28 shows similar spectra after annealing for half an hour at 1200 degrees C. (2192°F.). The crystals are now large and all traces of orientation have disappeared.

THE next spectra are of a specimen of "Staybrite" steel which normally has a face-centered cubic lattice. Figure 29 shows three spectra, N, P, T. The interesting thing to note about these spectra is that the effect of the rolling is to produce a body-centered lattice with its typical orientation. After annealing for half an hour at 600 degrees C. (1112°F.), we obtain the three spectra shown in Figure 30, where the pattern characteristic of a face-centered lattice makes its appearance. These two sets of spectra afford a clear comparison between the two characteristic spectra. In this case the annealing actually destroys the abnormal condition produced by the rolling and restores the normal. As a matter of fact, an expert examination of the spectra in Figure 29 does reveal traces of the normal face-centered lattice, but there is very little of it.

The next series is interesting as illustrating the effect of straining a metal and obtaining information as to what happens to the crystal units during the process. The X-ray tube is in a big protective cylinder, and below is a small arrangement in the nature of a tensile testing machine. The test piece, which is very small and thin, is placed before a pinhole through which emerge the X rays, and weights may be placed on a pan at the extreme end of a beam. Typical spectra are shown in Figure 31, 32, A, B, C, D. The actual specimen was steel. A was obtained before any weights were added. B was obtained after the metal had been stretched to just beyond its elastic limit. Here we have evidence of asterism, and the crystals are smaller; they have been to some extent broken up by the process. C is a spectrogram obtained well outside the elastic limit. The crystals are still smaller and the asterism is slightly more marked. D is a spectrogram obtained when the metal fractured. Here it would seem that

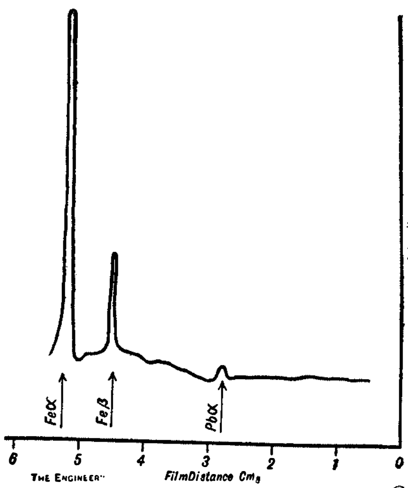


Figure 10: **Chemical X-ray method**

strain has been relieved with a consequent appearance of definite preferred orientation. It is to be noticed that in these experiments there is no appearance of any change until the elastic limit is reached.

Figure 7 shows X-ray line spectra obtained by the reflection method. They represent two specimens of electro-deposited nickel obtained by varying the depositing technique. The spectrum marked "dull" will be observed to show several faint lines and one which is very intense. This means that the number of atom planes participating to reflect the rays at this particular angle was very much larger than any other group. As a matter of fact, the intense line is due to the (200) planes, which means that the little crystals of nickel were mainly deposited like little bricks placed regularly side by side. On the spectrum marked "bright," on the other hand, there are at least three intense lines. This indicates that the crystals are not nearly as regularly arranged, but that several groups of planes combine separately to reflect the rays strongly. This means, of course, that the little crystals were deposited with much less symmetry. The specimen of nickel producing the "bright" spectrum was, in fact, much harder than that which gave rise to the "dull" spectrum. This, of course, would be expected.

Figure 9 shows graphs obtained from these two spectra and indicates the relative intensities of the spectrum lines. Figure 8 shows two more line spectra to show the difference in the spectra produced by α and γ iron—body-centered and face-centered lattices. It is often desirable to examine steels by this method to determine the relative proportion of the α and γ structure present. This may be achieved by a comparison of the intensities of the characteristic lines in the spectrum.

THERE is another application of X-ray analysis which has not received the experimental attention that it merits. I refer to chemical analysis by means of X rays.[3] Every element can be made to emit X rays which have a particular wavelength characteristic of the element and of none other. If we wish to analyze a material by X rays we must make our X-ray tube target of that material. The X-ray tube will then, under suitable conditions of operation, yield characteristic radiation which when measured will be recognized as characteristic of a particular element. It does not matter whether the substance to be analyzed exists in a free state or in a state of chemical combination with another. This is one of the important aspects which renders X-ray chemical analysis so valuable in certain cases. The amount of material, too, can be quite small. A recent application of the method in my own laboratory affords an interesting illustration. It was desired to know whether any solder was present in a minute fracture in steel. The fractured steel surface was accordingly mounted as an X-ray target in a special tube and an "emission" spectrum obtained. Certain lines were found on the spectrum characteristic of iron, and also one very faint line in the place where the characteristic line due to lead should appear. The spectrum line is too faint to reproduce in an illustration, but a graph of the spectrum was obtained and is shown in Figure 10. It supplied undeniable evidence of the presence of lead in the fracture.

From the illustrations and short introduction to the subject that has been given, it is hoped that engineers will appreciate the fact that this new method offers very definite promise in practical engineering problems; but, as I have said before, its development must be aided by the specialized knowledge and practice of those chiefly concerned.

The X-ray diagrams which I have used to illustrate the various applications of the method have been obtained in my laboratory by my colleagues, Messrs. D. E. Thomas, C. G. Pollitt, F. W. Osborne, and R. G. Friend.

[3]An article describing the X-ray chemical method, by Earle E. Schumacher of the Bell Telephone Laboratories, was published in *Scientific American*, December, 1928. Several excellent technical treatises on the X-ray analysis of crystals also are available.—*The Editor.*

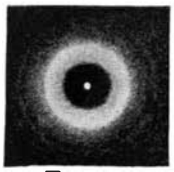


FIG. 11

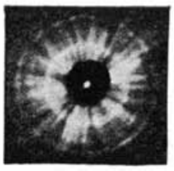


FIG. 12

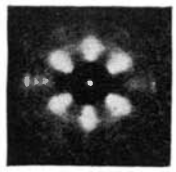


FIG. 13

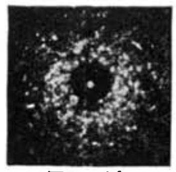


FIG. 14

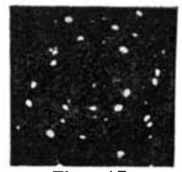


FIG. 15

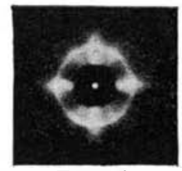


FIG. 16


FIG. 17

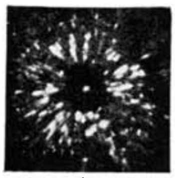


FIG. 18 (UNROLLED)

N P T

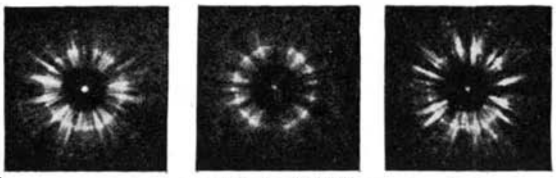



FIG. 19 (90%)

N P T

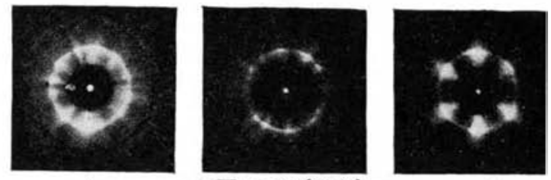



FIG. 20 (60%)

N P T

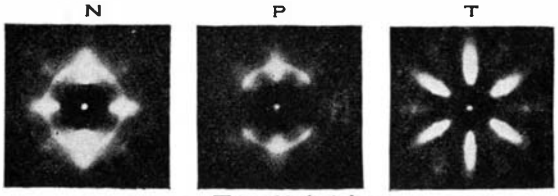



FIG. 21 (5%)

N P T

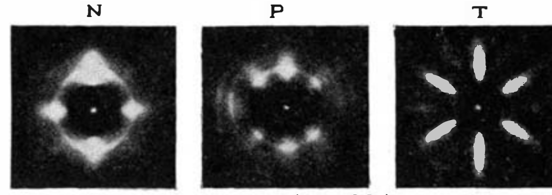



FIG. 22 (450 °C.)

N P T

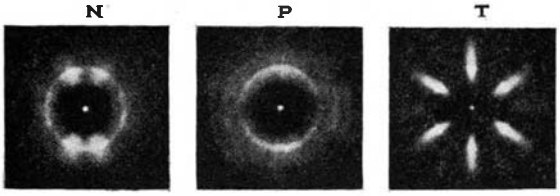



FIG. 23 (500 °C.)

N P T

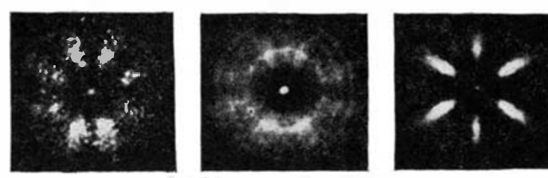



FIG. 24 (850 °C.)

N P T

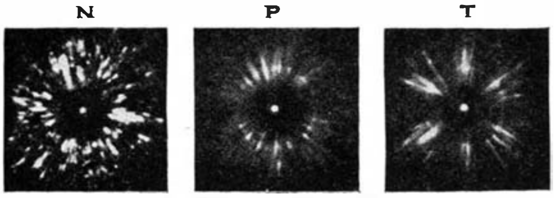



FIG. 25 (1050° C.)

N P T

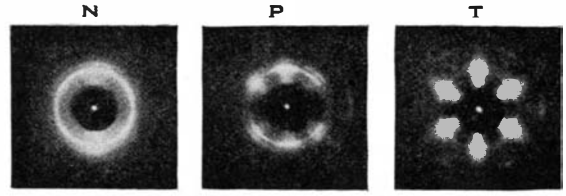



FIG. 26—MANGANESE STEEL

N P T

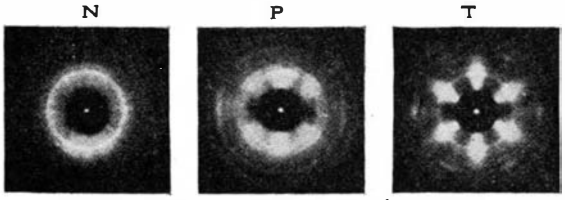



FIG. 27 MANGANESE STEEL (600° C.)

N P T

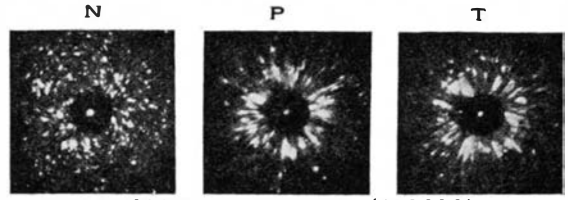



FIG. 28 MANGANESE STEEL (1200° C.)

N P T

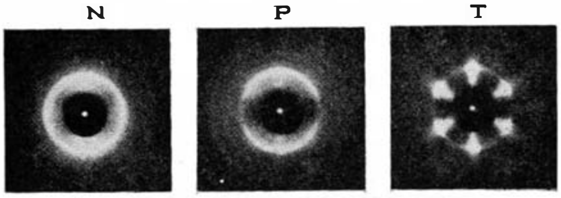



FIG. 29—STAYBRITE STEEL

N P T

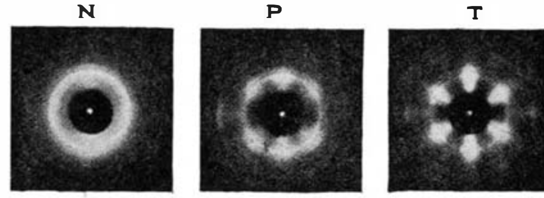



FIG. 30 STAYBRITE STEEL (600° C.)

A B

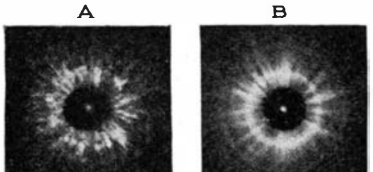



FIG. 31

C D

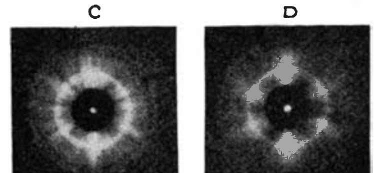
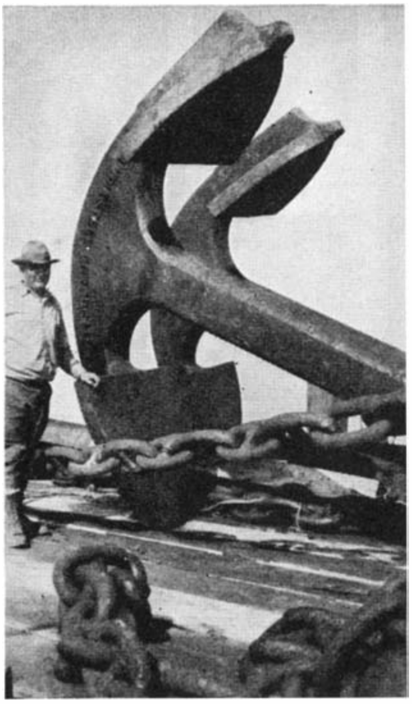



FIG. 32 AT FRACTURE

Figures 11 to 32: Spectrograms explained in the text. The author's article deals with metals and alloys, but the X-ray method (which should not be confused with ordinary X-raying, that is, merely looking through objects) has revealed some surprising facts "concerning the nature of things." It has been learned, for example, that rubber is crystalline, its atoms being geometrically arranged. A thousand common things we never thought of as crystalline proved to be so



Five of these eight-ton anchors will hold tankers while they load

PRE-CONSTRUCTED PIPE-LINE HAULED OUT TO SEA*

WHAT is believed to be the world's largest submarine oil-loading line was launched some time ago for the Standard Oil Company of California in Estero Bay, San Luis Obispo County, California. To laymen, at least, it probably is the most interesting portion of a new oil line leading from one of the most amazing petroleum-producing areas yet known to the industry, the Kettleman Hills.

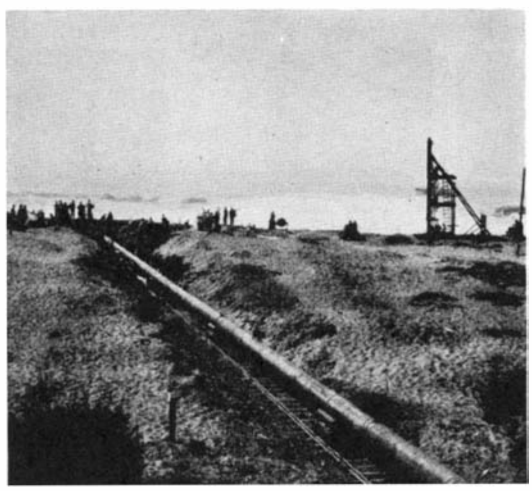
In order to provide an outlet for oil produced in the Kettleman Hills, the company has constructed a 10-inch trunk pipe-line from this field to the Pacific Ocean, a distance of 70 miles. Oil from the wells is collected through field lines to a central gathering station located near Kettleman City, where it is passed through rectifiers to remove dissolved gases. Heavy-duty steam pumps, operating at a thousand pounds pressure, then force the oil through the trunk line direct to storage-tanks on the coast. There are no intervening booster stations along the line. The high-pressure direct pumping is possible because the line is constructed of seamless pipe. All of the field joints are welded—there is not a screwed fitting or joint in the entire line.

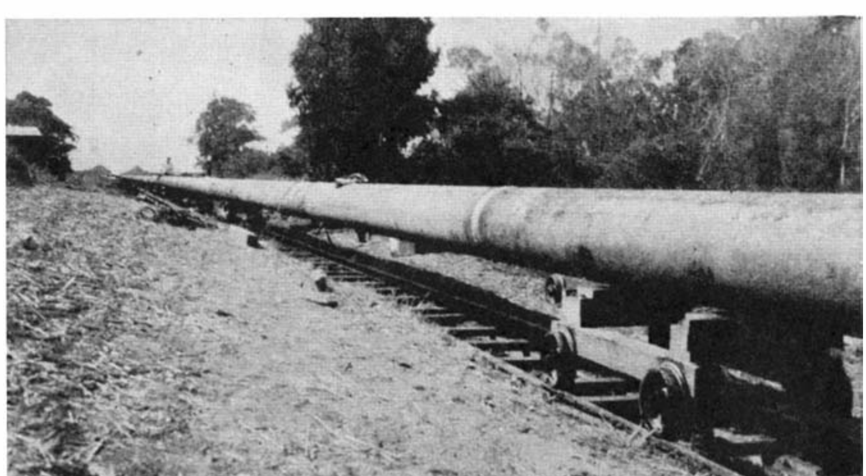
THE western terminus of the line is at Estero Bay, about 15 miles northwest of San Luis Obispo, near the town of Morro Bay. A station has been constructed here to load the oil into tankers which will carry it to the company's refineries. The site of this loading station approaches the ideal. The storage-tanks, which receive the oil from Kettleman Hills, are located about a mile from the beach on the top of a ridge that rises south of a small stream-bed called Toro Creek. The ridge is flat-topped, affording ample space for a large amount of tankage, which can be constructed with very little excavation. Four large tanks equipped with floating roofs have been installed on the ridge. They are concealed from the highway, which lies along the beach, by a shoulder in the hills.

Oil is loaded into tankers directly from the storage-tanks on the ridge. For this purpose, instead of building a wharf which, in the open bay, would be exposed to damage by storms, the company has constructed a submarine line that cannot be damaged by rough weather and which provides a more economical means for loading.

This submarine line consists of 16-inch welded steel pipe extending from the beach along the bottom of the sea to a point 3000 feet out in the ocean, where the water is deep enough to provide safe anchorage for the largest tankers. The shore end of the submarine line is joined to the tanks on the hills through a 20-inch pipe. A flexible rubber hose is connected to its sea end. When not discharging, this hose lies on the bottom, but it is arranged so that its end can be readily picked up to the surface by tankers for loading.

The launching of the submarine line and the installation of the marine equipment were done under contract by the Pacific Bridge Company. Preparatory to launching, the entire 3000 feet of 16-inch pipe was welded together into one long tube weighing about 300,000 pounds. This was placed on low cars running on a small industrial railroad-track that the contractor had laid on the floor of the valley of Toro Creek, which slopes gently back from the edge of Estero Bay. When all was in readiness, a steel towing cable was brought ashore from the Red Stack tug, *Sea Salvor,* anchored about 2000 feet off shore. This cable was attached to a pulling bridle secured to the end of the pipe-line. A sled to guide the line over any obstacle such as rocks was also firmly lashed under the end of the pipe-line. At a given signal, the *Sea Salvor* pulled the pipe-line out along the ocean bottom. When the line was in position, it was anchored with chain weights at several points along its length. It was secured on the beach by





Two photographs illustrating the manner in which the pipe-line was made ready for launching by welding it into a single piece over half a mile long

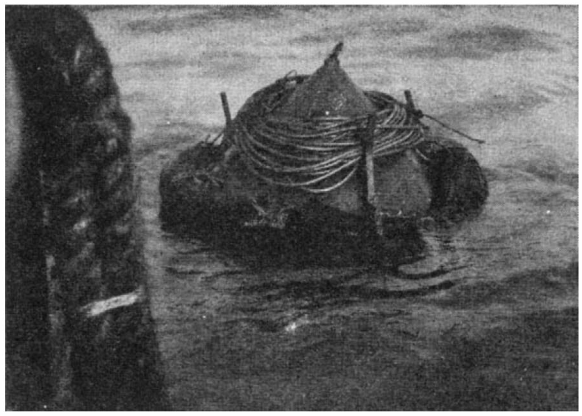
*Reprinted by permission from the *Standard Oil Bulletin.*

means of a heavy concrete block cast around the pipe.

After a hydrostatic test showed that no damage had occurred during the launching operation, a diver's crew installed the flexible hose at the sea end of the line. This hose is made of rubber, heavily reinforced with a spiral steel wrapping. A lifting bridle is connected to the end of the hose by a chain attached to a buoy.

Five enormous anchors, each weighing 16,000 pounds, were placed in a semicircle about the end of the submarine line to provide moorings for the tankers while loading. The tankers will not tie directly to the anchors, but will secure their mooring lines to big can-buoys attached to the mooring anchors by means of heavy forged-steel chain. These moorings were designed to hold the company's largest tankers in rough weather.

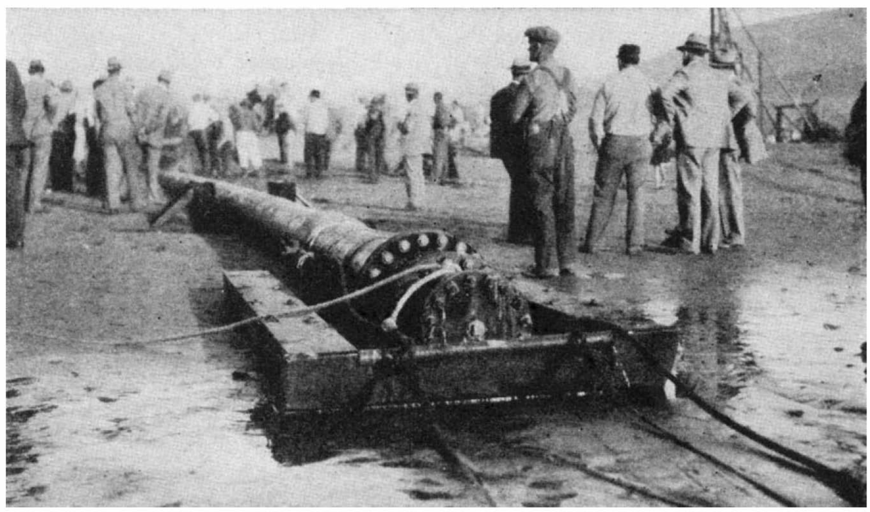
A bell-buoy was installed near the mooring site by special permission of the Bureau of Lighthouse Service. The sound of the bell warns other craft that they are approaching the submarine line and acts as a guide to incoming tankers in foggy weather.



The floating telephone station. The buoy with its extension line supports a flexible conductor that is connected to the armored submarine cable

In order to provide reliable communication between the shore station and the tankers loading at this terminal, an armored telephone cable was laid from the beach to the moorings, parallel to the submarine pipe-line. A flexible conductor spliced to the end of this cable is secured to a small buoy on which several hundred feet of telephone wire are coiled. During loading, this wire is passed to the deck of the tanker and attached to a portable telephone. As an additional precaution, during all loading operations, the telephone communication is supplemented with whistle, light, and semaphore signals.

With this terminal in operation, the oil is loaded into the ship by gravity, no pumps being necessary. The natural elevation of the tanks permits oil to flow through the large pipe-line at a rate between 15,000 and 20,000 barrels per hour. To produce such a flow with pumps would require some 2000 horsepower. The high rates of flow provided for enables tankers to make an extremely quick "turn-around," only about six hours being required to load even the largest vessels.



