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SCIENTIFIC AMERICAN

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By Jacob Deschin

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MARCH
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The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

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NINETY-SIXTH YEAR • ORSON D. MUNN, Editor

CONTENTS • MARCH • 1940

THE peculiar object on our cover is a 16-inch astronomical telescope of the Hartness, enclosed, turret variety, permitting observation from within when winter winds or summer insects bite. It has a massive, slanting, concrete cap that rotates on rolls, carrying with it a diagonal flat mirror (here invisible), a concave mirror at the end of a framework, and a small opening through which the twice-reflected light rays enter the cozy interior. On the nearer side is a long steel counterbalance. The photograph was taken at Stellafane, mecca of amateur telescope makers, near Springfield, Vermont, by Robert Cox.

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50 Years Ago in . . .

Scientific American

(Condensed From Issues of March, 1890)

REFRIGERATION—"Our food supply has been largely increased by the application of apparatus for mechanical refrigeration to ships. Our frozen meat trade with New Zealand is of recent development, and it has already reached enormous proportions. At present twenty-seven steamers and ten sailing vessels, all fitted with mechanical refrigeration machinery, are engaged in this trade."

FIRE BOAT—"The city of Boston has recently built and put into service a fire boat, designed for use as floating fire engine . . . The pumps . . . are of vertical, duplex, double-acting flywheel type. They are divided into two sets, comprising altogether 4 steam cylinders, 10 in. by 10 in., and 4 water cylinders of 10 in. stroke and 9 in. diameter. . . . In the illustration a good idea is given of the service that such a boat can perform. In addition to the two four-inch streams thrown from her forward deck under perfect control, a number of lines of hose can be carried from the header, so as to deliver water to engines on shore. Thus the boat is not merely for the protection of the water front. Much useful service can be executed in a belt 2,000 feet wide around the shore line."

TORPEDO BOATS—"Messrs. Yarrow & Co. have recently completed six first-class torpedo boats of what is now reckoned the standard type. The boats are of galvanized steel, and are 130 feet long and 13 feet 6 inches broad. Their triple expansion engines will indicate about 1,150 horse power, and, with a load of 20 tons on board, will drive the craft at a maximum speed of rather over 23 knots, or nearly 26½ miles an hour."

AMMONIA FROM AIR—"The production of cyanogen directly from atmospheric nitrogen has been made the subject of further investigation by F. Breneman . . . which leads to the conclusion that while cyanides and ammonia may be thus produced experimentally, there are as yet insuperable difficulties in the way of adapting those methods to industrial purposes."

STILL WANTED—"Those who have spent a half hour or so trying to ring up a man at the other end of a telephone line, and have found out after much effort that there was no one there, would feel better if there was on the market something which would at once, when a box was rung up, give a signal stating that there was no one to receive a message, and how convenient if some attachment could be devised for communicating the time the person would return to receive the message."

SUEZ—"Night traffic on the Suez Canal has increased very rapidly since electric lighting was started. Thus in 1887 there were in all 371 night transits made, but in 1889 this number had increased to 2,454 out of a total of 3,420, or upward of 71 percent of the vessels passing through the canal, and four-fifths of the total tonnage, used the electric light to assist them. At the same time the average duration of the passage has been reduced upward of 40 percent."

HORSES—"The horseshoe of the present should be improved. There needs to be something which will save the hoof from undue wear and breakage, while at the same time permitting of elasticity of movement when the weight of the body is alternately borne upon and taken from it. It is suggested that an improved roadway is needed in this climate; something that will wear as well as stone, be as easy to pull on as asphalt and give the horses' feet a good grip, so that they will not slip even in rainy weather."

ALUMINUM—"The aluminum industry is on a firm footing, both in Europe and America. There have sprung up two distinct lines of manufacture; the one a chemical process, and the other strictly metallurgical. The former produces pure aluminum, and continues to be a complicated process demanding skill and patience. The latter produces only the alloys of aluminum, and has been made extremely simple."

PILLOWS—"The latest fad in England is paper pillows. The paper is torn into very small pieces, not bigger than the finger nail, and then put into a pillow sack of drilling or light ticking. They are very cool for hot climates, and much superior to feather pillows . . . The finer the paper is cut or torn, the lighter it makes the pillow."

WOOD AS FOOD—"In an address delivered at Heidelberg, by no less eminent an authority than Victor Meyer, it is announced that 'we may reasonably hope that chemistry will teach us to make the fiber of wood a source of human food.' . . . It must be borne in mind, however, that theory, fascinating and promising though it may be, is not always capable of being followed up by a practical result."

PHONOGRAPHS—"The Automatic Phonograph Exhibition Company, of New York City, has been . . . formed to manufacture, lease, use, and sell a nickel in the slot machine, by means of which the dropping of a coin in the slot will operate a mechanism which will cause a phonograph or phonograph-graphophone to produce the sound recorded upon its cylinder, and after such reproduction cause the diaphragm to return to its original position."

NIAGARA—"The Niagara River Hydraulic Tunnel, Power, and Sewer Company will now, it is stated, carry out its plan for utilizing the fall of water at Niagara, by building its main tunnel and connecting cross tunnels with wheel pits."

Personalities in Science

GEORGE R. HARRISON

PROBABLY few scientists have a closer personal acquaintance with the reticent and elusive atom than Dr. George Russell Harrison, Professor of Physics and Director of the Research Laboratory of Experimental Physics at the Massachusetts Institute of Technology.

However, Dr. Harrison seeks the intimacy of the ultimately small not merely for the satisfaction of studying the behavior of particles of matter, but to influence them to contribute to man's health, comfort, and prosperity. He knows them from the years spent in the windowless, constant-temperature, vibration-proof spectroscopy laboratory at the Institute, which, through his efforts, has become a center of research in atomic science

Several years ago, Dr. Harrison decided that the first step toward a closer relationship between pure and applied research in the application of atomic physics to industry was to learn much more about the language and customs of atoms, so that the scientist could distinguish easily among them both tribally and individually. As a result of his work, there appeared last fall the first volume of a series of new tables of spectral lines which contains the accurate, necessary data of the 110,000 strongest lines emitted by the chemical elements. Data on the fainter lines will appear in subsequent volumes.

Speed and accuracy in gathering these data were made possible by two ingenious machines devised by Dr. Harrison. Although he says modestly that he was driven to these inventions as a means of escape from old and tedious methods of achieving the same results, his accomplishments are none the less astounding. One machine measures and computes the wavelengths of spectrum lines, while the other, known as the interval sorter, determines the energy of atoms and molecules from their spectrum lines, and is capable of making 50,000 subtractions a minute.

For his "notable work in spectrum photometry and spectrum analysis," Dr. Harrison was awarded the Rumford Medals in October, 1939, by the American Academy of Arts and Sciences in Boston.

Opposed to the hoarding of scientific knowledge, Dr. Harrison has become a leading interpreter of research. His recent book, "Atoms in Action," is ample proof of his success in the popular interpretation of his work and that of his scientific contemporaries.

Born, raised, and schooled in Southern California, Dr. Harrison was graduated from Stanford University in 1919. He became an instructor in that institution and continued studies which led to the degree of master of arts in 1920 and doctor of philosophy in 1922. Soon after, he was named National Research Fellow in physics and studied two years at Harvard, after which he returned to the faculty of Stanford as assistant professor, later becoming associate professor.

He joined the staff of the Massachusetts Institute of Technology in 1930 and became director of the physics research laboratory when it was founded in 1932. During 1930-31, he also served as research associate at Harvard.

Dr. Harrison is a fellow of the American Academy of Arts and Sciences, the American Physical Society, the Optical Society of America, and the American Association for the Advancement of Science, and is a member of Sigma Xi, honorary scientific society, and the American Association of Physics Teachers. He was married in 1926 to Florence Bartram Kent.

PURE SCIENCE TEAMS WITH INDUSTRY

DR. John A. Hipple, Jr., of the Westinghouse research laboratories, with a new mass spectrometer built to sort molecules and their constituent atoms according to mass. Its outside portion consists of two hemispheres wound with water-cooled copper conductors designed to carry 300 amperes at 150 volts. The upper half of the coils hoists off. Inside is the actual spectrometer, which employs a vacuum tube in which ionized particles are differentially affected by the magnetic field. Practical applications: Basic knowledge necessary in the design and manufacture of fluorescent lamps and mercury-arc rectifiers, as well as neon and argon tubes.

To fight the hookworm science first fights ignorance. Hookworms enter the body through the skin of the feet, if bare

SILENT ENEMIES

Until Sanitation Becomes Universal, Man Will Harbor Internal Parasites and Suffer From Them . . . Worms . . . Worms . . . Worms . . . Worms . . . Inside Us

By BENJAMIN ADELMAN

MAN is a walking hotel in which more than 100 species of parasitic worms reside. These parasites lodge in his skin, in his muscles, in his lungs, in his intestines and in his brain, while several kinds swim through his blood. Perhaps he is victimized by more worm foes than any other animal, for no other creature relishes so wide a variety of food and drink, roams everywhere over the earth, has such an extensive contact with soil, water, and insects, in which worms lurk.