To facilitate its progress over the ocean floor, the forward end of the pipeline was equipped with a sled. The pulling bridle is here shown in place

***In circle and above:* One of the divers who served on the job, at work and in repose**

To insure accurate control of the oil being loaded at these high rates, a control gate-house has been located at the foot of the hills near the beach. All the ship-communication equipment is located at this control house, together with an electric-flow meter which will give a continuous indication of the rate of flow. A 16-inch cast-steel, motor-driven valve located at the house is used normally for adjusting the rate of flow to the ships. A similar hydraulically operated valve equipped to close quickly without setting up a dangerous surge in the pipe is also installed here for emergency shut-off. The controls for these valves, together with the flow meter and all the other instruments, are centralized at a desk in the control house. Here the operator, with an unobstructed view of the ship with which he maintains continuous communication, can control the flow of oil at a finger's touch.

In planning the design and operation of this loading terminal, every possible precaution was included to guard against the spilling of oil. The United States Army engineers, in granting a permit for the installation of the submarine line, indicated that they were satisfied with the precautions made so that no oil would be released to contaminate the beaches in the vicinity. Not only have numerous precautions been provided against spills occurring during loading, but also a set of tanks and pumps is installed near the shore end of the submarine line, into which any oily ballast or bilge-water the ship may contain when she comes in to receive a cargo at this port, can be discharged. All the oil will be skimmed off these tanks so that nothing but clean water is discharged into the ocean.

GIANT TORTOISES

Nearing Extinction on the Galapagos Islands, They Are Being Propagated in the United States

By DR. CHARLES HASKINS TOWNSEND

The author and a tortoise on board the Fisheries steamer, *Albatross II*

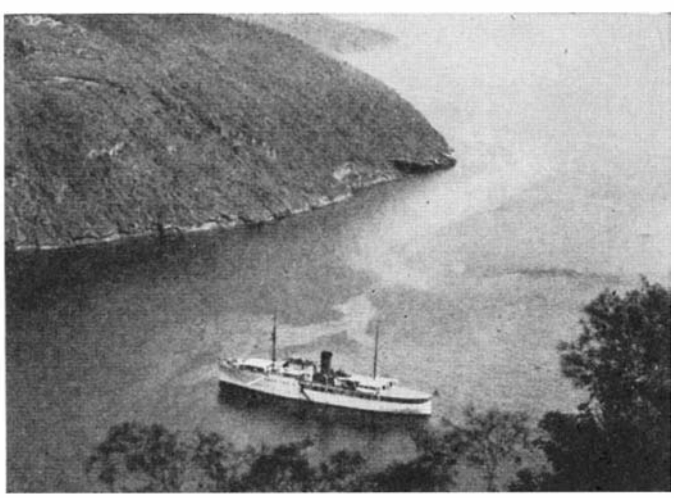
THE point of greatest interest in connection with the Galapagos Islands and their indigenous animal life is the existence of land tortoises of prodigious size, and formerly, in amazing numbers. Dampier, who visited the Galapagos in 1684, says of the tortoises: "It is incredible to report how numerous they are." Similar affirmations regarding their abundance are to be found in the accounts of the early navigators who followed him. It was this outstanding feature that gave the Galapagos* Islands their name. The abundance of large tortoises attracted to the islands food-seeking ships for three centuries—an attraction that persisted until the exhaustion of the supply.

With the wondrous tide of tortoise life brought to a low ebb in the 19th Century by man, there followed no rise when he withdrew. The pests he had introduced proved sufficient to prevent an increase among the scattered survivors. Dogs, pigs, cats, and rats abandoned there, returned to the feral state and increased to thousands. The eggs and newly hatched young of the tortoises became their food, few escaping. The adults, wearing their shell armor, were largely immune. Then followed the Ecuadorians, who killed tortoises assiduously for their oil. The animals have long been extinct on most of the islands where they once swarmed. Wild dogs and other predatory pests roam in thousands on the two large islands, where limited numbers of adult tortoises are still to be found—mostly in high country far inland.

TORTOISES are still hunted occasionally by Ecuadorians of the two small settlements remaining on the Galapagos. Therefore, their continued existence on Albemarle and Indefatigable Islands can hardly be expected.

With these facts under consideration, the board of managers of the New York Zoological Society authorized the writer, who had twice visited the Galapagos, to procure, if possible, a breeding stock of tortoises for colonization in our southern states and elsewhere under favorable climatic conditions. With the co-operation of the United States Bureau of Fisheries, the steamer *Albatross II* was sent to the Galapagos in April, 1928, under my direction.

The success of the expedition greatly exceeded our expectations. One hundred and eighty tortoises were captured in the mountains of southern Albemarle, which involved a week's journey with pack animals. We secured the services of twenty Ecuadorian colonists at the hamlet of Villamil, who with their burros made an effective collecting party. It was not practicable to transport any tortoises of large size in this exceedingly rough and trailless country. The loading of the tortoises on the ship was extremely difficult, as the coast is exposed to a heavy swell and the *Albatross II* lay two miles off shore.



The Astor yacht, *Nourmahal,* on which the author visited Galapagos Islands in 1930, in a cove at Albemarle Island

Most of the tortoises brought back were soon placed in colonies along the southern border of the United States. All are in the keeping of zoological gardens or other responsible co-operating agencies. These are located as follows: four colonies in southern Florida; others at New Orleans, Louisiana; Houston and San Antonio, Texas; Superior, Arizona; and San Diego, California. Other colonies were later established in Bermuda; Honolulu, Hawaii; and Sydney, Australia. All have the freedom of fenced, grassy ranges and are provided with dry shelters, to which tortoises can retreat during chilly weather or periods of unusual dampness. A number of small tortoises are retained at the New York Zoological Park until they attain larger size. Like the others, they will be placed only with responsible organizations in the south, co-operating with the New York Zoological Society.

THE great tortoise of Aldabra Island in the Indian Ocean has a history similar to that of the Galapagos tortoise. It was used for food by mariners for more than three centuries, when, threatened with extermination, its propagation was undertaken under the auspices of the British Government. Distributed among the farmers of the adjacent islands of the Seychelles, it was domesticated and soon became a valuable food animal. The New York Zoological Society is hopeful of similar success with its congener of the Galapagos.

While a distinct species of tortoise has been recognized on each of the ten islands of the Galapagos group that originally bore them, five have been described from the large island of Albemarle, which is probably too many. Albemarle has a length of 75 miles and heights up to 5000 feet. Each tor-

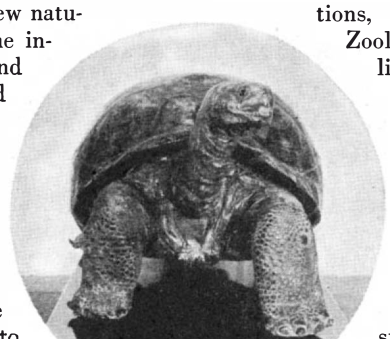
*Spanish for tortoises

toise in the colonies established by the Zoological Society wears a copper number and has been measured and weighed. These records will be continued annually for a number of years until the rate of growth and change with age are determined. In this way one of the many problems connected with the very peculiar animal life of the Galapagos may be advanced toward solution and some of the present confusion respecting species of tortoises eliminated. The origin of this isolated fauna is still unknown. The islands belong to Ecuador and lie 500 miles from the nearest part of the mainland.

WHILE at Charles Island we obtained from a cave a dozen large skeletons of the long-extinct tortoise of that island. These skeletons have served to establish the identity of the Charles Island tortoise as *Testudo galapagoensis*, a species long involved in uncertainty. It became extinct there in 1848. Twelve whaleships that participated in its extermination carried away 1775 tortoises, according to logbook records in my possession.

We were assured by natives of Albemarle that tortoises of large size are still to be found in the high interior of Indefatigable, an island having a diameter of about 25 miles. This island is one of the most difficult of the group to penetrate. Available records show that the catches of tortoises made here by the great whaling fleet of the 19th Century were small as compared with those made on more accessible islands.

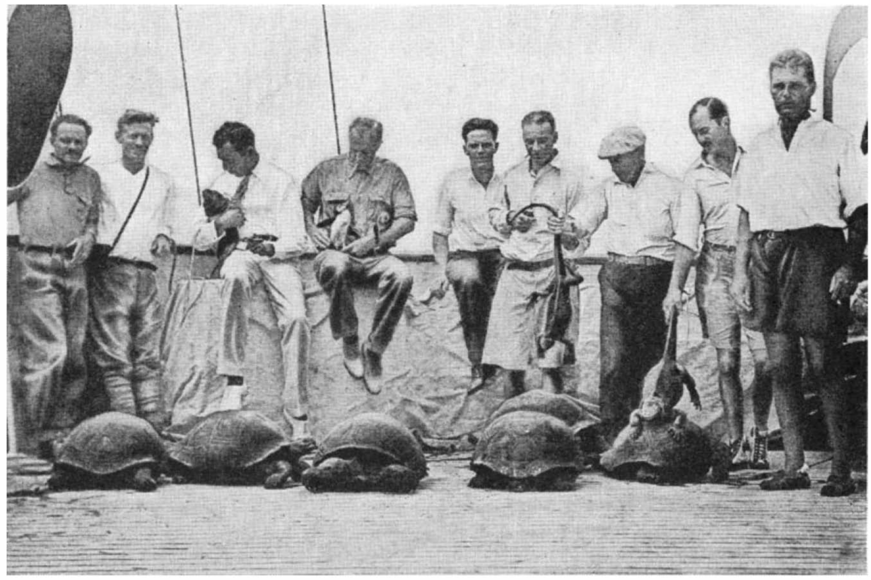
The tortoise of Indefatigable is known as *Testudo porteri*. Few naturalists had studied the indigenous animals and plants of this island until the arrival of Mr. Astor's yacht, *Nourmahal*, early in 1930. Like the others it suffers from the plague of introduced pests, and the remnant of its tortoise life is probably destined to disappear.



This 415-pound Galapagos tortoise (mounted) was raised in California

While on the way to Albemarle in 1928, the *Albatross II* stopped at Duncan Island, where a party of ten men sent ashore from Mr. W. K. Vanderbilt's yacht early in 1928 had obtained five tortoises. Our party of eight men spent two full days exploring its steep thorny slopes. We examined both lower and upper craters and reached the top of the mountain without finding any trace of tortoises. This small but exceedingly difficult island has been frequently visited and has yielded occasional tortoises up to the present year. It is possible that Mr. Vanderbilt's party captured almost the last of those living there.

Duncan Island furnished hundreds of tortoises to whaleships as late as the middle of the last century, when four vessels took away 356 tortoises between 1848 and 1863. Tortoises were reported to be plentiful there when explored in 1906. Man is their only enemy on this island except rats, which accounts for their persistence on an island only three miles long. Other domestic animals, if ever introduced, probably did not survive the dry season. The island is waterless except during rains. The tortoise of Duncan Island (*Testudo ephippium*) is well represented in museum collections, and the New York Zoological Park has three living adults, the gift of Mr. Vanderbilt.



Mr. Astor's party on the *Nourmahal*, with specimens of the young tortoises of Indefatigable Island. This species of tortoise was long supposed extinct

The species represented by our collection from the mountains of southern Albemarle is probably *Testudo vicina.* It has not yet been compared with other species described from that island. It seems to have disappeared from the low country. We found no traces of it, and hunting by passing vessels was discontinued years ago.

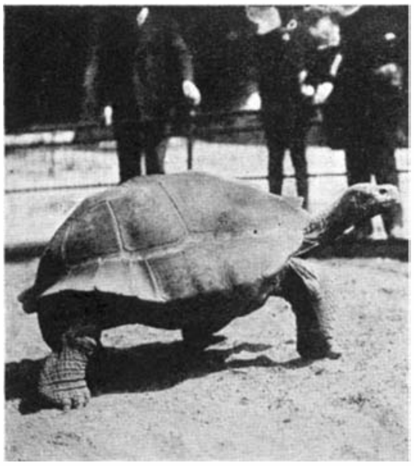
The former importance of the Galapagos tortoise as a source of food is but little understood at the present time. The narratives of the early navigators who visited the Galapagos all contain references to it. Great numbers of tortoises were taken for food by buccaneers, sealers, merchantmen, and whalers.

Among the logbook records of the whalers examined by the writer at New Bedford and elsewhere were those of 105 whaleships that carried away 15,830 tortoises during a period when there were 700 vessels in the American whaling fleet. Many of the whaling vessels made catches of 300 or more, one in 1834 taking 500. The extent to which it was used as food cannot be known until more logbooks can be examined.

Tortoises were kept on board without food or water for months, in some cases more than a year, and killed as required. The narratives of the early navigators and the logbooks of the whalers contain only favorable testimony regarding the edible qualities of the giant tortoise. Admiral Farragut, who served as a young officer on the U.S.S. *Essex*, at the Galapagos in 1813, wrote: "The meat cooked in almost any manner is delicious."

IT has been estimated that ten millions of tortoises have been taken from the Galapagos since their discovery. The Galapagos tortoise had apparently a food value to the Pacific whaling fleet for the best part of a century, not unlike that of the bison to the settlers of the great plains. It was known to the whalers as terrapin, a name usually spelled "turpin" in their logbooks. The giant tortoises still in existence on the Galapagos and on Aldabra are of great interest to naturalists. They represent the only survivors of extinct tortoises that in a very remote past inhabited North America and India.

The tortoises now colonized at points near the southern border of the United States are young and mostly of small or medium size, few weighing more than 150 pounds. They have already shown gratifying growth, the degree of which undoubtedly depends upon extent of range and access to grass or other food at all times.



A 350-pound Galapagos tortoise in the New York Zoological Park

The colony of tortoises at San Diego enjoys a well-fenced range of about five acres of hillside in the zoological garden. This area is well supplied with coarse grasses and low bushes, and has a few trees.

The tortoises at the Boyce Thompson Southwestern Arboretum, Superior, Arizona, have half an acre of desert land thickly grown with cactus—their favorite food, a concrete drinking basin, and a stone refuge during chilly weather. A 50-pounder here increased ten pounds in three weeks on a diet of prickly pears.

The three colonies located in zoological gardens at San Antonio, Houston, and New Orleans, have grassy ranges averaging about a quarter of an acre in extent.

UNTIL recently, there has been little information on record respecting the growth of the giant tortoise. A 29-pound male (*Testudo vicina*) taken from Albemarle Island in June, 1899, lived at Riverside in southern California, until April, 1914, when it died from exposure on wet ground. Its weight at death was 415 pounds, the carapace measuring 41 inches. It is also recorded that this tortoise increased from 29 to 350 pounds in seven years. It practically doubled its weight annually while young. Mounted, it is shown in the photograph on the preceding page.

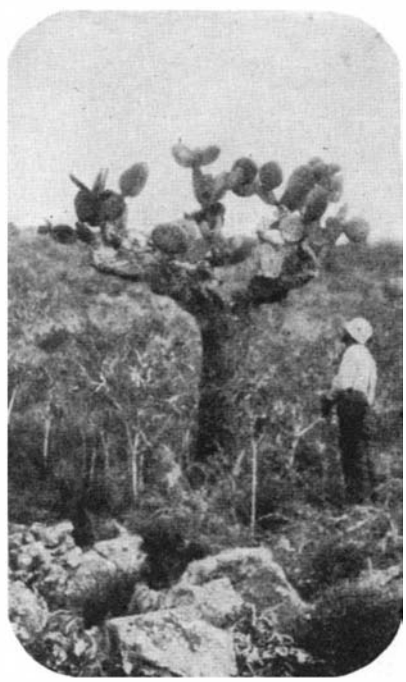
A tortoise of the same species was received at the New York Zoological Park in 1904, its weight being 140 pounds. It weighs at the present time (1930) only 360 pounds. Lacking in winter the outdoor life enjoyed by the California tortoise, its growth has been very slow. Nevertheless, it is a healthy and powerful animal, easily carrying a full-grown man.

We have now many young tortoises colonized at several points under various conditions and all in mild climates. As all have been numbered and weighed, we have already acquired definite knowledge as to rate of growth. Reports from these colonies show that tortoises under 20 pounds practically double in weight each year. The growth of those exceeding 50 pounds has been slower.

Should these animals increase in numbers, under the present experimental conditions, as is expected, the Zoological Society will eventually arrange to make them available to breeders as food producers suitable for propagation in southern and especially in arid regions.

Nature (London) in commenting on the attempt to propagate the giant tortoise says: "The only hope of keeping the stock alive was to establish it in conditions where its safety and continuance could be assured so far as human devices go."

The writer enjoyed the privilege of



What the going is like on Duncan Island, one of the Galapagos group

visiting the Galapagos Islands on Mr. Vincent Astor's yacht, *Nourmahal,* in April, 1930, when we were fortunate enough to secure eight specimens of the tortoise peculiar to Indefatigable Island (*Testudo porteri*). These, with Mr. Astor's approval, will soon be colonized in southern Florida. This species, the existence of which was in doubt, was found far inland. Certain large specimens, too large for a horse to carry, were left at liberty. Those brought out weighed from 40 to 80 pounds. We measured the bleached shells of several killed years before that were nearly five feet in length of carapace as measured over the curve. They must have weighed considerably over 500 pounds.

The following record from San Antonio, Texas, shows the increase in weight during two years of eight young tortoises located there:

Tag No.	Weight Lbs. 6/18/28	Weight Lbs. 7/1/30
75	12½	34
76	10¾	32
77	10¼	36
78	12	36
80	10½	38
84	10	38
86	32	62
89	13½	40
—	111½	316

Other records recently received are here presented without details, showing only increase in total weight of each colony of young tortoises:

Locality	No. of Tortoises	Weight in pounds 1928	1929	1930
San Diego	7	479		1041
Houston	14	192		709
New Orleans	7	101		286
Bermuda	10	66		175
Honolulu	6		159	378

Records from two other stations show similar rates of growth, while reports from four localities have not yet been received.

LET us consider this huge, slow-moving animal it is proposed to domesticate. It is a vegetarian, amazingly fond of cactus, which it eats spines and all, but in captivity is ready to eat grass or any vegetables set before it. It does not bite or make a noise. It doubles its weight annually while young and continues growing indefinitely when old, until weights of 500 pounds or more are attained. The females lay 20 to 40 eggs. The young shift for themselves. This tortoise is good to eat, as attested by the mariners who captured it. Let us at least prevent the extermination of the giant tortoise even if it cannot take rank with other domesticated food producers. Its origin in its isolated volcanic home is one of the unsolved problems of the Galapagos Islands, so interesting to all naturalists since Darwin in 1834 made observations there which have never been surpassed in zoological interest.

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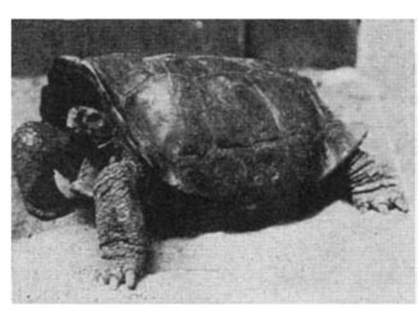
Commercial applications of the Diesel engine in the automotive field will be the subject of an article to appear soon.—The Editor.



A Duncan Island tortoise (*Testudo ephippium*) now in New York

FROM THE ARCHEOLOGIST'S NOTEBOOK

New Allenby Bridge Makes Petra Accessible

PETRA, the wonderful sculptured city of the desert, was for a long time inaccessible because of its remoteness and the danger from roving Bedouins. It can now be reached with comparative comfort by means of the Damascus-Mecca railway. One can now travel down from Jerusalem by motor to the Jordan, and hence by the new Allenby Bridge to Amman, the capital of Trans-Jordania. A train leaves twice a week for Maan, 120 miles distant. From this point camels or horses can be hired and the ruined city reached in about six hours.

The North Arabian Desert was always difficult to cross by reason of the juxtaposition of great barriers of granite and sandstone athwart the line of communication between the various cradles of the human race—between Egypt on the one hand and Syria, Mesopotamia, and southern Arabia on the other. At a time when maritime enterprise was still hesitant and fearful, man was forced in his infancy to seek a way through the desert. Petra was ideally situated geographically to form a clearing house for the commerce of the world as it was then. The land route from southern Arabia via Mecca to the countries of the Mediterranean was all-important for the supply of luxuries of life—"gold and silver, ivory, apes and peacocks" which the rapid development of civilization demanded. Petra began to establish a position as a cosmopolitan emporium about the 6th Century B.C. and retained this position for almost one thousand years. The City of Petra probably reached its greatest wealth and prosperity in the 1st and 2nd Centuries A.D. under the Romans. The east and west traffic became gradually diverted to a more northerly route by Palmyra and the north and south traffic probably took a line farther east, something like the Hajj route or the "Pilgrim Route" from Damascus to Medini, and very much along the line of the present Hijaz Railway.

This beautiful structure, hewn out of the solid rock, is 70 feet high

Petra is unique among the wonders of the Orient, being hewn out of the solid rock. The remains include native, Egyptian, Greek, and Roman art. The rock is beautifully colored which gives much light and vivacity to the 850 known temples, monuments, and tombs.

The monastery, carved out of solid rock, is surmounted by a huge urn

A most elaborate survey of the city has been recently made by Sir Alexander Kennedy whose researches have been published in a beautiful book entitled "Petra: its History and Monuments." The so-called Treasury of Pharaoh is a magnificent ruin and is one of the latest, dating from the time of the Emperor Hadrian who visited Petra in 131 A.D. The structure is about 70 feet high. A rock-hewn stairway of many hundreds of steps brings one to the largest of Petra's ruins, the El Deir or monastery. It is nearly 150 feet high and is surmounted by a huge urn which we also illustrate.

Chinese Pottery Dogs

THE antique pottery dog in The Metropolitan Museum of Art is interesting as it shows a breed which has apparently been known in China since the earliest representation of dogs. Similar dogs existed in the 1st Century A.D. and exist in the flesh at the present day. The attitude and spirit of the animal have been caught perfectly—a little lonely and forlorn, as out-of-doors dogs are apt to be in China.

An old Chinese artist caught the spirit of an abused unpedigreed dog

A Venus from the Sea

OCCASIONALLY the sea still gives up works of art. A marble statue of Venus has been recently recovered from the water near the island of Rhodes in the Mediterranean Sea. The head was found first and the body was recovered after further search. It is a new type of Aphrodite, of which there is only one other known example. It has been placed in the Rhodes Museum. Our illustration shows the body of the statue being hauled out of the water.

A marble Venus was recently recovered from the Mediterranean

At the left a 10-ton tree is being skidded over the garden wall. *Below:* Moving a large olive tree on a motor truck. When planted, this tree gave the appearance of having been planted more than 50 years ago by mission padres

LANDSCAPING WITH FULLY GROWN TREES

By H. L. POPENOE

TRANSPLANTING large trees to secure an immediate effect is a common practice among landscape designers and planting contractors throughout the country, but its adoption by the man of limited means has not yet become general. This is chiefly due to the necessarily large expense and the risk connected with the undertaking, but it is also due to the fact that special equipment plays such an important part in the handling of the trees.

The special equipment desirable for the easy and safe moving of large trees includes a derrick or large tripod, a chain hoist of sufficient strength to lift the tree from its place of growth and to settle it into its new location, and a truck or cart adapted to easy loading, capable of carrying a heavy weight. Block and tackle, rollers made of short lengths of pipe, bars, lifting jacks, ropes, and similar small equipment all come in handy when getting the tree into place.

Horticultural ability or training is even more necessary than the proper equipment for if the tree mover is not a judge of proper conditions, varieties, and methods, his chances for failure are multiplied. It seems almost criminal to uproot and move a tree that has taken years to grow, only to have it die.

One of the illustrations shows a three wheeled cart used by the writer, that has proved handy for moving balled or boxed trees as well as those that are moved "bare root." It is built low to make loading easy and is strong enough to carry a load of two or three tons. A brake lever working on a drum on one of the wheels prevents it from going too fast down hill.

The tree is lifted by a tripod and chain hoist until the cart can be pushed beneath. The tree is then lowered onto the cart, and hauled to the new location by team or truck.

IN making the cart, a heavy trailer axle and wheels were bought at an auto wrecking yard. The axle was two inches in diameter and the wheels were equipped with roller bearings and plain steel tires. In order to make the platform sufficiently wide, the axle was lengthened one foot by welding on a piece of steel. The platform was made of two-inch plank strongly braced with angle iron and iron rods and was attached to the axle with U bolts. The front wheel was arranged like a caster, and iron braces were extended from the king pin to the axle on each side. The wheel itself was made from a section of log with a heavy tire shrunk on and a pipe boxing set in. It cost approximately 35 dollars to build the cart.

Another truck for moving tall trees has a "reach" consisting of two 4 by 6 timbers, 20 feet long, connecting the front and rear axles. These timbers are four feet apart at the rear axle but run together at the front axle. The rear axle is seven feet long so that the rear wheels will readily straddle a fair-sized hole.

To load this wagon, the front wheels are removed and the reach is raised to a vertical position against the tree trunk. After blocking the wheels, the reach is carefully lowered to a horizontal position and the front wheels are replaced. If the spread of branches is wide, it is often necessary to build a cribbing between the trunk of the tree and the reach so that the branches will clear the ground.

After reaching the new location, the operation described above is reversed. The raising and lowering is accomplished by means of jack screws and cribbing, or if the tree is very heavy, with block and tackle.

In transplanting tall trees, guy wires or ropes are used as a safety precaution while raising and lowering the tree and these are left after the tree is planted until the earth has had time to become firm and the roots have taken hold of the soil. Otherwise damage may result from hard winds. Where the guy wires are attached to the branches they are run through a piece of hose or over some pieces of wood to protect the bark from damage. A coat of whitewash is applied to the trunk and larger branches to prevent sun-scald.

A very good time to cut back and thin the top of the tree to be moved is before it is raised to an upright position in its new location. If it is a deciduous tree the top may be cut back, leaving a few of the healthy, shapely branches. Each cut, so far as possible, should be at a crotch or lateral, and the wounds should be covered with an asphaltum or tree paint. In the case of broad leaved evergreens it is best not only to thin the branches, but to strip off most of the leaves as well. With this treatment trees that are ordinarily difficult to move, such as holly, can be moved successfully.

The object of this severe cutting back is to balance up the top with the root system, which is appreciably cut in digging. If the top is not cut back, the evaporation from the leaves and branches takes place more rapidly than the roots can supply moisture, and the tree would become so exhausted that even if it did not die, its growth would be seriously checked.

A TREE to be moved "bare root" can be handled with greater safety on a damp or cloudy day as then the roots do not dry out rapidly. It also saves many of the fine roots—to the ultimate benefit of the tree—if it is moved with a frozen ball of earth around the roots. This is a method in common use with conifers, where moving is done in winter.

In warm climates the same effect is secured by boxing. This permits the moving of medium-sized or small trees without serious shock and at a season when it would otherwise be impossible. It also permits the tree being held for sale, already established and in growing condition, without danger or loss. Such specimens have a much stronger appeal to the average planter than the same tree would have standing dormant and bare.

Boxing, especially from loose ground, is more easily accomplished when the earth is dug away from the ends of the proposed cube of soil leaving the sides intact. A tunnel the width of the box is then cut through under the tree and the bottom boards slipped in one at a time until all are in place. The end boards, already cleated together, are next set in place and nailed to the bottom. It is then possible to cut down the sides of the cube and board them up to the ends without letting the soil fall away from the roots. After filling all spaces left between the cube and the boards with loose soil and tamping it, the box is ready for moving. If the diameter exceeds three feet, the box is made of two-inch lumber held together by three-eighths inch iron rods that have been run through the sides and bolted, or by hooks bolted through the sides and held together by wire. This prevents wrecking the box while moving.

To remove the box from the hole, a tripod of 4 by 6 timbers, 20 feet long, is set over it and a three-ton hoist raised into place with a rope and pulley until it may be hooked into a heavy iron ring at the top. The other end of the hoist is then hooked into chains or cables that are made fast to the box. Box and contents may now be moved to their new location on the tree cart, or skidded over a plank track on rollers made of short lengths of gas pipe. The tripod and hoist again come into service to lower the tree into the hole which has been previously dug deeper than the depth necessary and partially re-filled with a mixture of well-rotted manure and soil. Fresh manure is never allowed to come in contact with the roots and if used, it is covered with several inches of soil before setting the tree in place. The sides and ends of the box are then removed but the bottom may be left in the hole to rot, if it cannot be easily removed.

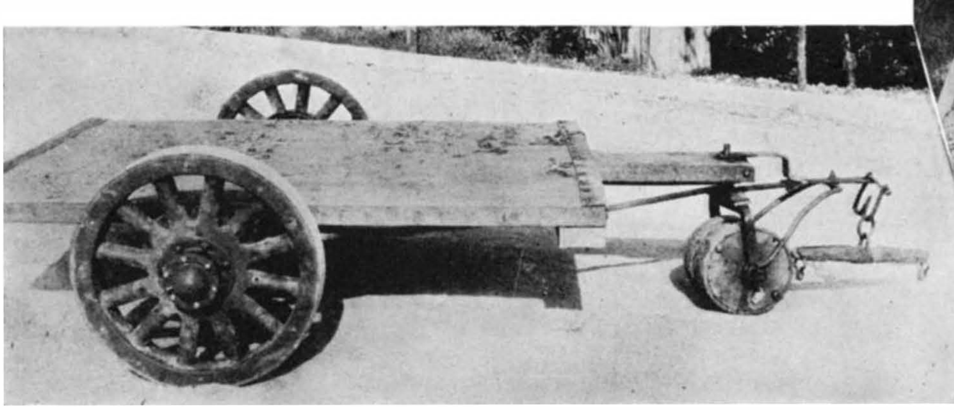
AS the soil is replaced about the roots of a transplant, it is well settled by tamping or with water. On bare root trees nothing can equal water for settling the soil and filling the air pockets under the roots.

In the selection of a tree for transplanting, it is obvious that one should pick a vigorous, healthy one. If it has grown in a location where it had to send its roots a long distance to food and moisture it will not have a compact root system and most of the fibrous feeding roots will be lost when digging it out.

One that has grown along a river or creek in alluvial soil will have an abundance of good roots close to the trunk and can be moved successfully. Trees that have been previously transplanted, such as nursery grown trees, usually have compact root systems. Root-pruning the growing stock in the nursery row is a common practice, and not only makes transplanting easier but increases the chances for success. The tree with plenty of young fibrous roots recovers quickly and easily from the shock of moving, but trees with old wood are slow to start growth, and often die after struggling along for three or four years. For this reason it is well to prepare a tree a year in advance for moving by cutting back both top and roots enough to stimulate new growth close to the trunk.

THE time for moving a tree is governed by its dormant period. Deciduous trees, conifers, and broad-leafed evergreens all are at a stand-still during cold weather and may be moved during the winter months, while some conifers and evergreens are dormant in late summer, putting out a fall growth after the rains start. Palm trees succeed best if moved during hot weather in late summer, for at this time there is little danger of the roots decaying before they take hold of the soil.

The loss of an occasional tree is inevitable. The percentage of loss may be reduced, however, if the trees are carefully watched during periods of dry or hot weather, and given plenty of water. And the occasional loss is more than balanced by the satisfaction of having gained years in the development of the home grounds.



At the left may be seen the tree wagon described in the text. Above is a chain hoist and tripod used in tree moving

An example of the best Maya sculpture from the ruins of Copan

ON THE TRACK OF THE MAYAS

THE Maya Indians of British Honduras are a people who, nominally Catholics, fuse paganism and Christianity in a delightful fashion. In their religion, Dios has to look after the whole world while the old Maya gods Huitz-Hok, the gods of the mountains and plains are very powerful—locally! There are the Virgin Mary, St. Anthony, St. Louis, and so on, all mixed up with the morning star, the thunder gods, the wind gods, the moon, the sun, water, and the spirit of vegetation.

The priests have hard sledding when they have to cope with Mahanamatz, a gorilla-like mythical animal which is said to have the same features as a man but is extremely hairy. These animals are supposed to live in rocky areas in the remotest part of the forest and stand upright. They are said to walk with their big toes turned backwards. If one of these animals catches a person it tears him open with its huge shaggy paws. It is useless to shoot it as the shot will not penetrate its thick coating of hair. The only hope of salvation lies in setting fire to it.

THERE exists among certain Mayas a curious belief in a monster that closely resembles the classical centaur. These monsters are said to be a cross between Germans and mares. Probably garbled accounts of the old Spanish cavalry handed down for centuries are responsible. The animals are harmless and have no occult powers. Black magic also flourishes sub-rosa and altogether the *Pater Noster* and the *Credo* have unfair competition.

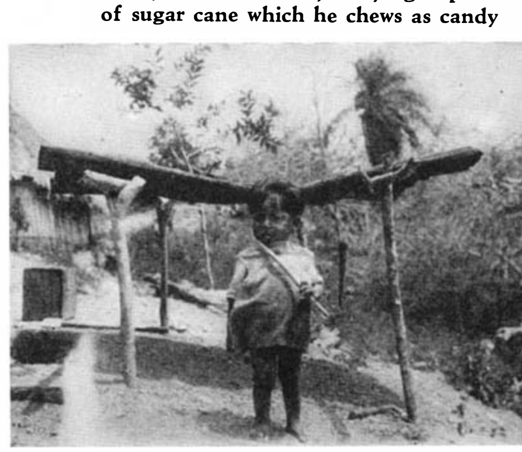
The above and the following interesting information was gleaned from J. Eric Thompson's "Ethnology of the Mayas of Southern and Central British Honduras." Mr. Thompson's publication is the result of four visits paid to British Honduras, the two last being in the interests of the Field Museum of Natural History, where he is Assistant Curator of Central and South American Archeology. The present population of British Honduras is small (estimated at 46,000 in 1923) and is extremely mixed, the bulk of the population being negro. The Maya-speaking population of the whole colony is 7806 (figures for 1921). There are a number of Indians in the western and northern districts who have unfortunately lost their language and now speak only Spanish.

One of the interesting stories showing the psychology of the Indian is related by Mr. Thompson. In 1883, some of the Mopan Maya inhabitants of the town of St. Luis, Petan, irked by constant taxation and military service, resolved to cross the border and live in British Honduras. They settled in a spot that is now known as San Antonio. Things did not go so well in the new community, crops were bad and fever was rife. A council was called and the unanimous decision was that the troubles were due to the fact that their old saints no longer protected them. It was decided that the saints should be seized from San Luis.

The distance between the two towns was 45 miles. At 9 P.M., when San Luis was asleep in its hammocks, the army descended. Only half the force did the plundering while the rest remained in reserve. Only axes were needed to force the church door. It was the work of a moment to seize the coveted statuettes as well as the church bells. The next night the saints had been installed in the little palm-thatched hut that served San Antonio as a church, and the stolen bells chimed across the hills to summon the inhabitants to hear the story of the "bloodless rape of the saints," as Mr. Thompson humorously calls it. A counter-attack was in order, the invaders from San Luis were arrested and after promising to make no further attack on San Antonio were released. The saints apparently preferred their new abode, for disease decreased and crops improved.

THE Maya communities of southern British Honduras are typical of their nation in that their whole life centers around agriculture. Their very existence is bound up with the crops. The clearings on which they grow their produce are known as *milpas* and are three or four acres in extent. In addition to the *milpa*, each family has a small patch of cleared land which is permanently under cultivation and in which perennials such as oranges and cacao are cultivated, but the pigs kept by every family make crop cultivation a gamble. The range of fruit trees, vegetables, and cereals grown by the modern Maya is wide, covering, as it does, in addition

In the oval are two Maya boys wearing masks used in a ceremonial dance. *Below:* An Indian child of San Antonio, in native dress, carrying a piece of sugar cane which he chews as candy



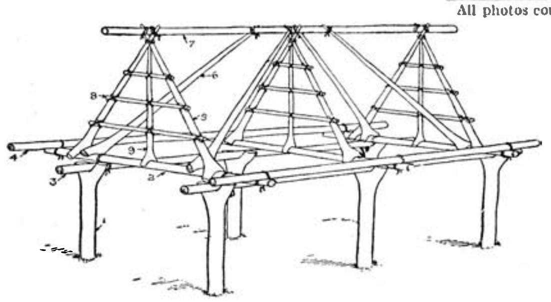
to the staple products of his pre-Columbian ancestors, a varied collection of plants introduced in colonial and more recent times.

The site of the plantation is often 8 or 10 miles from the village. After raising one crop the land is usually abandoned for 7 or 8 years to allow a second growth of timber to form. The land is cleared and sowed by groups who help each other. The evening before felling is to start on each plantation the members of the communal group gather at the house of the man whose land is to be cleared. There a vigil is kept up the whole night. Entrance to the "wake" is not confined to members of the group; friends may drop in, or members of the group be absent. Chicken, pig, tamales, tortillas, and so on, are served with cocoa, rum, and a drink called *posole*. Accordions, harps, or marimbas are produced and the night passes pleasantly enough.

At dawn the owner sets out alone, for he must perform certain ceremonies before the others arrive. Setting fire to a few pieces of wood in the center of his patch, he places on the flame a lump of copal incense while he offers a prayer to Huitz-Hok and other native gods. After cutting, the timber and brush are left about three weeks to dry before burning off. Another vigil with chicken, cocoa, and rum takes place. After the burning, a light rain is required to lay the ash and soften the ground for sowing. This can usually be depended upon during the first week in May.

ALL the religious devotion of the San Antonio Maya seems to be confined to the milpa. When it comes to marriage, however, it is with benefit of clergy. The men usually marry before the age of 20; the girls as a rule are married before they reach 16. Polygamy is never practiced. Divorce is unknown, but desertion is common. Cruelty is not uncommonly shown towards women, but never to children. The Easter festival is far from being dry and the gentlemen drink while the ladies wait outside to help their drunken husbands home. The ceremonies connected with death and burial are simple. The corpse is buried as soon as possible, usually without any prayer. A coffin is seldom employed and the Indians say that a man buried with a coffin will have to carry it all the way to Heaven.

All photos courtesy Field Museum of Natural History



A typical structure built by Maya workers without the use of nails, vine rope being used. The drawing shows the principles of construction involved

The most important activity of the Indians, aside from their agricultural pursuits, is hunting. The bag may include the peccary, deer, howling monkey, tapir, armadillo, parrot, partridge, pheasant, and other native wild life with outlandish names that convey no meaning to the uninitiated. The Mayas usually hunt with modern shotguns, although blowguns are used to some extent and bows and arrows are used for sports. Hunting parties of two to nine go far afield and Huitz-Hok is invoked as usual.

The houses or huts in San Antonio resemble those of Yucatan. The distinguishing feature is in the fact that the walls do not take the weight of the roof. This is supported by four or six posts numbered 1 in the diagram. On the tops of these posts rest horizontal beams, 3, which carry the whole weight of the roof. On them rest forked beams, 5; the ridge-pole is shown at 7; cross-beams at 8. The partitions are flimsy and there is no true sex segregation. The women visitors usually foregather in the kitchen, the men in the living room. The furniture is practically non-existent, aside from hammocks.

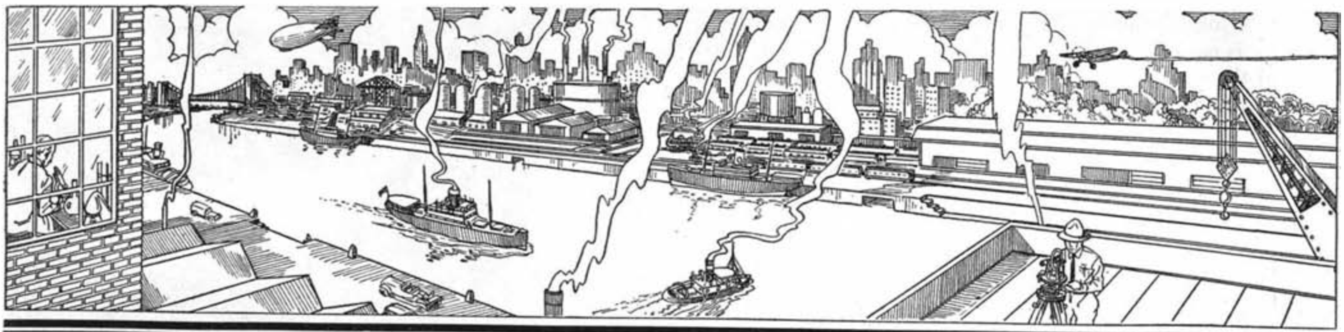
EACH of the important Maya villages has its alcalde (mayor). A new alcalde is elected each January. Names of candidates are proposed by the older men and the voting is carried on by a show of hands, any male over 17 being free to vote. The alcalde is paid a salary of four dollars a month and is responsible for the conduct of the village. He must furnish men for any task that the district magistrate at Punta Gorda may detail.

The alcalde also acts as local magistrate, all cases of crime or misconduct being brought before him. He has the power to impose fines up to 25 dollars or prison sentences of not more than seven days. The prisoner always has the right of appeal to the district magistrate. All serious cases that cannot be dealt with adequately by the alcalde's range of punishment are also referred to Punta Gorda. The alcalde is assisted in his duties by a segundo-alcalde (vice mayor) and eight policemen. The police are paid no regular salary but are paid 25 cents for every arrest that leads to a conviction.

OTHER areas are dealt with at length in Mr. Thompson's fascinating book. The sections relating to folk-lore are a valuable contribution to anthropology. The two Marshall Field Archeological Expeditions have helped us greatly in our understanding of the old Mayas by their studies of the peculiar habits of their direct descendants.

***Left:* A modern Maya woman wearing a blouse of domestic weave**

***Right:* Mr. Thompson assuages his thirst with a piece of water liana**



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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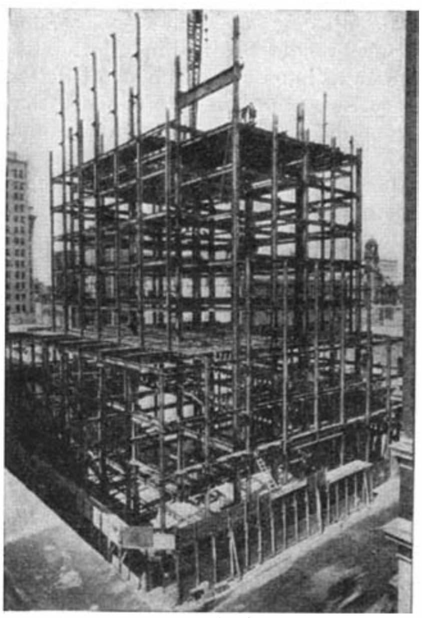
Nineteen-Story Arc Welded Building

THAT there is a definite trend toward the use of electric arc welding for fabricating the steel structures of large buildings is evidenced by a 19-story structure which is now being built by the Dallas



All the steel work for this nineteen story building is arc-welded

Power and Light Company, Dallas, Texas. In this building practically all the fabricating, both field and shop, is being done by this noiseless process which is rapidly superseding the noisy rivet hammer. So far as we have been able to learn, this is the tallest building yet fabricated and erected by electric arc welding.

Human Bites and Infection

THE savage in his defense and attack on other men was seldom provided with weapons or with the science of attack and defense. Hence he scratched, tore, bit, or otherwise availed himself of the weapons of the human body.

Rat-bite fever has been classified as a definite disease because the bite of the rat usually carried into the body certain organisms which produce a definite form of disease. Human bites are apparently also associated with special infections, because of the bacteria commonly found around the teeth.

Drs. M. L. Mason and S. L. Koch have summarized a number of cases of human bites, showing that the organisms usually involved in infections which follow such bites are the streptococcus, spirilla, particularly those of Vincent's angina, and the organism of syphilis. A bite on the hand is particularly serious because infections of the hands are notoriously crippling and likely to spread. The infection is usually introduced deep in the tissue through a small wound and the organisms present in the human mouth seem to have special virulence for the structures that are involved. The methods of treatment of infection of the hand involve wide opening and complete drainage with the application of antiseptic solutions and of heat.—*M. F.*

"Blackboards" in Color

THERE are very few people who would not agree that color in the schoolroom is desirable both from the standpoint of utility as well as beauty, for it is generally recognized that some colors are less tiring on the eyes than others. To meet this obvious need the American Rolling Mill Company has developed a process for making porcelain enameled "blackboards" in colors. Some of these in a light shade of green have already been installed in schoolrooms, but they may be obtained in brown, blue, or any other color or shade of color the architect desires.

To insure a smooth, flawless finish, Armco ingot iron special enameling sheets are used as the base metal. The sheets are placed in a press and the sides and ends are bent back one-half inch. This one-half-inch draw is then punched so that the panels may be joined together. Three coats of vitreous enamel are fused on to the pure iron base. Then the glossy surface is etched with acid to remove the glaze. When completed, the boards have a velvety surface that is free from troublesome reflections.

The actual installation of the boards is simple since they are light, easily handled, and can be installed by inexperienced workmen. First, the individual sections are bolted together to make up the desired length and backed up with insulating material to eliminate sound. Then they are lifted into place and held firmly with quarter round moulding.