Every country in the world, therefore, is plagued by worm diseases and the United States is not excepted. Quite a big fraction of America is wormy. For example, about one million Southerners still have hookworm in spite of a 30-year campaign.

Even more common than hookworm is the well-known disease of trichinosis. William Wolf in his article, "Animals Bring Us Disease," in the May, 1939, issue of Scientific American, stated that 16,000,000 people in this country are infected with trichina worms. We can't look down on other countries for being worm-ridden.

The strangest class of parasitic worms are the tapeworms, and some of the most remarkable tapeworms are found in Americans. Consider the "fish" tapeworm, a wriggling, animated tape running to a length of 60 feet. It is not an animal as we understand the term, but a family of 3000 to 4000 individuals or proglottids that are linked together in a long chain. Each proglottid leads an independent life, contains organs of both sexes and produces eggs all by itself. This monster worm can lay 36,000 eggs a day! The young worms dwell in the flesh of the fresh-water fish of the Great Lakes which are shipped fresh by the millions every year to cities throughout the country. Probably thousands of people are infected with this dangerous worm, which can cause a very severe anemia. It is a serious health menace that has had much too little publicity. Tapeworm infestation is easily diagnosed, even in its early stages, by spotting the eggs or proglottids in the human wastes and thus the victims can be readily discovered.

The fish tapeworm is not a native. It was brought in by Europeans working in the lumber industry of Canada and the Mid-West. Through sewage the fish became infected and, since bears, dogs, and otters as well as man eat fish, eradication of the disease is now an impossibility. The best hope of control lies in educating the public to eat only thoroughly cooked fish.

Fish tapeworm infestation, like other tapeworm troubles, is best treated by carbon tetrachloride. One dose of the drug kills 70 to 80 percent of the worms. Carbon tetrachloride is the modern successor of a long line of anti-helminthics or worm-killing chemicals. One of the first, dating to the Middle Ages, was male fern. Many doctors still use the

extract of the roots. The chief disadvantage of male fern as a remedy is that the patient must be starved for 36 hours before being dosed, and few patients are willing to submit to such treatment. Carbon tetrachloride, on the other hand, can often be taken without preparation.

Trichinosis and hookworms are very common diseases but they may soon be surpassed in prominence by a little-known newcomer — oxyuriasis, or pinworm infection. Pinworms are home-loving parasites fond of bathrooms and fixtures, but for decades doctors dismissed them as a mere children's disease as trifling as chickenpox. Parasitologists knew that the pest was extremely prevalent, but for the most part pinworms flourished in safe obscurity until three years ago, when the United States Public Health Service started to investigate thoroughly America's most widespread parasite.

Every angle of attack — diagnosis, treatment, distribution, and, most important of all, the life history of the creature — was tackled and in three short years enough new facts were unearthed to establish pinworms as a medical problem.

THE first question the Health Service asked was simply, "How many people have pinworms?" Obviously, the whole population couldn't be examined, so the only feasible method was to take samples of the nation and from these estimate the extent of the disease. The Service's experts sampled Washington, the Nation's Capital, and discovered that, out of 2091 Washingtonians, 861, or 41 percent, were infested! Since pinworms appear to favor the cities, the rate in the country may be lower but it is possible, although not proved as yet, that pinworms may be far more prevalent than most doctors believe; and let it be remembered that pinworms can cause indigestion, insomnia, constipation, and have even been suspected of inciting appendicitis.

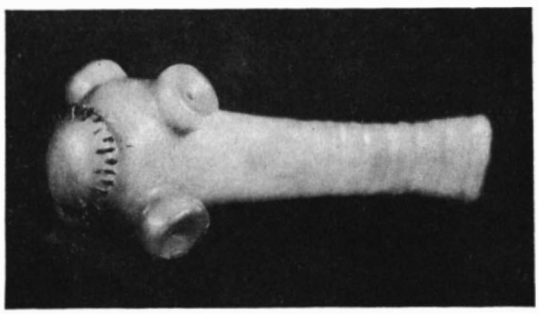
The ubiquitous pinworm achieves his success, not by hard work, but by a clever bit of strategy which sets him at the head of his class. Other intestinal worms lay their eggs inside the intestine; therefore their eggs are confined to the human wastes and can be distributed only by contact with them. Hookworm is the classic example. The pinworms, contrarily, crawl out of the digestive tract at night, and deposit their eggs on the skin. For as long as ten days the eggs may remain alive and in this period are scattered over clothing, bedclothes, furniture, bathroom fixtures, and even dry up and are wafted by the air currents to the walls and ceiling! Small wonder that pinworms run in families!