Ancient Procedure for Making Damascus Blades

AN ancient formula for the manufacture of the famous Damascus steel blades has been unearthed by L. A. Marple, of Pittsburgh, Pennsylvania, and is reprinted in *Industrial and Engineering Chemistry.*

"Let the high dignitary furnish an Ethiop of fair frame, and let him be bound down, shoulders upward, on the altar of the god Bal-Hal. Then let the master workman, having cold-hammered the blade to a smooth and thin edge, thrust it into the fire of cedar wood coals, in and out, the while reciting the prayer to the god Bal-Hal, until the steel be

One of the two German "queens of the seas", the *Bremen,* has her funnels painted. Enough paint to coat a small house is necessary to put a coat on the funnel shown

of the color of the red of the rising sun when he comes up over the desert toward the East; and then, with quick motion pass the same, from heel thereof to the point six times through the fleshy portion of the slave's back when it (still the sword) shall have become the color of the purple of the king. Then, if with one swing and one stroke of the master workman, it severs the head of the slave from his body, and displays no nick nor crack along the edge and the blade may be bent around the body of a man and break not, it shall be accepted as a perfect weapon."

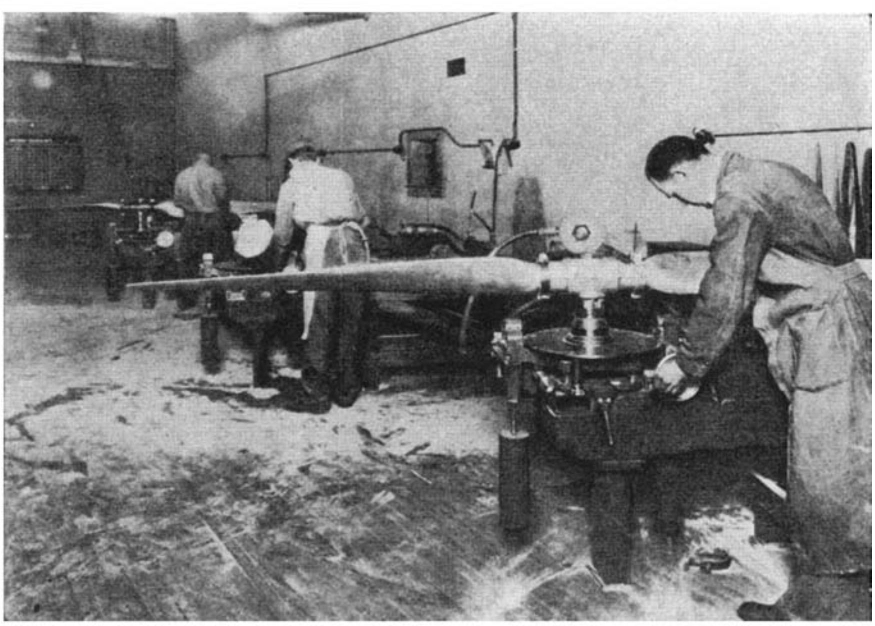
Mr. Marple believes that modern methods of tempering steel, though less romantic, work just as well and are much more pleasant.—*A. E. B.*

Balancing Airplane Propellers

THE balance of airplane propellers is one of those things that the average person seems to take for granted, not realizing that much careful work must be done on each propeller before it is ready for use. Yet variations in density of the material will not allow the propeller to be in balance even though the outside dimensions and contour are identical in the two opposing blades. A method of balancing metal propellers developed by the Gisholt Machine Company, however, insures that any residual unbalance due to density or due to faulty workmanship will occur in a predetermined position where it may be corrected without harming the propeller efficiency or strength.

In this process, the propeller blade forging is first mounted in a special fixture carried on the chuck and steady-rest of an engine lathe. The hub end of the blade is completely finished, including the drilling of a 1⅛-inch hole about six inches deep in the center of the hub.

The blade is then mounted in a master steel hub with a master blade mounted on the opposite side of the hub. This assembly is then mounted on the balancing unit of the Gisholt Static Balancing Machine shown in the accompanying photograph. The blade forging is then ground to shape, frequent inspections being made of the pitch of the blade at the required stations. As the blade is worked to approximate size, the condition of balance of the blade about the longitudinal axis is frequently checked by the indicator of a spirit level and a weighing dial. If the blade is worked and checked for balance in this manner, all of the remaining unbalance can be taken care of by plugging the 1⅛-inch hole in the hub end of the blade.



Airplane propellers being balanced as explained in the accompanying text

Device Makes Phonograph Records at Home

A NEW device which makes it possible for anyone to make his own records in the home, has just been placed on the market by the RCA Radiola Division, according to an announcement by Mr. V. W. Collamore.

"The new home recording apparatus is part of a combination Radiola-phonograph instrument," Mr. Collamore said, "so that all three functions of the complete instrument utilize practically the same mechanism. A special switch makes it possible to record excerpts from favorite broadcast programs at the same time that the radio set is operating."

Mr. Collamore pointed out that while the records made in the home cannot be expected to equal in quality the results of the highly developed and costly apparatus of the recording laboratories, they will find an interesting and infinite field of application as "audible snapshots." Of the many uses to which this home recording system may be put, Mr. Collamore mentioned it as a possible aid to vocal and instrumental instruction, permitting the student to detect and correct his own faults. It could also be used for the dictation of personal messages to friends and relatives with something of the personality of the speaker; for recording important family events such as baby's first efforts at speech, birthday and anniversary greetings, and the children's instrumental and vocal efforts.

A simplified microphone is used for the recording process. The speech or music picked up by the microphone is amplified, passed through the regular phonograph pick-up system and impressed on a special record. The record measures six inches in diameter and is composed of a durable cellulose material. A special chromium plated needle with a blunt head is used for the recording process and for playing back the record. The grooves in the record, of which there are 90, have been previously cut, so that it remains only for the needle to impress the electrical sound waves on the grooves. A simple four-way switch makes instantly available the phonograph, the radio, the recording system, and the playback.

A young woman uses the device with which "audible snap-shots" (phonograph records) may be made in the home on special disks

Food and Growth

THE greatest advances of the first third of the 20th Century have been in the field of nutrition. Perhaps the most significant of these advances has been the change in the point of view. Scientists formerly thought that the type of human being then existing represented the highest type possible. With the coming of our modern knowledge of nutrition, it seems likely that the application of this knowledge may present a different type of man than the one we know today.

The use of vitamin D and of irradiated ergosterol as a routine in infants will mean the absence of bow-legs as well as a better development of the long bones of the body. The proper application of our knowledge of vitamin B may mean a better functioning intestinal tract, increased appetite for good food, and thereby better growth. The application of our knowledge of vitamin A apparently will bring about increased resistance to disease. Vitamin E, which has to do with sterility, may mean better opportunity for reproduction by those capable of passing on to future generations a higher type of mind.

Our early knowledge of the vitamins concerned itself entirely with the terrible end results of complete omission of these vitamins from the diet through development of the conditions called deficiency diseases. Xerophthalmia, a form of inflammation of the eyes leading to blindness, is due to absence of vitamin A; pellagra and beriberi result from a deficiency of vitamin B; scurvy is due to the absence of vitamin C; and rickets is associated with the absence of vitamin D. Modern research is concerning itself with the effects of relative absence of these substances from the diet and the possibility of producing more healthful existences for the vast majority of people by proper feeding.

Such significant facts as the increased height and weight of girls and boys entering college today as compared with girls and boys of the same age 20 to 50 years ago are absolute evidence of the results that may be accomplished.

With this machine, colors may be matched with absolute precision

It has even been taken for granted that the brain of man as it is developed today represents the highest type of intellect conceivable. Yet Frederick Tilney, in his book "Master of Destiny," emphasizes again the fact that the brain of man today represents a great evolution forward from the brain of human kind thousands of years ago. Who can say what will be the type of man of the future?

We know today that there is no specific brain food, notwithstanding the fact that quacks and charlatans have in the past vaunted fish, celery, phosphorus, and what not, for this purpose. The magic of the past was ready to accept the belief that there were specific foods for specific substances. The science of the past doubted these superstitions and beliefs because there was no evidence to indicate the slightest basis for them. Scientific knowledge developed in the last quarter century has proved the truth of the general belief at the same time that it disproved the actual superstitions held by many people.—*M. F.*

A Machine Classifies Colors

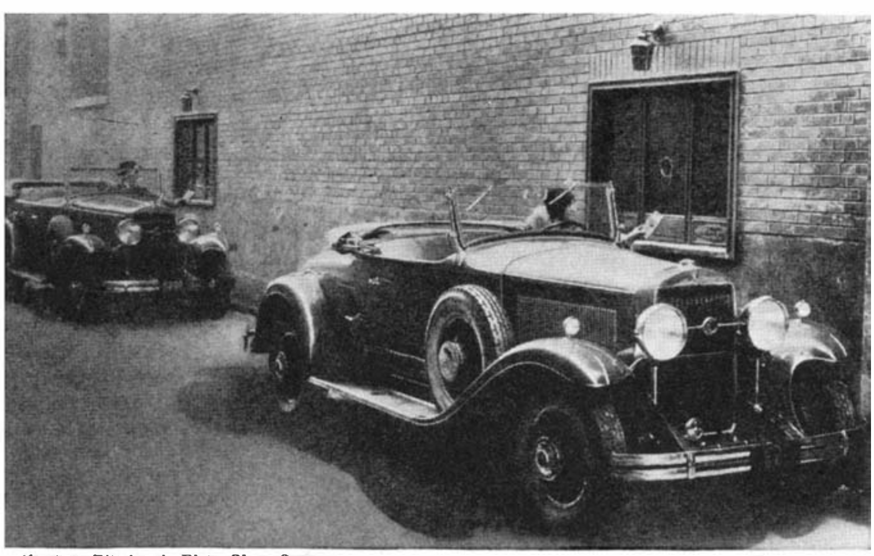
At a recent meeting of the Technical Association of the Pulp and Paper Industry, Professor H. H. Sheldon described to the paper makers his "coloroscope" by means of which colors can be accurately and infallibly matched. The instrument, now commercially available, is based essentially upon the ability of the now well-known photo-electric cell to differentiate light both as to color and intensity and to cause a corresponding electrical response through suitable electric circuits.

Obviously, the use of the coloroscope in the paper industry is only one of the useful applications that appear to be ready to welcome the new device. In printing, dyeing, and paint-making—in fact every industry where colors are used—the advantage of classifying colors with mathematical precision rather than depending upon the fallible human eye is extremely important.—*A. E. B.*

Bandit-Proof "Auto-Teller"

A NEW device known as the "Auto-Teller" which enables customers to make deposits and transact business direct with the teller without leaving their cars supplies a long felt want in present-day congested traffic. The inconvenience and delay of parking in restricted areas and crowded traffic, and the hazards of carrying funds to and from the bank have been eliminated by this device. Located advantageously in an outside wall along a thoroughfare, the "Auto-Teller" affords unique facilities and complete protection both to the customer and the bank. Two of these devices have been installed in windows in the rear wall of the Grand National Bank of St. Louis where their rapidly increased use is daily proving their popularity.

Designed and perfected by The J. H. Wise Company, Inc., Protection Engineers, the device is built to withstand the elements and is bandit and bullet-proof. The frame is of cast steel and the openings are enclosed with Multiplate bullet-proof glass 1⅛ inches in thickness. The glass is composed of an outer layer ¼-inch thick, a center core ¾-inch thick and an inside layer ⅛-inch thick. It is as transparent as ordinary plate glass and will withstand the fire of 45 caliber steel-jacketed bullets. For decoration the glass has an ornamental sandblasted etched border.



Courtesy Pittsburgh Plate Glass Company

For patron-convenience and for protection: bandit-proof bank teller's cage

The center glass contains a combination speaking aperture and gun port which amplifies the voice and permits the teller and customer to converse with ease in moderate tones. Immediately under this, at counter height, is the pass tray through which money or papers are passed between teller and customer. This device is ingeniously constructed so that when it is open on the outside it is automatically closed on the inside. The entire window with fixtures is so arranged as to make it impossible for the teller to be intimidated with a gun or otherwise. There are no openings that could permit drafts or inclement weather to affect the one on the inside. These devices are patented and are of solid cast bronze, being made of merchantable bronze on the exterior and manganese bronze on the interior.

The "Auto-Teller" should prove indispensable for banks in congested areas of our larger cities, where inside or rear walls permit auto traffic. It is also adaptable for sidewalk use, particularly when payrolls can be handled on the outside of premises.

Chemistry of Sauer Kraut

SAUER kraut juice, which has become popular as a beverage in recent years, is not generally thought of as a fermented drink. Making kraut is, however, essentially a fermentation process, for when the cabbage is packed down in brine, fermentation is brought about by organisms which are normally widespread and require no inoculation. These organisms are salt-tolerant. The salt added, not only improves the flavor but, what is more important, prevents malfermentations.

F. C. Blanck, of the United States Bureau of Chemistry and Soils, explained to a recent meeting of the American Chemical Society that the reducing sugars normally present in the cabbage are broken down into lactic acid with small amounts of alcohol and acetic acid. The gaseous product of this fermentation is nearly 100 percent carbon dioxide, with possible traces of hydrogen and methane. The quality of sauer kraut depends largely on the temperature at which the fermentation was conducted. The most favorable temperature was between 60 degrees and 65 degrees Fahrenheit. High temperatures favored the production of soft and pink sauer kraut. A rise in temperature of three to five degrees during the first eight days was coincident with the greatest activity of the bacteria and is believed to have been caused by bacterial action.

Sauer kraut fermentation is carried out

in the absence of air. The oxygen and necessary energy are obtained from the constituents, mostly sugars, extracted by the salt. The active organisms do not utilize the lactic acid formed, so the fermentation ends with the acid production.—*A. E. B.*

Perfume Plant

THROUGH the kindness of one of our readers of New York we learn that the photograph bearing the legend "Distilleries in a perfume factory at Grasse" (France), which was selected by the editor to illustrate the article entitled "Perfume," in our number for last August, actually was taken in a plant in Germany. The picture was obtained from an outside source and there was no apparent reason to doubt the statement written on it that the plant shown was in Grasse. In the interests of scientific accuracy we are glad to make this correction.

A Novel Air-cooled Engine

THE simplicity and lightness of the air-cooled engine are to some degree offset by the increased head resistance of the outwardly projecting cylinders. In large sizes of engine, the cylinders also impede the pilot's vision. The English Napier Company has for some time been developing a novel form of air-cooled engine in which these disadvantages are largely removed.

The new Napier engine has 16 cylinders but their arrangement in four blocks of four cylinders each, vertically opposed, giving an H formation, results in an engine of compact frontal dimensions and small head resistance. The engine is shown in side view in our illustration. The engine develops 300 horsepower and its weight is 620 pounds. This is not as low a ratio of pounds per horsepower as in many present-day air-cooled engines of the star or radial type. Nevertheless, the improvement in vision and reduction of head resistance make the new motor of real interest.—*A. K.*

Contra-Propeller

WHEN the air passes through a rotating airplane propeller its speed is increased in the direction of the flight of the airplane. At the same time the air is given a swirl, or rotational velocity.

It is therefore suggested that behind the moving propeller a fixed contra-propeller be placed, with its blades set at such an angle that the swirl of the air is removed. Such a contra-propeller is shown in the sketch.

When applied by Doctor Wagner to steamships the contra-propeller has proved valuable in increasing propeller efficiency. It might not prove as advantageous for the airplane; nevertheless, it deserves a trial.

It will be noted in the sketch that the contra-propeller does not extend all the way out. This is proper, because the swirl is greatest toward the center of the propeller.—*A. K.*

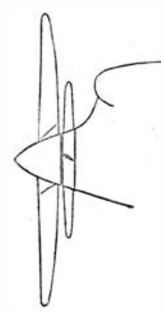
Energy from the Atmosphere

THE French are very fond of ingenious and novel devices for securing additional sources of energy. We have, for example, Doctor Georges Claude, whose recent experiments in securing energy from the differences in temperature existing at the bottom and at the surface of the sea are no doubt familiar to our readers.

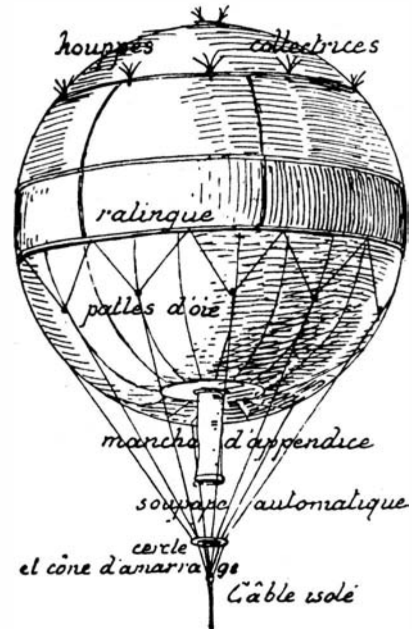
Now another Frenchman, Monsieur H. de Graffigny, writing in *L'Aérophile*, suggests a new use for the captive balloon; namely, securing and utilization of atmospheric electricity.

Scientific experiments over a long period of years have shown quite definitely that electric potential increases as we pass from ground level to altitudes. The voltage difference between two levels a thousand yards apart is enormous, say 300,000 volts; the amperage is very much smaller but is not negligible.

M. de Graffigny states, in fact, that two French inventors working on Mont Blanc have managed to light several incandescent lamps by means of this principle. Another inventor, a Doctor S. Zildard, of Paris, has illuminated neon lamps by the same principle.



The contra-propeller, which has been successfully applied to ships, as it would appear, from the side, if adapted for use on the airplane



The ingenious balloon devised by the French for "collecting and utilizing atmospheric electricity." It has electric collectors and an insulated electric cable leading to earth

The suggestion is that a captive balloon would be suspended in the air, and would be provided with rigid metallic rings and metallic electricity collectors. The electricity collectors and the rings would all be inter-connected and an insulated cable would bring the energy down to earth.

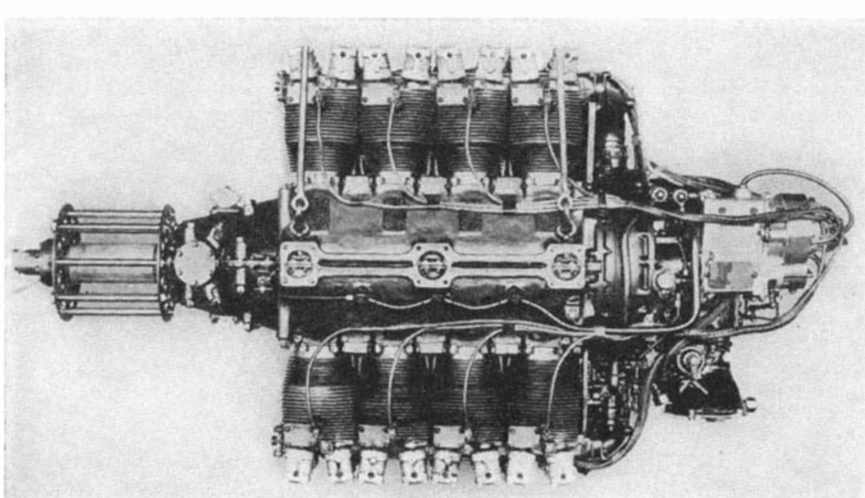
The difficulty is, of course, that we would have to utilize energy of high voltage but low current. Many other difficulties suggest themselves, such as the dangers of thunder storms, the maintenance of the balloons, and so forth. Still it would be very wrong to say that sometime in the future there would not be here another application of the captive balloon.—*A. K.*

The Fog Eye

AN architect of Huntington, Long Island, Paul Humphrey MacNeil, after many years of patient work, has developed what he calls a "fog eye," intended to lessen the dangers of either marine or airplane navigation in fog.

The principle of the apparatus is based on the fact that the infra-red rays, which are invisible to the eye, are not impeded by fog. The infra-red ray will penetrate the densest fog, impenetrable by the most powerful electric beacon. The lighthouse, lightship, or airway beacon, will be provided with a projector which will shoot out these invisible infra-red rays to aid ships or airplanes, as the case may be.

The projector will operate somewhat like a telegraph transmitter, sending the infra-red beams in dots and dashes. These dots and dashes will be picked up by a receiver in the airplane, containing a detector element similar in principle to the delicate thermo-couple used by astronomers in the measurement of the radiation of heat from the stars. The detector element is placed in a vacuum and receives the infra-red rays



Compact frontal dimensions and low head resistance are characteristics of this novel engine, one side of the "H" formation being shown in this picture

through a window of fluorite, the energy of the rays being converted into heat when striking the detector.

Combined with the detector are amplifying relays, automatic signal devices, and recording instruments, which give both a visible and audible record of the signals to the pilot. In a test of the invention at Roosevelt Field, Long Island, recently, the infra-red ray was effective through a mile and a half of fog bank that had held the pilots completely in check.

There is no doubt that the "fog eye" is another and highly useful method of attack on the problem of fog or blind flying.—*A. K.*

Safety Belt Strength

THE strength of a safety belt should be amply sufficient to prevent the passenger from being thrown from his seat, either in rough maneuvers in the air or on a bad landing. At the same time, the concentration of stress that a safety belt can impose on a man's body may itself be a source of danger.

The best safety belt would be one which, adequately strong, would yet distribute the load over a large part of a man's body. It is to be hoped that some new type of safety belt will be devised to meet these requirements.

It is interesting to note how strong present-day safety belts are: According to the Bureau of Standards, the limits of strength are between 700 and 1200 pounds.—*A. K.*

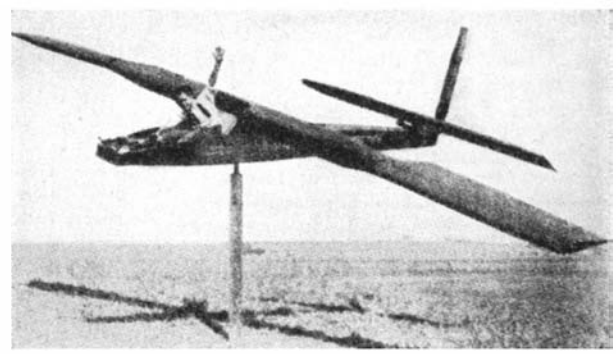
Ground Training for Gliding

THE one drawback in glider training is that the actual time which the elementary student spends in the air is very brief. The duration of a glide may not exceed 20 seconds and a student therefore has very little time to familiarize himself with the action of the controls.

A number of methods have been proposed for "ground glider training." Two of them are shown in our illustrations. In one, a full sized glider, with a student in it, is mounted on a universal or ball and socket joint on top of a tower some ten or twelve feet in height. The glider, exposed to the gusts of the wind, sways in all directions, and the student has a lovely time trying to keep it pointing in one direction and on an even keel by the use of the ordinary glider controls. The student certainly ought to learn a great deal from the process. This type of training has been invented by Paul Chamberlain of Los Angeles.

Even in training for powered flight, it is possible that some form of artificial "ground flight training" may be helpful. Two men, H. S. Myers and P. D. Smith, also of Los Angeles, have designed a power glider which they call the "Cycloplane" which has enough power to do many maneuvers on the ground, but which cannot leave the ground. Seated in the "Cycloplane" the student can do a great deal of pitching, make a turn on one wheel and can otherwise get the hang of things very readily. This may be of some real help when actual flight training is begun.—*A. K.*

Above: **The Cycloplane in which the student can do a number of glider maneuvers without leaving the ground.**



At right: **The ground glider, invented by a Los Angeles man, which has the controls of a regulation glider or sailplane.**

Some Data on Parachutes

IF a man is thrown overboard from an airplane, how fast will he fall? The man in the street answering such a question would probably set down an impossibly high figure. As a matter of fact, the Army Air Corps, among other organizations, has tested the speed of a falling dummy, simulating a man, and has discovered that such a dummy, weighing about 180 pounds and the size of a man, with a dummy parachute packed on his back, will attain a speed of only 119 miles per hour after falling some 1200 feet in 11 seconds.

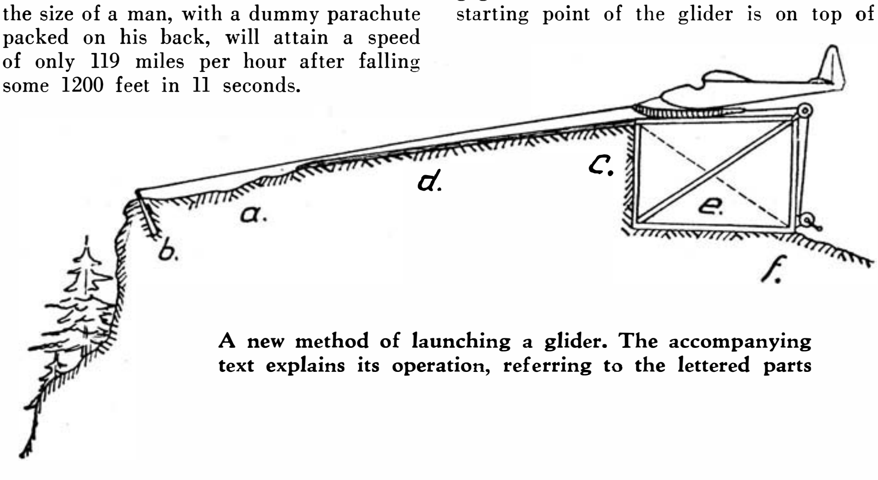
The main importance of tests on the speed of a falling body lies in the light that it sheds on manually controlled parachutes. Airmen who are open to the possibility of jumping for life are interested in the lowest altitude for a safe leap. A parachute, such as the Irving 'chute, opens, on an average, in 1/5 to 2/5 of a second. If we assume that a man may fall a second before pulling the ring, then the above data would indicate a hundred feet as the minimum altitude lost before the 'chute would open. One member of the "Caterpillar Club" escaped at 150 feet, and several pilots have leaped safely from their planes at 200 feet above the ground. It is interesting to read in *Aircraft Engineer* that English and American experts conducting experiments independently have arrived at the same conclusion.—*A. K.*

A New Method for Glider Launching

NO one takes gliding as seriously and energetically as the Germans, and they are continually announcing interesting little wrinkles. The appended sketch, which we owe to the courtesy of *Flugsport*, illustrates an ingenious method of improving the launching process.

Referring to this sketch, the plank *d*, about 12 yards long, is carefully soaked or covered with oil so as to lessen friction. The glider is mounted on a starting sled so as to lessen the strains imposed on the glider itself.

At the front end of the starting sled there is attached a long rubber cord of either two or three strands. This rubber cord is anchored down in the ground at the point *b*, and the glider is connected with the sled through a short wire and a starting hook so arranged that the glider is readily disengaged from the sled when in the air. The starting point of the glider is on top of



A new method of launching a glider. The accompanying text explains its operation, referring to the lettered parts

the hangar *e*. The glider, mounted on the sled, is carefully drawn back as far as possible by turning the shaft and handle *f*; at the same time the cords *a* are put under considerable tension. When the handle *f* is released, the tension of the cords pulls the glider down the incline and launches it speedily into the air. To prevent the sled itself from going overboard, there is a gentle brake on the shaft which comes into action when the sled approaches the end of the runway.

It is quite obvious that a mechanism of this description will facilitate gliding take-offs and make life easier for the persevering glider enthusiast.—*A. K.*

Inflating the Metal-clad Airship

WE have had occasion to describe fully the construction of the first successful metal-clad airship the *ZMC-2* which is now being successfully used in service by the Naval Air Station at Lakehurst, New Jersey. The process of inflation of such an airship is a matter that calls for careful technique.

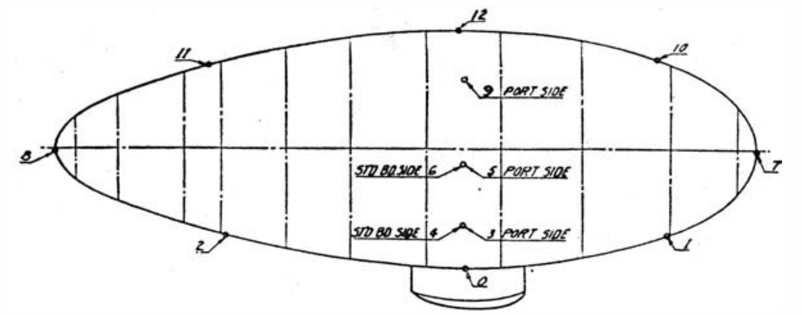
It is very difficult to separate helium from air, so the original inflation was carried out in two stages. In the first stage, carbon dioxide displaced the air in the ship. The carbon dioxide was introduced at the bottom and the air forced out at the top of the hull. In the second stage the process was reversed. The lighter helium was led in at the top while the heavy carbon dioxide was forced out the bottom of the hull.

When ready for inflation, the hull was suspended in the hangar with everything in place. The carbon dioxide cylinders were stored between the hull and the wall of the hangar. These cylinders were attached by means of two "octopus" manifolds to a six-inch pipe line allowing 16 cylinders to be discharged into the pipe line at the same time. The six-inch pipe ran the entire length of the ship and was tapped at three points by lines which led to the bottom of the hull. The carbon dioxide was forced into the bottom of the hull at about 10,000 cubic feet per hour. The displaced air was exhausted from the top of the hull to the outside of the hangar through other connections.

The helium inflation was of a similar character. The helium was run in at 10,000 cubic feet per hour. Unfortunately some of the helium was mixed with the carbon dioxide; therefore a scrubber was used to separate the helium from the carbon dioxide in the exhausts. In the scrubber a caustic solution absorbed the carbon dioxide, and the pure helium was returned to the hull.

Since no drier was used, the helium gas in the hull contained considerable water vapor. Some of this vapor was condensed and drained from the hull. Subsequently a drier was set up and a blower forced helium into the drier, caused it to travel through the apparatus and return to the hull. The drier was simply the caustic soda scrubber rebuilt.

A number of sampling tubes as shown in the sketch were placed at various points of the airship. It was found on test that the helium was 92 percent pure in the airship and that the carbon dioxide was reduced to negligible proportion.



Position of gas sampling tubes on the hull of the metal-clad airship

One feature of the metal-clad airship is reduction in the loss of helium. Only 100 cubic feet are added every 24 hours to replace leakage from the hull. In the fabric airship the air leaks inwardly, but in the metal-clad there is no inward leakage of air. This gives the metal-clad airship a decided advantage over the fabric ship since the purity of the helium is thus left intact after service.—*A. K.*

Latest Army Observation Plane

TESTS of the *XO-1G*, the latest Curtiss military observation plane, have been completed by the experimental division of the Curtiss Aeroplane and Motor Company at the Garden City plant and the plane delivered to the United States Army Air Corps.

This plane is powered with a water-cooled Curtiss D-12 engine developing 425 horsepower, and showed a speed, in preliminary tests, of 147 miles per hour which is considerably faster than other types of observation planes with equivalent power.

Features which provide the pilot and observer with greater comfort and convenience are made possible by several changes in design such as a landing gear streamlined with "pants" for reducing wind resistance and increasing ease of handling on the ground. The wheels are located farther back than on other designs; the landing gear is shorter, tending to eliminate ground loops. A 12-inch pneumatic tail wheel has been located well back and the landing gear struts have been constructed to lessen side motion when shock absorbers begin action, thereby reducing the aerodynamic interference between struts; consequently the drag is less. Parking brakes are provided and the tail skid is steerable.

Six degrees down-vision over the nose is provided.

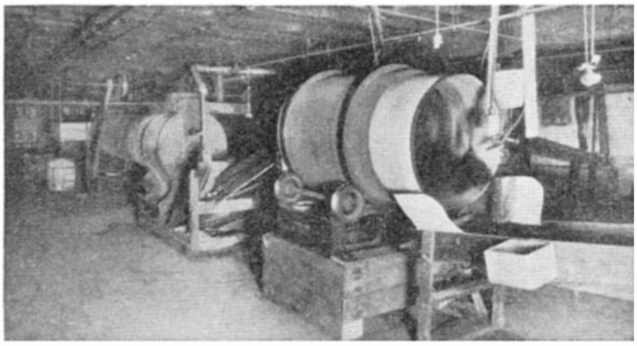
An upper wing cutout eliminates air draft on the pilot. The gunner's compartment has been improved with two alternate gun mounts and a new type of gun mount which eliminates the various disadvantages of the old scarf ring and the newer arm type as well. Less wind resistance, saving of weight, larger arc of travel and ease of operation to eliminate awkward positions when firing over the side are features of this mount. When not in use, this new gun mount drops partly into the cowl.


The metal-clad airship in the hangar where it was built. Its metal "ribbon" construction is shown

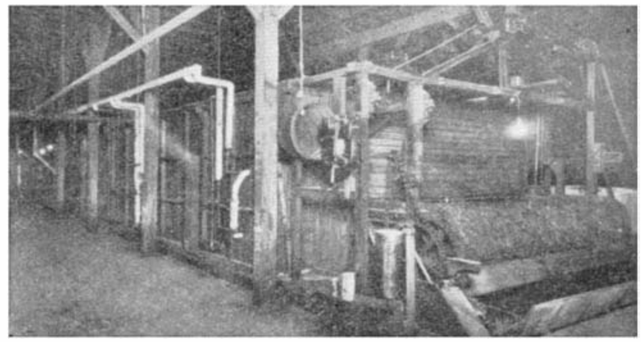
To give the rear gunner more freedom of movement, the rear cockpit has been enlarged. The seat slides on rollers, and can be moved to the forward part of the cockpit, entirely out of the way. It is so arranged as to allow the gunner to sit on it com-

(*Please turn to page* 57)


The Army's latest observation plane is beautifully designed

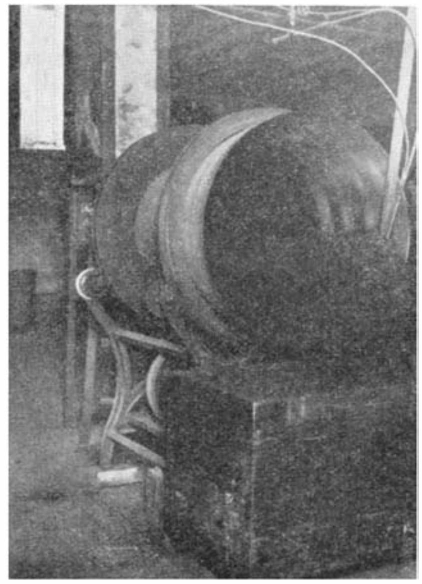


Rotary conditioner, cooler and mixer



Continuous apron heat-treating machine, where temperatures range from 160° F. upwards to 300° F. and over. 10,000 pounds a day

Where tobacco is mixed hot or cold, dry or moist. Capacity 50,000 pounds a day



Where rum is sprayed on the cool tobacco

MIXING AND BLENDING TOBACCO

IN the magnificent new Missouri State Capitol building, overlooking the banks of the Missouri River, is the interesting H. L. George collection of relics. One of these exhibits contains the following inscription:

"The natives of North America held tobacco in sacred regard. They made smoke offerings, accompanied by invocations to their Deities and Spirits; treated disease with tobacco; offered it in propitiation of angry waters; to allay destructive winds; to protect the traveler; to ward off danger; to bring good fortune. Tobacco was cultivated in most tribes by men alone, and usually smoked by them only. It was dried carefully, and kept as free from moisture as possible. That intended for immediate use was hung in bags of birch bark, deer skin, or skins of other animals, or in baskets."

Taken literally it seems just ignorant superstition, doesn't it? But, maybe behind it all, was the appreciation by those old Indians of that peculiar virtue in tobacco, of giving pleasure under all circumstances. The Indians evidently valued it as their choicest treasure—sort of a cure for all ills, even though used in its crudest form. What an even greater treasure is Wellington, the perfect blended tobacco, with seventy-eight years of study and experience behind it. That's how old the Christian Peper Tobacco Company is, having been established in 1852, at which time tobacco was dried only on nice sunny days on the roof, and the flavor was cooked in the kitchen at home. The business is now in the hands of the third generation.

"Tobacco smokers little realize what a difference there is between a mixed tobacco and a blended tobacco. They can't, because they have no opportunity of making comparison on exactly the same leaf," says Mr. Elmer C. Peper, President of the Christian Peper Tobacco Co. "Take Wellington", Mr. Peper continues. "The selection of the seven different tobaccos, and their proper quantities, was the result of seventy-eight years' experience in the tobacco business. Given these seven tobaccos, one might say it would be an easy matter to mix them. It is, if you mix them. It isn't, if you blend them. Each one of the seven goes through a different process in order to bring out the quality for which it was selected. The nature, time, heat and moisture of each process is different. Some of these tobaccos are mixed warm, some cold, some wet and some dry. Each one is added at a particular stage of the blending. Such a little thing, for instance, as the direction of the wind, makes a difference in our treatment. Sounds funny, perhaps, but the direction of the wind affects the temperature, as well as the draft and moisture in our factories. It is thus only by the exercise of extreme care, in every detail, that the best of the flavors of the seven kinds of tobacco can be refined and blended into a smoke whose composite natural flavor is most unusual.

We'll "Break In" Your Pipe--*Free!*

WOULDN'T you like to smoke a pipe without the exasperation of "breaking it in"? Now you can! We'll gladly have the world's sweetest cake and flavor mechanically smoked into any briar pipe you send to us. And then return it promptly ...without cost!

Only real, honest-to-goodness tobacco will be used to fill your pipe. You have your choice of Wellington London Mixture, or English Walnut, the newest thing in cigarette and pipe tobacco. You'll be surprised to find how smooth and sweet either brand will make and keep your from-then-on favorite pipe. So if you are "breaking in" a new pipe now, or have one not fully broken in, just mail to us and let our experts complete the job.

Please make sure that your pipe is wrapped well enough to be safe from damage. Enclose return postage. Print your name and address on the outside of package. Also which brand is preferred, "English Walnut" or "Wellington". Address Christian Peper Tobacco Co., 711 N. 1st., St. Louis, Mo. It is wise to insure package.

Special Xmas Gift Offer. One pound tin Wellington London Mixture for $1.50, postage prepaid to any address in the United States

WELLINGTON

Made by CHRISTIAN PEPER TOBACCO CO., St. Louis, Mo.

"To get the full benefit of them some thought should be given to the care and the use of your pipe. We had no idea there was as much to pipe smoking as there is until we talked to a confirmed old pipe lover. This is what he said.

"'Is there anything as good as smoking a good tobacco in a good pipe? If there is, I haven't found it. First of all you must have a good tobacco, like Wellington, for instance. Second, you must know how to smoke your pipe. A real pipe smoker always has six or seven tried and trusty pipes. He never smokes one when the stem and bowl has become foul. Every once in a while he uses alcohol to give the pipe a thorough cleaning out, but he does not allow it to stand in the pipe. If you will exercise this care and use Wellington, you will get increased pleasure from pipe smoking.'"

Pipes are made out of rather interesting materials. A few of the best are—

Amber, generally used for mouth pieces, sometimes for the bowl, is a mineralized vegetable matter. Amber is used because of its attractiveness and the faint odor given off when heated. Amber, however, is more or less easily broken.

Meerschaum, "foam-of-the-sea" is a rare peculiar clay. The desirability of this clay as a pipe material arises from the fact that it absorbs some of the smoke, and when treated with wax, turns a beautiful color.

The use of the popular Missouri corn cob pipe has extended all over the world. It is made from a certain species of corn which has an extremely large cob, and is grown with the best success in Missouri. Corn cobs have absorptive qualities, too.

Briar is the most popular material of all. It combines most of the good qualities of the other materials and at the same time will stand more abuse. Briar is the root of a heather grown in the high regions of Southern Europe. The most desirable roots are one hundred years or more in developing. For this reason, with the increasing popularity of pipes, these roots are becoming rare and no doubt will some day practically disappear from the market. Many other woods are used, such as apple, pear, maple, laurel, etc., many of them made to imitate Briar, but none of them are as satisfactory as the original briar from Southern Europe.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 56)

fortably whether he is facing forward or toward the rear.

The horizontal tail surfaces of the airplane are very efficient. The Handley-Page type balance is used on the elevators. Without any load whatever in the rear cockpit, it is possible to land the airplane without rolling the stabilizer all the way back. With full military load, the ship still trims very easily with the stabilizer, and retains longitudinal stability power-on and power-off.

The pilot's seat is given more vertical travel and the inclination of the seat back is greater to make it more comfortable for taller and larger men. A changed front gun installation allows all instruments to be grouped on one board, which follows army design as closely as possible. The center section is indirectly lighted and the instrument board is covered with a crash pad—2½ inches thick of sponge rubber—with holes cut through to see the instruments.

Miscellaneous installation features include a ball-bearing control stick designed to eliminate service troubles, an ammunition box removable for filling and easily handled, a small baggage compartment on the left side of the ship directly ahead of the instrument board, and a large canvas baggage compartment in the camera bay which can be used when neither the gun, camera, nor radio are carried and which folds out of the way otherwise. The stabilizer may be adjusted from either cockpit.

A cutout in the trailing edge of the upper wing reduces the backwash on the observer's cockpit, benefits the vision and decreases the aerodynamic interference between the upper wing and the front cockpit windshield. Thus, the air flow from the propeller is not forced through a small opening and wind resistance is reduced.

The Stenode Radiostat

In the article entitled "Television Needs New Ideas—and Less Ballyhoo" by A. Dinsdale, which appeared in our November, 1930 issue, mention was made of the Stenode Radiostat system invented by Dr. J. Robinson of England. Since the publication of this article much interest has been expressed in the receiver and we have been asked for constructional details. As yet they are not available.

Essentially the Stenode Radiostat receiver consists of a superheterodyne of conventional design with the exception of the second detector circuit. Here is incorporated a Piezo crystal and a series of capacities in a bridge circuit. By means of this particular arrangement, Dr. Robinson has been able to increase the selectivity to a point heretofore thought impossible.

In a demonstration held in the Engineers' Society Building in New York City, the other day, the writer witnessed a test of a Stenode Radiostat receiver in comparison with a standard superheterodyne. A small transmitter had been set up at one end of the demonstration hall and had been

(*Please turn to page* 60)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

IN the November number we published brief descriptions of five telescopes made by average beginners. This time our space is devoted to a description of a large instrument such as more experienced amateurs may expect to make as their second or third job. The description comes from A. V. Goddard, 282 Northeast 49 Street, Portland, Oregon.

"Although I have almost learned the SCIENTIFIC AMERICAN'S instruction book 'Amateur Telescope Making' by heart, and have recommended it to many others," says Mr. Goddard, "I must admit that I bought my mirror. It was made by John Mellish of St. Charles, Illinois, the same person who figured the 30-inch for the University of Illinois.

"I began about 20 years ago experimenting on mirrors, liquid objectives—that is, filling the space between two ground surfaces with silicate of soda—and buying small inexpensive telescopes and objectives, making an extension on my tube. I became rather discouraged with my mirrors because I would try them once, obtaining a good image, then the next time they would be distorted. I did not know at that time that the temperature was affecting my glass. I finally decided on a mirror made by someone who knew how, hence the 16-inch. I found out afterward that I was bothered just as much by temperature with the new glass, until I learned to give it time to cool, and then later to use a fan [explained below—Ed.].

"As for results on the 16-inch, I have seen seven satellites of Saturn and of course all of the rings. At very rare intervals I have seen the companion of Sirius and also the companion of Antares. The climate here at Portland is not good enough for much power and I use a one-inch eyepiece more than any other. However, I have been able to use up to 640 diameters magnification quite successfully. I can see the surface markings in the lunar crater Plato quite clearly when the light is right.

"The small refractor in the photograph is a four-inch Gall and Lembke with a John Berni objective. It is very good and I use it mostly on the sun. It comes in handy to have an extra glass when a class or group of people come.

"The tube and mounting of the 16-inch weigh about 750 pounds, so I have a ball thrust bearing around the two-inch shaft of the polar axis. This also makes the R. A. motion very steady. The concrete base is 20 feet in diameter and two feet thick in the center around the 12-inch pillar. (I wheeled all the concrete, too, a sidelight on astronomy.) The pillar is solid concrete with a six-inch pipe set in the top and a six-inch cast iron 45-degree ell threaded on to the pipe. I am fortunate in that Portland is on the 45th meridian and the ell was just right.

"The declination axis is a two-inch cold-rolled shaft set in boxes on a steel plate which has been welded to a heavy collar set on the end of the polar axis. The circles are cast brass disks ten inches in diameter, with the hours and degrees ruled on the perimeters. The divisions are down, respectively, to four minutes and three degrees, which are in turn divided on the verniers.

"The tube is heavy-gage galvanized iron and is 17 inches in diameter and 128 inches long. The finder is a two-inch glass with cross-hairs. I plan to have an observatory later. The dome will be 20 feet in diameter."

Mr. Goddard and his two telescopes

IN his letter, just quoted, Mr. Goddard referred to a fan. The use of an ordinary electric fan for maintaining a circulation of air through the tube of a telescope was mentioned on page 405 of our number for last May. All astronomers, professional and amateur, know that star twinkling, unsteadiness of image, "boiling," and sundry other optical nuisances are caused by atmospheric conditions, mainly the irregular distribution of temperature in the air, which produces differential refractive effects; and that a night with misty, hazy air usually will provide better seeing than a still, sharp night, in which the stars stand out against a crystal clear sky. It usually is assumed that the whole of this effect takes place aloft but some workers have questioned whether half of it, at least, is not caused actually *within the tube of the telescope itself*. Here, too, there often are temperature effects, due no doubt to the stratification of air in the tube. Accordingly, last May, it was suggested that open-sided—that is, latticed—tubes might prove to be superior to the type of tube made of solid sheet metal or wood.

Bearing on this point Mr. Goddard adds the following comment to his letter: "I have the 16-inch reflector but as yet no observatory, and I found the open or latticed variety of tube was unsatisfactory in my case because of the interference of street lights, so I finally settled on the present closed tube with an open door just above the large mirror. This worked better, but often I would have to wait an hour or more for the mirror temperature to settle. I read of some experiments by Professor W. H. Pickering with a fan, so I decided to give it a trial.

"I purchased a small six-inch electric fan and attached it direct to the tube so it would blow in through the door. But the slight vibration of the fan was so magnified in the eyepiece that the idea seemed impracticable. I then secured the standard for a music rack and made a separate mounting for my fan, also in order that I could raise it or lower it and set it at any angle. When I first tried it, a friend who was not accustomed to looking through a telescope happened to be calling, so I asked him to look at Jupiter. Only about three of Jupiter's belts were visible—until I turned on the fan. Then he said, 'Why, that makes a *great* difference. I can see 100 percent better.'

"The effect was like blowing away a fog, and the detail, even with 600 diameters, was very clear. Since then, I have found the fan so far ahead of any other method that I always use it."

WHAT was it that Professor Pickering said about the use of a fan, in the article Mr. Goddard read? We quote it from *Popular Astronomy* for last March, where it was published: "We all know when first starting a furnace in the autumn, that the hot air does not at once pour out of the flue, but is for a time blocked by the cold air already there, and which floats on top of the hotter, lighter medium; later gradually mixing with it, and finally being forced out into the room. If we could look through those mixing masses of air in the flue, we should find the seeing intolerable. It occurred to me while using my reflector that that was just what was occurring within the iron tube of my telescope. When the shelter is rolled away, and the instrument is exposed to the outside air, the upper end of the tube is cooled by radiation to the sky, while the lower end, not so completely exposed, retains some of its original warmth. We accordingly have within the tube a mass of cold air resting upon a mass of warmer material. Since the quality of the seeing is not influenced by the velocity of the air currents, whether within the tube or in the sky, no matter how high that velocity may be, but is strongly influenced by the least difference of temperature, I determined to go to the bottom of the matter and collect the fundamental facts."

PROFESSOR Pickering next describes experiments he made, ascertaining actual temperatures in various parts of the tube, and in the surrounding air, by means of thermometers, and concludes: "The obvious remedy to employ is to use an electric fan, forcing a current of air from the window near the mirror up through the tube. Care must be taken to support the fan in such a manner that it shall not jar the telescope. A six-inch fan is plenty large enough. With poor seeing, due mainly to currents in the upper air, the improvement resulting is not marked, but with good seeing it is most striking. It is very nicely illustrated by throwing a bright star out of focus before turning on the fan. The image usually rotates, sometimes in one direction, sometimes in the other. The rings always visible in such an image constantly vary in shape, with an appearance that we may describe as 'moulding.' The instant the fan is turned on all is instantly changed, the rings become circular, and all rotation ceases. Mr. Phillips in a recent paper (*Journ. Brit. Astron. Assoc.*, 1929, 39, 113) speaks of having tried an 'electric blower' but does not seem to have been quite satisfied with the result, because trouble began 'as soon as the blower is stopped.' In my original paper (Report on Mars, No. 41 *Popular Astronomy*, 1928, 451) describing the use of a fan, I state that an 'electric fan sending a current of air through the window near the mirror, and up through the tube, was later found to give greatly improved results.' It did not at that time seem necessary to me to state that the fan should be kept going. In order to avoid jar I always support it on a cushion.

"Since the opinions as to the relative advantages of open versus closed tubes are so divergent, it appears to me likely that with neither form are the mixing air masses entirely avoided, and that each observer should settle which is the best form for his own individual case. However, when an electric current is available, I feel that a closed tube with a fan entirely avoids the whole difficulty, and is therefore better than any open tube can be."

WHETHER to use the conventional closed tube, a latticed tube, or a closed tube with a fan driving air through an opening near the base ought, it would seem, be determinable once and for all by a simple experiment. The case is not, however, that simple—not by a long shot. No two telescopes, no two situations, no two nights are alike, and therefore the decision will not easily be arrived at in many instances. At least, no opinion ought to be formed until, like Mr. Goddard, the user has observed conditions over quite a period of time. Workers who have formed opinions are invited to submit them for publication, for the benefit of others. Some have had trouble with the latticed tube due to dewing of the mirror. Sometimes this may be remedied by wrapping the lower part of the tube with cloth—or making it solid in the first place.

TELEPHONE BOGARDUS 4400 CABLE ADDRESS "VOLUNTEER"

VOLUNTEER PRISON LEAGUE
OF
THE VOLUNTEERS OF AMERICA, INC.
(FOUNDED BY MRS. BALLINGTON BOOTH)
NATIONAL HEADQUARTERS
34 WEST 28TH STREET

NEW YORK. Dec. 1, 1930

To the Editor of
The Scientific American
New York City

Dear Sir:

In years gone by I have been greatly helped and cheered by the response I have received from your readers when, through your pages, they have learned of our Christmas work for the wives and little children of prisoners. In these sad prison-shadowed homes there is so much of privation and real suffering added to the shame of the father's imprisonment.

This work is not purely local, for all over the country the Volunteers of America are in close personal touch with these families through our nation-wide work in the prisons.

We find mothers struggling hard to shelter and feed their little ones, but try as they will there is never very much left over to buy them clothing, and nothing at all for the toys and good cheer of the Christmas season.

May I again ask help from those in happier homes, who can, by this touch of sympathy, help to lift the burden that is breaking many hearts. Toys, dolls, clothing and money will be gratefully received at our headquarters and passed on to these desperately needy and worthy families.

Let me add that the Volunteers of America is a duly incorporated Organization, that our accounts are carefully kept and audited and that receipts will be sent out by our Treasurer for every gift received. The Wardens and Chaplains in any prison in the land will, I know, heartily endorse this work as being practical and successful.

Please send all donations to Mrs. Ballington Booth, The Volunteers of America, 34 West 28th Street.

Very truly yours for our Country's Prisoners,

MAUD BALLINGTON BOOTH

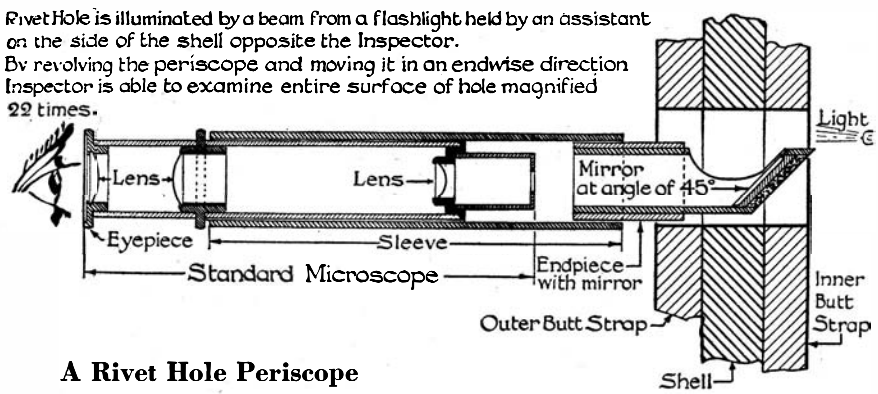
Maud B. Booth

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 57)

tuned to emit a wave about two kilocycles away from that of a local station. The local station was tuned in on the standard superheterodyne but reception was completely spoiled by the interference from the transmitter in the room. Then the same local station was tuned in on the Stenode Radiostat and even though the transmitter in the room was operating at a frequency only two kilocycles from that to which the Stenode Radiostat was tuned, it was impossible to detect any interference whatsoever.

Apparently Dr. Robinson's system holds great promise for the future. However, it is not as yet available in commercial form.—*A.P.P.*



A Rivet Hole Periscope

FOR decades engineers have been studying the serious "ailment" known as "caustic embrittlement" which affects steam boilers, causes cracking of the metal around the rivet holes, and often causes disastrous explosions. Much light has been shed on the subject but there is still much to learn since experience with various kinds of feed waters leads to a number of what appear to be contradictory conclusions.

The accompanying illustrations show the ingenious Hartford Rivet Hole Periscope designed by Assistant Chief Engineer Morrison of the Hartford Steam Boiler Inspection and Insurance Company. This instrument has proved of great value on many occasions and is one of the means whereby early discovery of caustic action has been made possible. Cracks so small that they are invisible to the unaided eye are magnified 22 times by the reflecting mirror and lens, and no matter how deep the hole, the instrument permits a minute examination of its walls. Its ingenious construction is shown by the sectional drawing.

Kill Ferocious Fish With Electric Device

A CANNIBALISTIC fish killer with a snake-like body, known as the gar, is being eliminated in southern waters by electricity, according to J. G. Burr, research director of the Texas game, fish, and oyster commission.

The gar-killer consists of a barge with a seine attached to one end. Wires that run throughout the seine are charged with electricity by a specially built generator. A 200-watt spotlight plays upon the water, and the gars which swim close to the surface are blinded, caught in the net, and stunned by the electric current. The hapless gar sinks to the bottom and suffocates, while other fish, which may have been stunned, float to the surface and soon recover.

"Ridding the waters of gars would mean the saving of millions of fish each year," Mr. Burr says.

Soap from Sulfur Smell

SULFUR smell in coal gas has been converted into medicinal soap at Ohio State University. Results of one year's experiments with this soap were recently reported to the medical section of the American Chemical Society by Dr. Emery R. Hayhurst, professor of hygiene at Ohio State University. He said the soap is made from a new form of sulfur which was discovered some time ago while removing sulfur and other impurities from coal gas.

The sketch above shows a cross-section of the new periscope for examining rivet holes, and the notes explain its operation. *At right:* Method of using periscope in a large boiler

The sulfur resembles moderately wet clay. It differs from other sulfurs in that it is composed of finer particles, all of them under ten thousandths of an inch in diameter. Twenty percent of this new sulfur was mixed with castile soap and perfumed.

Dr. Hayhurst said he tried this soap on members of his own family and the families of some of his scientific friends with no harmful results. It was then tried upon a wide variety of persons, from babies to machinists, and on different types of complexions. It was found to be free from damaging effects to scalp, hair, or nails, and did not sensitize the skin.

"Its effects are remarkable," said Dr. Hayhurst, "in practically all cases encountered of simpler chronic skin diseases like eczema, acne, and facial blemishes." Three manufacturers of plated materials told the professor that the gas soap appeared to cure platers' rash, and one concern reported that after a seige of mechanics' boils, lasting over five years, the gas soap eradicated them within three months.—*A. E. B.*

Rabies Treatment for Drug Addicts

FREQUENT dog-bite cases from an Egyptian village led to the discovery that the villagers, addicted to narcotics, were resorting to subterfuge to gain access to a rabies hospital in Cairo, where they believed the treatment would cure their craving for heroin, according to a report made public by the Department of State.

The doctor in charge of the Cairo Antirabic Institute noticed a curious frequency of dog-bite cases from a particular village in lower Egypt. Usually in a large proportion of patients bitten by a reputed mad dog, the dog is eventually killed and sent up for examination. He observed that although these cases all came from the same village, in no case was there any record of the dog. He, therefore, had his suspicions and finally put one of the patients through a very close cross-examination with, as a result, the following admission:

"I and the rest of us who have come up here for treatment for rabies have actually never been bitten by a dog. We are all dope addicts. We are ruined men with no hope. We have lost everything and there is no one to help us or cure us of our addiction. Some months ago, one of our villagers named Mohamed, who was a hopeless drug addict, happened to be bitten by a mad dog; he was sent up here for treatment for rabies and was eventually sent back to our village, cured not only of the rabies but also of his desire for dope. When we saw this we marveled and said, 'Here is a way of being cured of our heroin addiction. But how are we to get to this Cairo hospital?'

"We thought it over and in the end went to the village barber who, as you know, is the Government sanitary agent, and we said to him: 'O barber, we want to go to the mad dog place in Cairo as they will cure us of drug addiction. But how are we to get there?' So the barber thought for a time and then said: 'Come back again in a week.' A week later we went back and the barber explained to us that to get to the Cairo hospital we must seem to have been bitten by a dog so as to get a certificate from the local public health doctor.

"He then showed us how he had got the jaws of a dead dog and had fitted the jaws with a steel spring and explained to us that with this machine he would give us the necessary lacerations to simulate the bite of a live dog. We, therefore, each of us, at reasonable intervals, were bitten in the leg, or elsewhere, by the barber's 'dog,' submitted ourselves to the public health doctor and got sent up here to the hospital where we are sure we shall be cured of our desire for dope."

Comic perhaps, but pathetic to a degree. It would at the same time be of interest to know whether the Pasteur treatment may not possibly have some effect on narcotic addiction.—*The United States Daily.*

No Skeleton Key Can Open This Door

THOSE who depend upon skeleton keys and such paraphernalia to open resisting doors will find such instruments of no avail at one of the rooms of the Vacuum Tube Engineering Department of the General Electric Company at Schenectady. The door of that room opens only at the touch of the finger—and only at a particular touch. If you don't know the formula or code, if you haven't the "open, sesame," you can't enter.

Such a door at the outer portal of a lodge room would guarantee the exclusion of all but the initiated. The guard at the outer gate is no longer necessary. Knock correctly and the door swings open, and you see the "welcome" on the mat. You do not have to depend on the judgment or bouncing power of a doorman.

This demonstration of the magical properties of electricity is an application of the newest tube development of the General Electric research laboratory. The thyratron, as the tube is called, directly controls large amounts of power; an input of a fraction of a watt is sufficient for the typical thyratron to "turn on" a kilowatt.

At the right of the laboratory door there is a metal plate. The plate has a fixed electrical capacity. When this fixed capacity is unbalanced by the application of variable capacity, such as tapping by a person's hand, a series of four thyratrons on the inside of the room is set into operation, each with a particular duty in an intricate electrical circuit. The final thyratron operates a relay which releases a lock and starts a motor on the hydraulic door-opener. The circuit may be set for any sequence of contacts or touches, and will respond only to the sequence for which it is set.

If "52" is the secret code, for example, the metal plate is tapped lightly five times, followed by a pause of a few seconds, and then tapped twice. The thyratrons then function, and the door swings open.

The mechanism that causes a door to swing open to a secret code knock

Knock correctly on the proper spot and this door will open at once

Athlete's Foot

ATHLETE'S foot has come to be a commonly known condition because of the extensively advertised preparations for its relief. This condition is a form of ringworm, and it is not surprising that specialists in diseases of the skin are beginning to report cases of extension of the condition to the hands and to other portions of the body. Organisms responsible for the disease are transferred from the feet to the hands and by means of the hands to other portions of the body, such as the inner side of the thighs and the buttocks, which provide conditions particularly suitable to growth and multiplication. When the condition occurs on the hands there are oval spots slightly inflamed, with scales. The organisms can be found in these spots when scrapings are made and studied under the microscope. Some people are apparently more sensitive to this type of infection than are others, and investigations show that there may be special sensitivity of the type commonly called allergic or anaphylactic. —*M. F.*

Dry Powder Extinguishes Fires

A NEW form of fire extinguisher which utilizes a dry chemical, expelled in a cloud by nitrogen or carbon dioxide, has been developed. The method briefly consists in blowing a dry, powdered chemical, which gives off carbon dioxide when heated, through a hose and controlled nozzle by means of an inert gas.

In the hand extinguisher, the inert gas is carbon dioxide, which is contained under pressure in the extinguisher body. In the larger sizes, a separate cylinder of nitrogen under 2000 pounds pressure serves to expel the extinguishing chemical in a cloud. The range of this cloud is about 30 feet and its blanketing effect permits the operator, according to the manufacturer, to approach close to the fire. The extinguisher is said to be suitable for all types of fires and has been approved by the Underwriters' Laboratories for use on class B fires of inflammable liquids.

Among the advantages claimed for the extinguisher are the rapidity of its blanketing and smothering action, its effect of blowing out the flame, the impossibility of its freezing, and non-injurious character of the chemicals.—*A. E. B.*

Neuritis in Car Drivers

MANY drivers of motor cars sit with the window of the sedan open, which permits a constant draft of cold air to strike the shoulder. Doctor Rathelot, a well-known French physician, has just described a condition observed exceedingly frequently; namely, neuritis in the shoulder of the driver who follows the custom mentioned. The pain appears in the shoulder and radiates toward the neck and the back. Cold and damp weather makes the pain more severe and people who have previously been subject to rheumatic disorders are more likely to suffer than those who have not. The French physician describes the condition as a sciatica of the arm, because it is so similar to sciatica in the aged. Apparently it is due to inflammation of the nerves supplying the region concerned. He has not seen a case in drivers of open motor cars, but the condition occurs invariably in drivers of closed motor cars who keep the window open while driving.—*M. F.*

Geophysical Prospecting

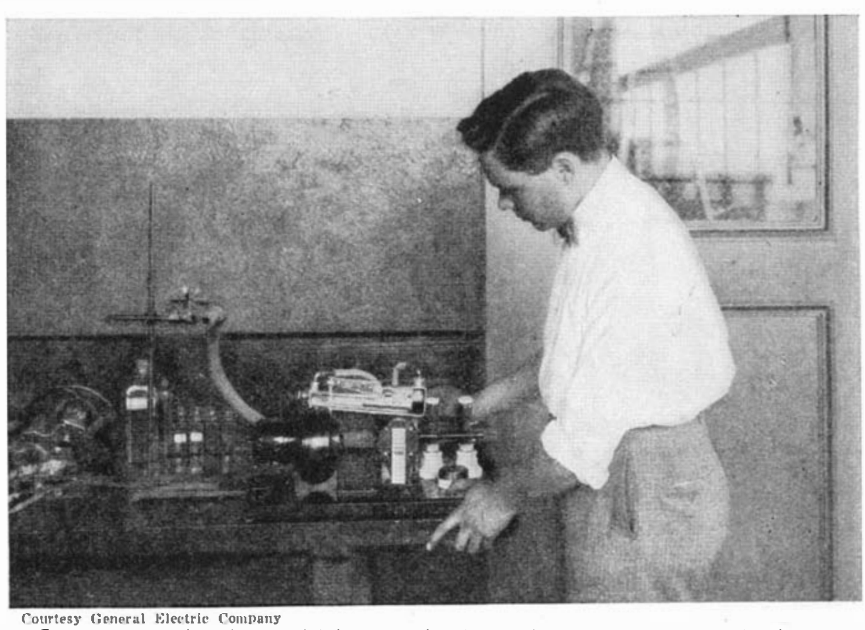
HOW valuable some of the geophysical methods of prospecting—for example the seismic or artificial earthquake method and the gravitational or torsion balance method—previously described in the SCIENTIFIC AMERICAN, have proved to be in the oil industry is shown by a summary published in *Oil Weekly* (Houston, Texas), Volume 56, No. 7.

Forty new oil fields have been found though all are not yet drilled. Twenty-two of them are in Texas and 18 in Louisiana. Fourteen new fields were found in 1929 and, when drilled, they gave a total production of 6,302,100 barrels of oil. "It is to the glory of the geophysicists and their science," says Jack Logan, the author of the summary, "that every one of the 14 new fields of 1929 was discovered by the use of the geophysical instruments."

"Falling" of Dew

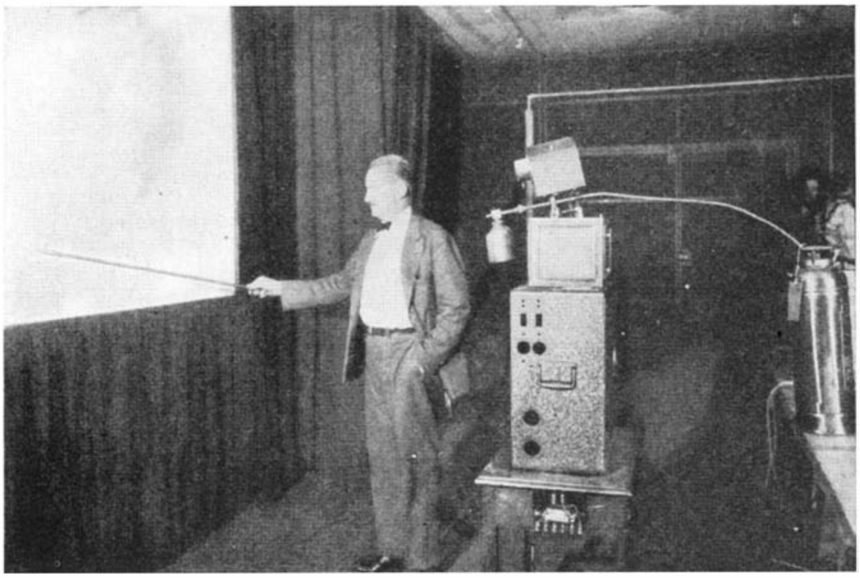
THE problem of the "falling" of dew has long been one concerning which there are many men of many minds, and their confusion is still confounded, as evidenced by several recent articles about it in *Nature.* One group, esthetic and poetical, says that dew falls, and says it in language often so beautiful that it would be all but sacrilege to question its truth. Another group, looking at the other side of the shield, or, literally, the underside of the leaf, insists that it rises. A third, and pacifist group, urges that both are right, that dew rises and dew falls. This leaves room for only the iconoclast, and that room is taken, for there are those who are emphatic in their statements that it neither rises nor falls. Well, as usual, they are all right and all wrong—each right according to his own definitions of the terms used, and wrong according to the other fellow's definitions.

According to my understanding, all dew is liquid water, except, of course, mountain dew, if any one insists on being so meticulous. Furthermore, it is that particular liquid water that has condensed onto relatively cold objects (objects whose temperatures are below the current saturation or dew point) from immediately adjacent water vapor. According to this definition, dew, a mass of liquid water, does not fall. That would be rain, drizzle or the settling of fog or haze—the descent of water-drops. But even so, we can speak of the falling of the dew in the same correct sense that we speak of the falling of the night, that is, in the sense of gathering as if by falling, or merely in the sense of occurring. And this,



Courtesy General Electric Company

So sensitive is this electrical "chemist" that it can detect mercury vapor in the atmosphere when the vapor is present in a quantity of only one part in 20,000



A demonstration of another use of the photoelectric cell, by Dr. Phillips Thomas of the Westinghouse Electric Manufacturing Company. The photoelectric cell constantly "scans" the white screen. When the demonstrator lights a fire, the cell "sees" it and releases a stream of carbon dioxide, thus extinguishing the flame

I believe, is what most of us, poets and all, mean when we speak of the falling of the dew—merely that it is forming or gathering.

However, one may insist, and some do so insist, that even if dew is formed by the condensation of water vapor, the vapor molecules had to get to the place of condensation by motion in some direction—down, up, or sidewise. If the air is still, and if the top of an object is bedewed (a very common occurrence) we doubtless would be right in insisting that the final travel of the vapor was downward, wherever it originally started from and however tortuous its intervening path. In this sense, the sense of final course of the vapor molecules that go to make it, some dew does fall—does go down—not owing to gravitation, but to difference in vapor pressure, a pressure that is least at the place of condensation where the vapor is continuously disappearing or flowing away as if into a sink. In exactly this same sense the dew on the underside of an object, a leaf, for instance, has risen.

Many of the "dewdrops" on the tips of grass and other growing vegetation have not been produced by condensation at all, but by exudation—the flow of water up the leaf and out at its tip or tips. This false dew has, in general, risen. Also it may happen that the absolute humidity (quantity or mass of water vapor per unit volume) immediately over a bedewed lawn, say, is quite as great during the formation of the dew as it was immediately before, owing to an abundant supply of vapor from the damp sod beneath. In this case it may be said that all the dew has risen, the dew on the upper side as well as that on the under side of each and every object.

If, therefore, we adequately prepare the way by definitions appropriate to our needs, we can correctly say that dew falls (in either of two senses), rises, does both, or does neither.

How then about frost—is that frozen dew? Dew in the sense above used, liquid water condensed from vapor, freezes whenever, after it has formed, the temperature falls sufficiently low, whereupon it becomes a kind of frost, but not the fine, white, feathery sort known as hoar frost. This latter variety, by far the more common, is formed by the direct condensation of water vapor into ice. It does not pass through the liquid state, hence never was dew and therefore is not frozen dew, as dew is here defined.—W. J. HUMPHREYS in *Science.*

Lactic Acid

MILK turns sour because the bacteria in it convert the sugar to lactic acid. Now sour milk is not a very popular beverage, but paradoxically, lactic acid is being used more and more in soft drinks and other food products, says J. F. Garrett in a recent issue of *Industrial and Engineering Chemistry*.

Commercially, lactic acid is produced by the fermentation of molasses or corn starch. A fermentation usually requires five to six days for complete conversion of the sugar to lactic acid, although the time may vary widely with conditions. When it is completed, sulfuric acid is added and the calcium lactate converted to lactic acid and calcium sulfate. The latter is filtered off and washed. The resulting weak lactic acid (about 8 percent) is concentrated in vacuum pans to the desired strength.

The leather industry is the principal consumer of lactic acid, utilizing probably 80 to 90 percent of the entire consumption of the country. Its most important function in leather processing is the removal of lime from dehaired hides.

The dyeing and finishing of textiles constitutes an important field for the use of lactic acid, particularly in chrome mordanting and in acid dyeing process as applied to wools.

In recent years a large amount of lactic acid has been used in the production of ethyl lactate, a high-boiling solvent for the nitrocellulose used in the production of pyroxylin lacquers.

The edible and U. S. P. grades of lactic acid are gradually finding increased uses in widely diversified lines of food and beverage products, some of which are infant foods, low-alcohol beers, soft drinks, candies, poultry, and stock foods. In infant foods, lactic acid appears to have a corrective effect upon the digestive tract; in nearbeers its purpose is improvement of flavor and odor; in soft drinks and certain candies it acts as an acidulent replacing citric and tartaric acids.—*A. E. B.*

Oxygen Treatment

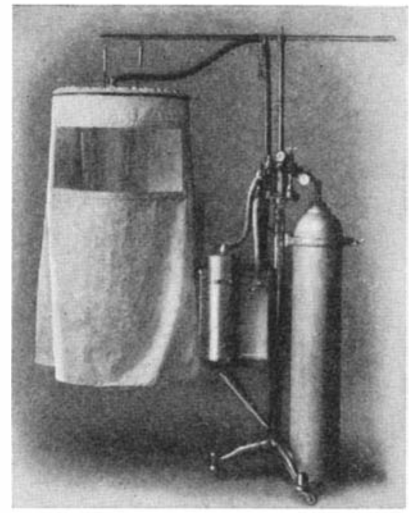
NOW that the life-saving value of oxygen in the treatment of pneumonia and in several other conditions has been definitely demonstrated to be beneficial, attempts have been made to provide simplified apparatus that is easily available and that can be used in the home or in the institution. Special head tents that are easily portable have been developed. Oxygen apparatus formerly used depended on the presence of a motor to blow the air and to keep it in circulation. The motor caused a noise which irritated the nerves. Furthermore, it sometimes stopped suddenly. It required constant lubrication and because of the electrical connections was dangerous when used with oxygen under high pressure. It was also necessary to provide a cooling system which demanded the use of ice and the possibility of leakage of water.

Workers in the Cornell University Medical College have now developed an apparatus which does not require a motor and which has other improvements of great value. In the new device, the motor blower is replaced by an injector and utilizes the high pressure flow of oxygen for its motive power, drawing the air from the hood through the regenerator on one side and forcing it through the cooling system and back through the hood on the other. The device also has a cooling system which avoids the inconvenience of the use of ice by the use of dry ice, or solid carbon dioxide. It is provided with a portable hood containing a window. The operation is simple and would seem to overcome the difficulties with the older types of apparatus.—*M. F.*

Scrap Metal Recovery

DON'T scoff at the junk man! He is really a factor in a tremendous business. According to the United States Bureau of Mines, the value of certain metals (other than iron) recovered from secondary sources in 1929 was $331,027,900, which is $56,416,600 more than in 1928. This increase in total value was almost entirely due to the greater recovery of and higher yearly average price of copper and copper alloys in 1929. There were also increases in the average prices of lead and zinc and decreases in the average prices of antimony and tin. There was a large increase in the quantity of secondary copper and brass and small increases in the quantity of secondary lead and secondary aluminum. The secondary recoveries of zinc, tin, antimony, and nickel showed small decreases.

The shipments of scrap copper and brass to Europe were considerably less in 1929 than in 1928 and the brass scrap re-melted by secondary refineries did not increase. The large increase in secondary copper was that reported by smelters and refineries that treat mainly primary metal, which increased from 116,323 tons in 1928 to 167,079 tons in 1929, and in copper (in alloys other than brass) which increased from 95,000 tons in 1928 to 120,000 tons in 1929.



Oxygen treatment apparatus, described at left, showing hood, mechanism, tank, and the supports

There was a decrease in the quantity of lead and lead in alloys reported by secondary smelters, but those smelters and refineries which treat mainly ore and concentrates reported an increase of nearly 10,000 tons in pig lead and about 4600 tons of lead in antimonial lead from secondary sources.

The zinc recovered by re-distillation decreased about 1300 tons and that recovered by sweating and re-melting about 4000 tons. There were increases in the quantity of zinc dust, lithopone, and zinc sulfate made from zinc residues and drosses and in zinc dross exported, but a decided decrease in the quantity of zinc chloride made from zinc skimmings and the like, in 1929.

The de-tinning plants treated about 17,400 tons more clean tin-plate clippings in 1929 than in 1928 and the yield per ton increased slightly. No old tin-coated containers were treated for the tin coating in 1929, though some were re-melted for window weights. About 76 percent of the recoveries at de-tinning plants was as tin content in tin tetrachloride, tin oxide, and other chemical compounds.—*A. E. B.*

Water Purified by Electrolysis

THE purification of water by the removal of salts from a central section of a cell, through diaphragms, to cells containing anode and cathode poles has been developed in Germany. By passing the water from the central compartment of a series of cells, the water in this compartment becomes gradually purer until the anions and cations are practically all removed. The water so purified, it is claimed, is equivalent to distilled water and can be obtained at a much lower cost. The apparatus consists of 10 cells placed side by side. The purified water passes by siphons through the central compartment of each cell. The anode and cathode waters are removed by wash water, which is fed from dripping nozzles and escapes from overflow pipes in the anode and cathode cells respectively.

Prof. Edward Bartow and R. H. Jebens of State University of Iowa recently tested out the new apparatus and report, in *Industrial and Engineering Chemistry*, that it works very well. They found that tap water containing 725 parts per million of impurities was purified to 15 parts per million by passage through the cells. Since this small residue is chemically inert, the purified water, they say, will serve for most of the common uses of distilled water.—*A. E. B.*

Depths of Earth Yield Frozen Gas

FROM the interior of the earth beneath Jackson County, Colorado, comes snow-white, solid carbon dioxide, which freezes at 70 degrees below zero, Fahrenheit. Enough is obtainable in one day to fill a train, Prof. F. F. Hintze, of the University of Utah, reveals in a report to the American Institute of Mining and Metallurgical Engineers.

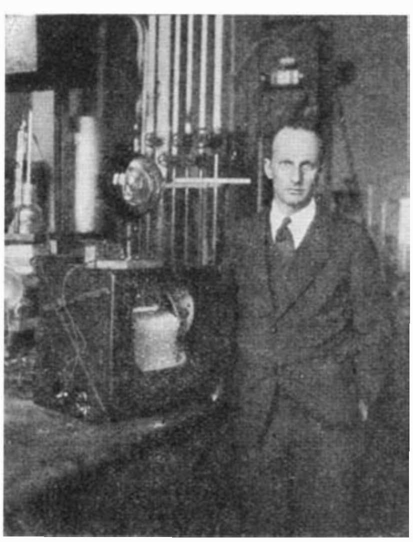
Professor Hintze explains with proper technical exactness that the carbon dioxide is contained in the earth as a gas under very high pressure, not as the cold solid. But when it comes to the surface, mixed with about 10 percent oil, it expands so fast upon being released from confinement and gives up so much heat that it freezes both itself and the oil.

In its frozen state, engineers would apply this gas, the same that is exhaled from human lungs, to the refrigeration and preservation of food.—*Science Service.*

Artificial Wool from Wood

HAVING successfully improved upon the work of the silk worm by developing rayon, the chemist is now turning his attention to the task of going the sheep one better by producing an acceptable artificial wool. A step toward this goal is announced by German chemists who have developed a fiber which they call Vistra. It is made from wood cellulose, converted into viscose, and then pressed through spinnerets of such fineness that 40,000 yards of the fiber weigh only 1 pound.

The wool-silk of another German rayon factory is made from raw rayon, untwisted fibers of which are cut into the proper staple length, curled, and then fabricated. The artificial wool produced in this way costs approximately half as much as washed natural wool.—*A. E. B.*



The rare element caesium is used in the photo-electric cell, shown on top of the cabinet. The layer of caesium is exactly one atom thick —in other words, it is very thin!

The Chemical Kiss

THE skin on the face of a pretty girl is made up of 13 chemicals! John H. Foulger, well-known chemist, Medical College, University of Cincinnati, says 100 grams of skin contain: Water, 61 grams; albumin and globulin, 0.7; mucoid, 0.16; elastin, 0.34; collagen, 33.2; phosphates, 0.032; fats, 0.761; common salt, 0.45; potassium chloride, 0.04; lime, 0.01; also minute quantities of magnesium oxide, iron oxide, aluminum oxide, and sulfur.

Charles Ludwig in the Cincinnati *Times-Star*, is inspired to verse by this chemical analysis of sex appeal.

The skin you love so much to touch,
Now savants tell us, isn't much—
Take thirteen chemicals and mix,
And skin jumps from that bag of tricks!

In epidermis of sweet lass,
Potassium and chlorine gas
Unite with common iron rust!
—Our fairy is not even dust!

And when you kiss and say "Yum, Yum"
You osculate magnesium!
Her cuticle has lime and salt—
Now will your fondling ardor halt?

Hell's phosphorus and sulfur, too
Come into play when lovers woo;
Commingle in the velvet skin
With mucoid and with globulin.

Aluminum in pan and pot
Doth never cost a man a lot:
Much dearer Al_2O_3
In every maiden's cheek you see.

There's KCl and H_2O—
How strange that men admire it so!
The formula you love so well
Has CaO, NaCl

And since the awful truth is out—
Fair skin's no more than sauer kraut—
Will gallant lovers now all beat
From cooing trysts a cold retreat?

NOT MUCH! Dame Nature put in skin
A chemical named COLLAGEN!
Its still small voice doth lure all men—
Depend on it, they'll CALL AGAIN!

—*A. E. B.*

Parasitic Plant May Be Good Food Source

A PLANT with flowers but no leaves, that gets most of its food by tapping the roots of other plants and grows to be 10 or 20 times as heavy as its host, yet without causing the latter any apparent injury, was described recently by Walter T. Swingle of the United States Department of Agriculture. It has the further distinction of being good for human food, and of maturing a good crop on as little as three inches of rain a year—believed to be a record for food plants possible in dry regions.

It was originally discovered about 80 years ago, in the desert near the California-Mexico boundary, but until a little over a year ago remained a great rarity. Now, however, it has been rediscovered in great abundance, and has received its first thorough botanical study.

The part used for food is the thick, fleshy root, in which the plant stores water and a reserve of food material. The original discoverers found the Papago Indians using it for food, and when they tried it roasted over a fire they found it very good. Mr. Swingle suggested that inasmuch as no other useful plant can be induced to grow in this arid region, it might be worth the white man's time to follow the lead of the Indian on a larger scale.—*Science Service.*

CURRENT BULLETIN BRIEFS

SHORT REVIEWS OF BULLETINS AND PAPERS ON SCIENTIFIC AND ALLIED SUBJECTS, AND WHERE TO GET THEM

The Apartment Cottage is a small pamphlet in which apartment planning is adapted to the small house. Plans and specifications for any of the houses can be obtained at an extremely low figure. *Model Plan Service Studio, 3725 Valentine Road, Kansas City, Mo.—20 cents.*

Southern Baffin Island, an account of exploration and investigation and settlement during the past 50 years. *Director, Northwest Territories and Yukon Branch, Department of the Interior, Ottawa, Canada.—Gratis.*

A Study of Some Characteristics of Vegetable Oils (Publication No. 276—Field Museum of Natural History, Botanical Series, Vol. IX, No. 2) by James B. McNair. *Field Museum of Natural History, Chicago, Ill.—25 cents plus postage.*

Brown Pyrometers. (Catalogue No. 15A). The urge of industry accounts for the rapid perfection of pyrometers during the last decade. The beautifully executed 100 page pamphlet is almost a monograph on the subject. *The Brown Instrument Co., Philadelphia, Pa.—Gratis.*

Medical Department Report, United Fruit Company, is a valuable work for informing students of tropical medicine of the problems encountered in countries where this company operates. The book can only be sent to those specially interested and is sent gratis to such persons. *United Fruit Company, 17 Battery Place, New York.*

The Salamanders of the Chicago Area (Zoology Leaflet, No. 12, Field Museum of Natural History) by Karl P. Schmidt is a pamphlet with colored and black illustrations. *Field Museum of Natural History, Chicago, Ill.—25 cents.*

Restoration of Ancient Bronzes and Cure of Malignant Patina (Museum Technique Series No. 3, Field Museum of Natural History) by Henry W. Nichols, deals with methods which are in use in the Field Museum. This process was first developed by Prof. Colin G. Fink at Columbia University and has been described in this magazine. *Field Museum of Natural History, Chicago, Illinois.—50 cents.*

Effectiveness of Moisture-Excluding Coatings on Wood (Circular 128, United States Department of Agriculture) by George M. Hunt, gives the results of various experiments made at the Forest Products Laboratory by different investigators on the moisture-proofing of wood by coatings and impregnation treatments. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Keeping Pace with the Oil Industry (Book No. 1259) is an elementary leaflet on petroleum production. *Link Belt Company, Chicago, Ill.—Gratis.*

Bureau of Ethnology, Annual Report for 1927-1928. Most of the 857 pages consist of scientific papers on anthropology of Salishan, Thompson, and Osage Indians. *Superintendent of Documents, Washington, D.C.—$2.35 (money order).*

Outlines for Studies of Mammalian Life Histories (Miscellaneous Publication No. 86 United States Department of Agriculture) by Walter P. Taylor. Few lines of inquiry possess greater interest or importance than those that deal with the activities of the wild animal in its natural environment. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

American Medicinal Plants of Commercial Importance (Miscellaneous Publications No. 77 United States Department of Agriculture) by A. F. Sievers deals with a subject of considerable importance to many dwellers in the rural sections of the country as it affords a gainful occupation. The 74 pages are profusely illustrated. *Superintendent of Documents, Washington, D. C.—30 cents (money order).*

Airway Map of the United States (Aeronautics Bulletin No. 8, Aeronautics Branch, U. S. Department of Commerce) is a folded map showing lighted and other airways, together with proposed airways. This is an exceedingly valuable and authentic map and can be obtained from *Aeronautics Branch, U. S. Department of Commerce, Washington, D. C.—Gratis.*

Comparison of the Physical Properties of Various Kinds of Cast Iron Pipe (Department of Engineering Research, University of Michigan, Ann Arbor, Reprint Series No. 6) by F. N. Menefee and A. E. White gives valuable facts presented at the Annual Convention of the American Water Works Association. *Department of Engineering Research, Ann Arbor, Mich.—50 cents.*

A Pioneer in High Pressure Steam, by Geo. H. Gibson, describes the unique contribution of Carl Gustaf Patrick De Laval (1845-1913) the Swedish engineer who was responsible for many mechanical engineering improvements besides the De Laval separator with which his name is usually associated. He originated, according to this pamphlet, the diverging steam nozzle, the high speed helical gear, the flexible shaft, and the use of steam at 750 degrees Fahrenheit and at the critical pressure. *De Laval Steam Turbine Co., Trenton, N. J.—Gratis.*

Geology and Mineral Resources of Northwestern Alaska (Geological Survey Bulletin 815). A comprehensive, 350-page investigation of a previously little known region, particularly with regard to oil possibilities. *Superintendent of Documents, Washington, D. C.—One dollar (money order).*

Geophagy (Field Museum Publication 280) by Berthold Laufer. World-wide studies of the peculiar but widespread human habit of eating earth and clay. *Field Museum of Natural History, Chicago, Illinois.—50 cents (postage extra).*

Data on Metal Base Experimental Road gives particulars of a section of road as constructed in Sangamon County, Illinois. *Poston-Springfield Brick Co., Springfield, Ill.—Gratis.*

OUR POINT OF VIEW

(Continued from page 13)

We do not recall any administration witnesses admitting to the Senate that one bad result of the London pact was the dangerous tension that its deliberations caused between France and Italy. It was openly discussed in Europe but scarcely mentioned here. Unquestionably developments during the London Conference increased the tension between France and Italy, but the basic causes of that tension are conflicting territorial ambitions that now appear irreconcilable and it seems very imprudent for our State Department to assume voluntarily any portion of the responsibility for the present unhappy relations existing between France and Italy.

It is rumored that behind the persuasions of Mr. Gibson is the thinly veiled threat to withdraw British and American financial support to Italy if she does not come to terms with France. In the present state of Italian finances, such economic pressure would amount to extreme coercion, and would involve us deeply in the affairs of continental Europe. The United States should do her part in the various efforts being made to restore stable conditions in Europe, but we should carefully circumscribe the limits of our efforts and resist all temptation to play the leading rôle as Europe's prime pacificator. Such an ambition proved President Wilson's undoing.

Germany—Hitler—Breunig American dollars are regularly intervening in European affairs and in a way that may prove to be very helpful to Europe. An American syndicate under the leadership of Lee, Higginson and Company has lent $125,000,000 to the German Premier Breunig to keep the German cabinet in power in spite of bitter attacks by the German Fascists and German Communists. The influence of President Hindenburg was naturally thrown to Breunig's cabinet, but even with that assistance the decision was close.

Unquestionably Hitler's Fascist party more nearly represents the great bulk of German opinion than any other, and it is a safe assertion that no German is really reconciled to Germany's new boundaries or to her liability for financial reparations. For the present Germany is content to pay small installments, mostly with borrowed money, on her reparations and live within her present territories because her wisest leaders are convinced that this is the best course open to her.

Germany is aware that if she bides her time many of her former enemies will soon lose interest in the execution of the provisions of the Versailles Treaty. In Great Britain and Italy majority opinion today is probably in favor of revision of the treaty; only France, Poland, and the states of the Little Entente are strictly anti-revisionists so that in the not distant future Germany may expect that her request for a rectification of frontiers will receive support from some of her previous foes.

Palestine Zionists all over the world are attacking the decision of the British Government to restrict the sales of land in Palestine to the Jews. The government claims that it is only holding an even balance between the interests of the Arabs and Jews, who, together, constitute the bulk of the population of Palestine. No doubt Great Britain would be pleased to wash its hands of the whole matter, but having accepted the mandate from the League of Nations, it must carry on.

At this distance it is impossible to pass on the merits of the case, but Great Britain can not be fairly accused of anti-Semitic feelings. England has entertained less prejudice against Jews than any other European country. Jews not only are prominent in British business but have taken a distinguished part in the British government. It was the oriental ideas of the brilliant Disraeli that made Victoria Empress of India, and in our own time Lord Reading has served as Viceroy of India, the most regal position offered to a British subject. The British government may have erred in its last decision, but it is certainly not inspired by any but good will towards the Jewish people.

Indian Conference There are no idle moments for MacDonald for he has now to face the Indian Conference, that meets in London to determine the future status of India. There are indications of a definite lessening of the tension between the Indian Government, the independent Princes allied to the British Government, and the Indian people of British India, with a growing feeling that a peaceable solution of the problem can be found. Lord Irwin, the present Viceroy, is pursuing a conciliatory policy that has had a good effect on the personnel that will present the Indian point of view at the Conference. There is plenty of good will on the part of the representatives of the British Government and a formula should be found that will satisfy the natural aspirations of the Indian people for a larger share in their government without loosening the bonds of the British Empire or placing too great a political responsibility on an untried electorate.

The whole world, with the possible exception of Russia, will wish the Conference success, for a proper settlement of this disturbing question will directly improve the economic conditions of India and the United Kingdom, and indirectly benefit the trade of the world.

COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY

New York Bar

Consumption of Turpentine and Rosin Increases

MARKED increase in 1929 in the industrial use of naval stores, particularly in use of turpentine for manufacture of paint and varnish was reported in a Department of Agriculture statement just issued. The full text of the statement, as published in *The United States Daily*, follows:

A marked increase in the consumption of rosin and a noticeable increase in the use of turpentine by industrial concerns during the calendar year 1929 is disclosed by the figures just made public by the Bureau of Chemistry and Soils, United States Department of Agriculture, and published at the request of producers and consumers of naval stores.

Industrial consumption of rosin in 1929 increased by 157,384 barrels to 1,104,771 barrels, about 16 percent, and consumption of turpentine reached a total of 5,622,695 gallons in 1929, an increase of 318,596 gallons over 1928, or about 6 percent.

The largest increases in the industrial use of rosin during 1929 were in the manufacture of paper and paper size, soap, and paint and varnish. There was an increased use of rosin by all industries except the linoleum industry, where there was a decided decrease from the quantity used in 1928.

The largest increase in the use of turpentine in 1929 was in the manufacture of paint and varnish. There were also increases in the use of turpentine by manufacturers of chemicals and pharmaceuticals, paper and paper size, printing ink, sealing wax, insulations and plastics, by shipyards, car shops, and so forth, and by makers of shoe polishes, soaps, and for miscellaneous purposes. There was a decreased use of turpentine by manufacturers of automobiles and wagons, linoleum, oils and greases, and by foundries and manufacturers of foundry supplies.

Stocks of rosin at the southern primary ports, distributing points and plants of industrial concerns were larger than they have been for the last two years, while stocks of wood rosin at steam distillation plants were smaller. Stocks of turpentine at southern primary ports, distributing points, and plants of industrial concerns were lower than for the last two years, but stocks at central distributing points were decidedly greater, as were also the stocks at steam distillation plants and destructive distillation plants.

Exports of turpentine reached a total of 16,940,179 gallons, showing an increase of more than 3,000,000 gallons, and there was a slight gain in the exports of rosin from the United States from March 31, 1929, to March 31, 1930, the 12-month period for which export and import figures for naval stores are calculated by the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Turpentine and rosin are among the most important products of a chemical nature exported from this country and show an increase in both instances over exports for the past three years. Imports of turpentine and rosin showed an increase over the previous year, due principally to further development of the industry in Mexico. Imports from France, which were probably at their peak in 1925 and 1926, have continued small. Mexican naval stores are imported mostly into Texas and southern California.

Traffic Signal Patented

A DESIGN patent for a traffic signal was recently issued to Paul P. Horni. In connection with this patent, he appealed the final rejection of the following claim:

"The ornamental design for a traffic signal, as shown."

The opinion of the board follows:

The references relied upon are the following: Meden, design, 58096, June 7, 1921; McOmber, design, 65349, July 29, 1924.

The application involves a design for a traffic signal.

The design comprises a group of four half cylinders arranged in spaced relation symmetrically about a common vertical axis, the cylinders having their flat faces presented outwardly. The half cylinders are united by circular plates at the top and bottom, said plates being provided with radial protuberances which connect to the half cylinders at the outer flat sides. Three lenses and hoods are placed on the flat sides of each half cylinder.

The principal reference relied upon by the examiner is patent to McOmber. This patent discloses the main housing of the traffic signal provided with four flat faces symmetrically arranged about a vertical axis, and the faces connected together by what appear to be somewhat concave walls. The patent also discloses a roof structure overhanging the housing and a base structure attached below the housing. Lenses and hoods are located on the flat faces.

Patent to Meden discloses substantially the same form of hood as in the present design.

The examiner has rejected the claim as not defining patentably over the McOmber patent, taking the position that there is no invention in removing the roof and base structure and modifying the form of the hood as shown by Meden.

It appears, however, that this is not the only thing that the applicant has done. If these changes be made the design would still have a different appearance. The McOmber patent fails to show the semicylindrical sections spaced around a common axis. In the McOmber reference the four faces are connected by somewhat concave plates leaving no spaces between them. The contour and configuration are different. When viewed from different angles it would have a distinctively different appearance. The design as a whole is symmetrical and ornamental and we believe is clearly patentable over the art.

The decision of the examiner is reversed.

Mechanical Goods Are Misdescribed

MISREPRESENTATION of mechanical articles is involved in two stipulation agreements signed recently by respondents with the Federal Trade Commission.

A motor appliance was said to be patented when it was not, while watches which had not been overhauled or reconstructed were advertised as "rebuilt."

Names are not revealed as is customary in stipulation proceedings, but the essential details are as follows:

(1.) An appliance for use in internal combustion motors is manufactured by an individual who advertised it so as to imply that the product is patented, which is not so. He agreed to stop this practice as well as to cease printing false statements on the carton in which his product is packed concerning the price or value of the article, and supplying customers with an article labeled with a false price known to be in excess of that at which it is usually sold at retail.

(2.) Signing a stipulation, a corporation jobber of fountain pens, pencils, watches, and novelties agrees to stop using the word "rebuilt" as descriptive of watch products which have not in fact been overhauled or reconstructed.

The company agrees also not to carry in its advertisements addresses of factories, and to discontinue employing the word "factories" in a way that would imply to buyers that the company owns or controls the factories indicated, wherein these watches are made, when such is not true.

Garment Trademark

IT was recently held by First Assistant Commissioner Kinnan that the American Maid Undergarment Company, of Chicago, Illinois, was not entitled to register as a trademark for ladies' and misses' gowns, bloomers, and so forth, a mark consisting of the representation of a young woman partially clad in an undergarment, seated before a dresser, beneath which appears the words "American Maid," in view of the prior use by the American Maid Company, of New York, New York, of a mark for the same class of goods which consists of the pictorial representation of the standing figure of a young woman clothed in undergarments and stockings, back of which figure is a black disk less in height than that figure, with the words "American" and "Maid" appearing on the right and left hand sides respectively of these features, and that the registration which had been obtained by the American Maid Undergarment Company under the Act of 1905 should be cancelled.

After noting that the petitioner for cancellation had taken testimony but the applicant had not, that that testimony established adoption and use prior to the registrant's date of filing and the only question therefore related to the similarity of the marks, he said:

"There is some showing that the petitioner has used its mark without the figure of the standing young woman but this is deemed immaterial. The use of the mark including the pictorial representation of the standing figure of the young woman is certainly not shown to have been abandoned. Both marks use the same distinctive notation, "American Maid," and the pictorial representations of the figures emphasize the meaning of this notation. It seems plain that customers would call for the goods by these words. It would be difficult to describe the marks, in calling for the goods, in any other way. . . .

"Being familiar with the petitioner's mark and seeing that of the respondent upon the same class of goods, customers would be led to suppose the variation in the pictorial representation merely indicated some particular or different kind of undergarment put out by petitioner rather than that it represented a different origin."

Priority Must Be Proved

THE trademark shown in the application of the Hawaiian Pineapple Company, Ltd., of San Francisco, California, and Iwilei, Hawaii, consisting of the words "Royal Palm" appearing between the pictorial representation of two palm trees is registrable over two prior registrations cited by the examiner but is so similar to the mark of the West Indies Fruit Importing Company, Registration No. 223,555, that it is not registrable to the applicant unless priority of adoption and use is proved.

In the decision handed down, after noting that the applicant had previously registered the words "Royal Palm" alone and also noting the statement of the examiner that when in the present application the representation of palm trees was included it gave the mark much greater similarity to that of the West Indies Fruit Importing Company and stating that applicant's mark was no more similar to two of the registrations cited than was the mark of the West Indies Company, the First Assistant Commissioner said:

"It is considered, however, to be plain enough that the applicant must be denied registration in view of the registration to the West Indies Company unless the applicant was the prior user of this composite mark including the words and the representation of the palm tree. Since the applicant alleges a date of adoption and use prior to that set forth in the registration of the West Indies Company and asks for an interference it is thought proper that such a proceeding should be instituted."

Wall Board Trademarks

IT was recently held by First Assistant Commissioner Kinnan that Bronston Brothers and Company, Inc., of New York City, New York, is entitled to register, as a trademark for wall board, calcined gypsum, and so forth, the notation "Flametex," notwithstanding the prior adoption and use by the Celotex Company, of Chicago, Illinois, of the term "Celotex" as a trademark for wall board and similar material.

The ground of the decision is that the marks taken as a whole, in view of the use by others of the notation "tex" in various marks, are not so similar as to be likely to cause confusion when used upon goods of the respective parties.

In his decision the First Assistant Commissioner, after stating that the marks are wholly dissimilar except for the last syllable, said:

"Viewed in their entirety, the common portion is regarded as such a minor part that confusion or mistake is deemed unlikely. Purchasers of goods of this kind may be distinguished from those who purchase small articles which sell for a few cents and such as are called for by servants and children, and ordered over the telephone. It does not seem that anyone who would purchase wall board would be at all likely to be deceived or misled if the two marks appeared in the same market upon these goods. The first and dominant portion of each mark is more likely to be noted by purchasers and the wide dissimilarity between 'Celo' and 'Flame' would seem sufficient guaranty against confusion."

He then stated that a number of trademarks ending in the syllable "tex" as previously registered for goods of this same general class had been noted, and that the Court of Customs and Patent Appeals in the case of the Apex Electrical Manufacturing Company *versus* Landers, Frary and Clark (not yet published)

* * * noted that "Prior registrations may be shown to prove that a word or symbol in a registered mark has so frequently been used in prior trademarks, registered or unregistered, as to make such word, as applied to particular goods, public property," but found in that case no such showing had been made.

Mr. Kinnan also held that the Chicago Panelstone Company, of Chicago, Illinois, is entitled to register the notation "Opal-Tex" as a trademark for ornamented wall board notwithstanding the prior adoption and use by the Celotex Company, of Chicago, Illinois, of the notation "Celotex" for wall boards and material of a like nature.

The reasons given for the conclusion reached are the same as those given in the decision of the Celotex Company *versus* Bronston Brothers, appearing immediately above.

Mechanical Feature Is Not Trademark

IT has been held that the National Stone Tile Corporation, of San Francisco, California, is not entitled to register, as a trademark for hollow tiles, a mark said to consist in a groove or depression formed in the transverse web and end walls of one side only of the tile.

The ground of the decision is that such a groove has mechanical function and is an integral part of the tile and consequently can not serve as a trademark.

In his decision, after noting that affidavits had been submitted by the officers of the appellant corporation that this depression or groove was adopted solely for trademark purposes, and noting further the argument that it is difficult to place properly on such articles a suitable trademark and calling attention to the patent to Nelson, 1,572,305, in which a groove, somewhat deeper than that shown in the trademark drawing, is placed in a tile for mechanical purposes, First Assistant Commissioner Kinnan said:

"It is evident that if the appellant obtained registration of its alleged mark the patentee could not manufacture the tile disclosed in his patent without infringing this trademark. While the appellant claims to have adopted this form of tile long prior to the date the patentee filed his application, yet if registration were granted, it is clear the appellant would in effect obtain a perpetual patent for a tile of this type, since a trademark registration may be renewed indefinitely."

And then, after stating that, whatever may have been the purpose in adopting the groove in this tile, such a groove would, when the tile is used, serve the purpose of ventilating the wall as well as furnishing a channel through which electric wires could be run, he continued in the following manner:

"It seems also quite probable that the purchasing public, even if it recognized that the tile is of a character made only by the appellant corporation, would not look upon the depressions or grooves as constituting a trademark. In connection with this holding, attention is invited to the decision in the case of Herz v. Loewenstein, 192 O. G. 993, 40 App. D. C. 277."

Oil Mark Refused

IN the case of Barstone Oil Company *versus* American Oil and Supply Company, Assistant Commissioner Moore held that the American Oil and Supply Company, of Newark, New Jersey, is not entitled to register, as a trademark for lubricants, the term "AmOviS" in view of the prior adoption and use by the Barstone Oil Company, of Chippewa Falls, Wisconsin, of the term "MorVis" as a trademark for the same goods.

The ground of the decision is that the marks are confusingly similar as applied to the goods in question.

In his decision, after noting the specific differences between the marks, the Assistant Commissioner said:

"As to sound, the two marks are regarded as confusingly similar when pronounced as they would be by the average member of the purchasing public.

"As to appearance, while on comparison differences would be observed, yet, when the two marks are carried in the memory, it is believed that those differences would be forgotten."

With respect to the applicant's argument that in view of prior registrations no one is entitled to a protection so broad as to prevent another from including the syllable "vis" in a dissimiliar mark and noting certain decisions, he said:

"I am of the opinion that the two marks, when considered as a whole, are confusingly similar to each other and that the rule applied by the courts in many cases to the effect that the newcomer should not adopt a mark closely approximating that of an earlier user should be applied in this case."

BOOKS SELECTED BY THE EDITORS

ASTRONOMY—*By R. H. Baker, Prof. Astron., Univ. of Ill.*

THIS is the latest in general astronomies. It gives one a start to find in a standard text book accounts of events that occurred, seemingly, almost yesterday. Various astronomers and special astronomical journals have given this book flattering reviews and even a partial reading of it shows why. It honestly deserves them.

There already were four good, modern astronomies—Fath's, Mitchell and Abbot's, Russell, Dugan and Stewart's, and Duncan's—each differing in length, depth, purpose, and appeal, each therefore needed today in the scientific book collection of the well-informed non-professional reader.

Baker's new book is quite large (6⅜" by 9¼"; 505 text pages) and is profusely illustrated. Some of the drawings explain better than words do, certain common beginners' "puzzle points," and the specialized works named at the ends of the chapters indicate careful selection. This is another invaluable aid to the isolated reader who, if he buys further reading matter, wants it to be *the* book on the subject and not just *a* book. The author's style is simple and direct, not the well-known eight-jointed-word or sesquipedalian style.—$3.90 postpaid.—*A. G. I.*

REPORT OF THE SMITHSONIAN INSTITUTION—1929

ANNUALLY the Smithsonian Institution selects from the whole English speaking world's scientific literature the most interesting papers of the past year and reprints them in a book which, if given a regular title like other books, would become a scientific best seller. Due to some technicality all this matter must come out each year as the "appendix," though an overgrown appendix (this year 452 out of 608 pages), of the Institution's Annual Report. Scientifically inclined readers who are "wise" to this exceptional bargain (the book if retailed would sell for at least five dollars) make a regular practice of getting these "reports" yearly. Obtain, not from SCIENTIFIC AMERICAN, but from the Superintendent of Documents, Government Printing Office, Washington, D. C. —$1.75, postage free.—*A. G. I.*

SONS OF THE EARTH—
By Kirtley F. Mather, Prof. Geology, Harvard University

READERS who wish to know the main facts of historic geology without studying all the detail of a standard textbook will find them ably and authoritatively presented in this 263-page, illustrated popular account of earth history by a well-known geologist. There are other popular books covering roughly the same ground, but what a difference there is between a book written by a man who really feels his subject and one written merely by a habitual "book writer" who attempts to translate available textbooks into acceptable language! The latter usually manages to give many false impressions which sadly warp the science he attempts to present, while the former not only "translates" but accurately interprets. This difference shows up to the advantage of the book under review; what it may lack in jazziness and "pep" it more than makes up in authenticity. —$3.70 postpaid—*A. G. I.*

INTRODUCTORY ECONOMIC GEOLOGY—
By W. A. Tarr, Prof. Geology and Mineralogy, Univ. Missouri

AN interesting presentation in as simple a manner as possible of a general picture of the earth materials used by man. The treatment of the formation of the more common minerals, their distribution, mining, treatment, uses, and so on, is clear and fundamental, making more than an elementary knowledge of geology unnecessary to a thorough understanding of the book. A fine reference for the private library.—$5.20 postpaid.

AN INTRODUCTION TO CHEMISTRY—
By J. A. Timm, Asst. Prof. Chemistry, Yale

FOR those whose major interest is elsewhere, yet who need the methodology and philosophy of chemistry, this book is especially prepared. It gives the scientific procedure as it has been applied in the derivation and testing of the fundamental theories and their application to the development of natural resources and to the problems of industry and daily life. The development of the theory from an historical point of view gives a broad summary which correlates the various advances. A cultural treatment quite different from the usual text.—$3.65 postpaid.

CRUSADERS OF CHEMISTRY—*By J. N. Leonard*

NO better description can be given than that in the foreword: "This book does not pretend to be a complete and inclusive history . . . nor is it a condensation. . . . It is a study of six men whose lives are red-letter pages in the history of science," Bacon, Paracelsus, Boyle, Priestley, Cavendish, and Lavosier. Far from being a dried recital of events and accomplishments, here we find ingeniously and interestingly developed, the human element with the political setting which in some cases forms an important aspect when viewing the just relation of pioneering in these various lines to the development of the sciences as we now appreciate them. A chemist with thorough scientific training relates history in a most fascinating style.—$2.90 postpaid.

PUNCHES, DIES AND TOOLS—*By J. V. Woodworth*

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By Prof. F. E. Austin

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By W. Bowden, Asst. Prof. History, Univ, of Pa.

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A CENTURY OF ATLANTIC TRAVEL 1830-1930—
By Frank C. Bowen

THERE has been a considerable addition to the literature on shipping appearing in the last three years, dealing especially with clippers, whalers, and Mississippi packet boats. The present author does not neglect the sailing ship, but he devotes most of his space, and rightly, too, to the steamship; and he has kept his treatment divided into decades. The subject is a fascinating one. Think of the problems involved: immigration, speed, luxury, and super-luxury. Think how records have changed. Think of the poor old *Mauretania* coming up Ambrose Channel passed by her snub-nosed sisters of German extraction (and construction), the *Bremen* and the *Europa*. We like to remember the days of the golden nineties when a first cabin passage could be had on the swift *Eutruria* for 60 dollars and the saucy *Arizona*, fresh from her iceberg-bucking experience, took you home again for 50 dollars. The story is all there in this book which gives the why and wherefore of combinations and other factors which might be called the financial background. We have looked in vain to find any transatlantic ship of any importance which has been omitted. It is a necessary book very well done.—$4.20 postpaid—*A. A. H.*

WHO'S WHO IN RAILROADING

A BIOGRAPHICAL directory of railway officials of America and others who, while not actually employed by railroads, are nevertheless quite closely affiliated and can be properly designated as railway men. Significant facts regarding business careers, personal information concerning families, social, religious, and political affiliations are given in detail to provide most adequate and satisfactory biographical portraits. 6 x 9, 579 pages.—$8.75 postpaid.

PRE-WAR AMERICA—*By Mark Sullivan*

THIS is the third installment of a remarkable series of books called "Our Times." It would not be far wrong to refer to this super-newspaper correspondent as an "American Pepys." He has a faculty of crystallizing manners as has been given to few people. His history is sound, his facts are accurate, and his way of telling a story is irresistible. The period might be called the "bunk decade" for this was the great period which ended the shameful insurance scandals and which let railroads earn an honest living by doing away with rebates and passes. The illustrations of costumes, even of so few years back, are side-splitting. Of course a large part of the interest in the book is that played by what ironical critics call "King Theodore the First." This altogether picturesque and sometimes lovable character is displayed man-size on a broad canvas. The chapter on "Pre-War Popular Songs" is one of the most alluring 92 pages we know of—15 per cent of the book. If we search the attics of our memory we can find few additions.—$5.25 postpaid.—*A. A. H.*

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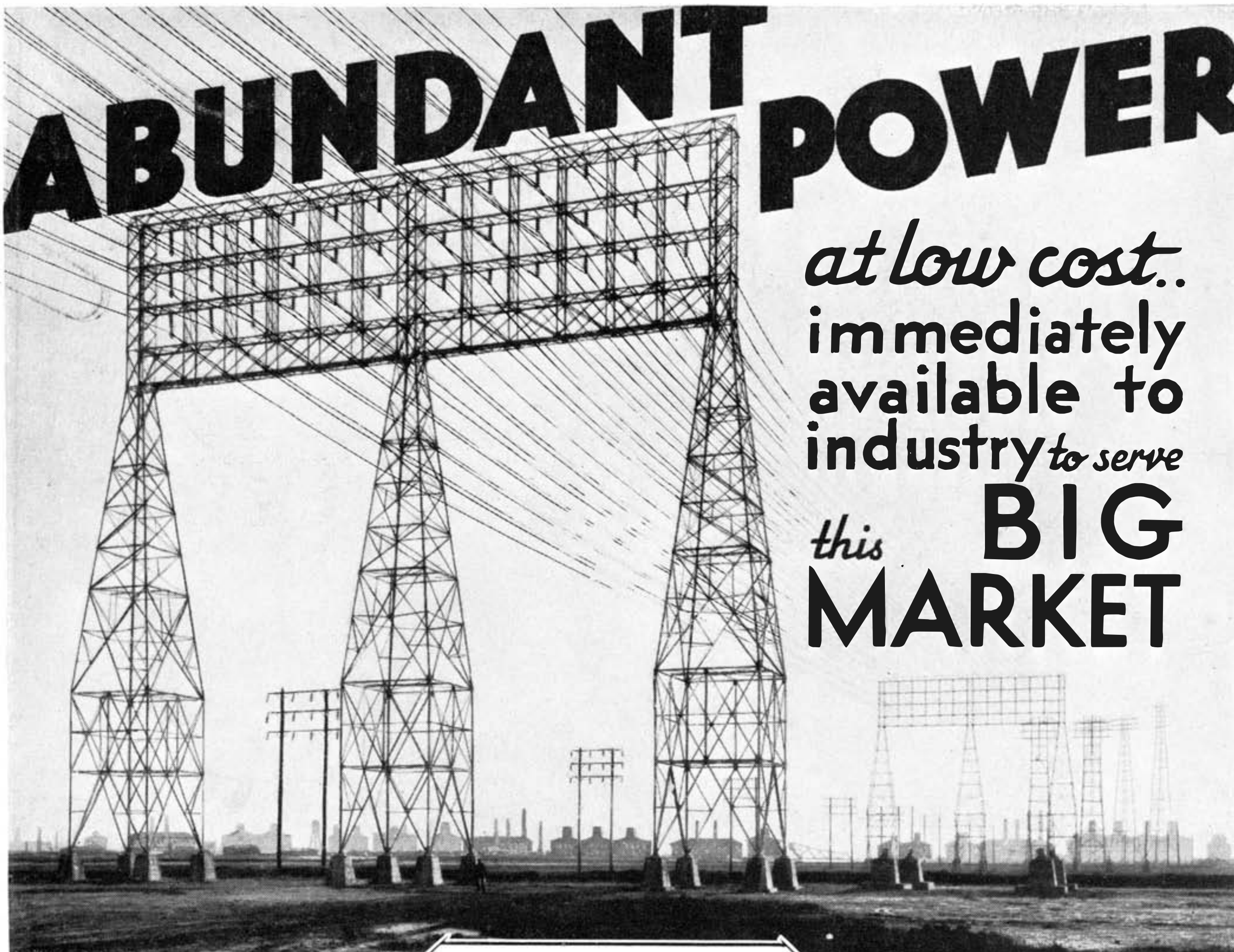

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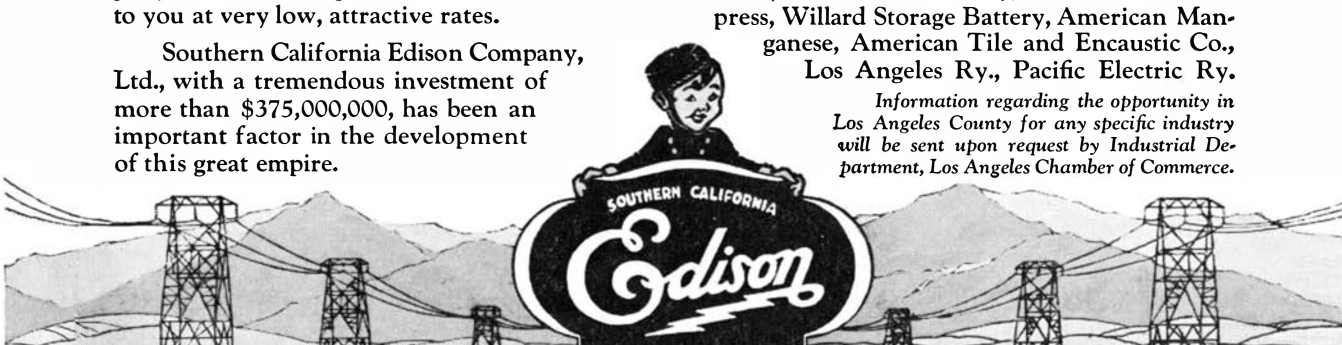

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