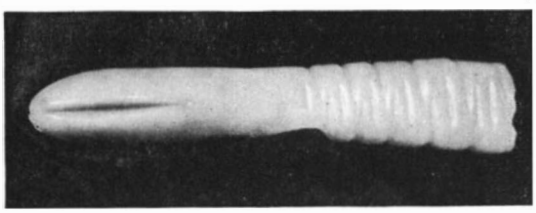
Yet that's only one difficulty. Give a hookworm victim an efficient drug which will rid him of 90 percent of his guests and he'll usually recover and overpower the rest, but eliminate 90 percent of a pinworm victim's parasites and the unlucky patient will shortly be as badly off as before — pinworms are persistent!

The most hopeful possibility of control lies in repeated treatments. The Public Health Service concluded that a course of daily doses for ten days would clear out the parasites and prevent reinfection while the pinworm eggs died out, and, after years of research, hit upon a very promising drug, tetrachlorethylene, which has cured 91 percent of a group of 122 test cases.

The most terrible parasite in this country, fortunately for the rest of us, is found only in a small group of Negroes of Charleston, South Carolina. These people are the prey of elephantiasis, the horror that swells the limbs or organs until they reach a tremendous size — hence the name.

In India, land of strange sights, elephantiasis sufferers are counted by the thousands. Unlike other worm diseases, elephantiasis is not caused by live worms since the living filarial worms in the patient's blood are harmless. Their corpses do the damage by blocking up the lymph ducts. These swell under pressure and then burst, flooding the lymph into various regions of the body. Sometimes the legs become so enlarged that it is impossible to lift them.





Courtesy United States Medical Museum

Above: **A model of the head of *T. salium*, the common tapeworm from pork. *Left:* Model of the head of fish tapeworm. Thorough cooking kills both of these kinds of tapeworms**

Like malaria, yellow fever, and dengue fever, elephantiasis is passed along from present patient to patient-to-be by mosquitoes. When the common tropical house mosquito, *Culex quinquefasciatus*, sucks a sufferer's blood, she swallows a few of the infant filarial worms, creators of elephantiasis. One day, about two weeks later, the mosquito bites another human but this time she gives as well as takes. The larvae slide down its proboscis into the bite. One bite is not enough, however. Only heavily infested individuals show symptoms and therefore the disease is confined to localities where many cases live close together.

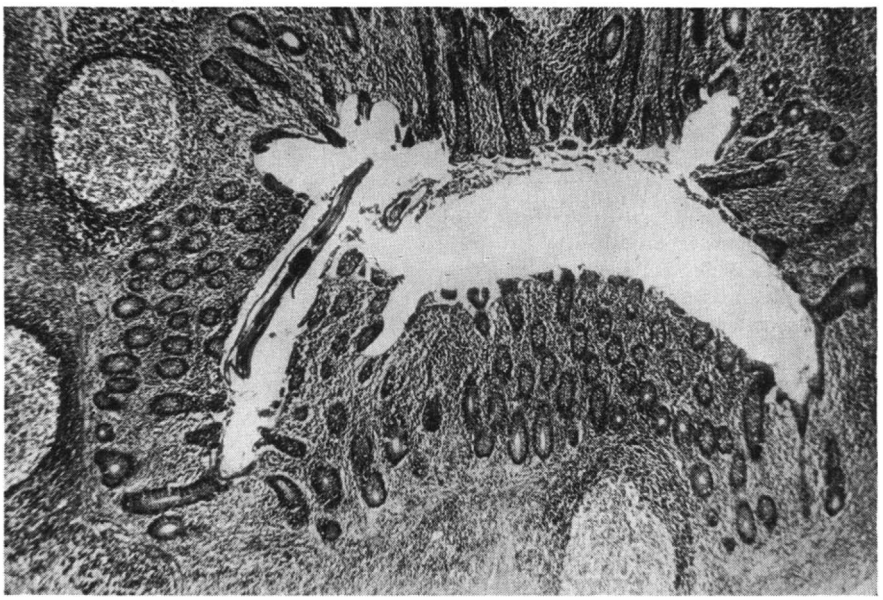
The filarial worms can tell time. As a rule the baby worms appear in the blood under the skin from about 10 P. M. to 4 A.M. but are almost completely absent during the day. For 40 years scientists have argued over the why and wherefore of this astonishing phenomenon. One group suggested that the embryos are long lived and hide somewhere in the interior of the body during the day, migrating to the surface at night, but this theory doesn't seem very likely. An embryo has about as much chance of remaining in a large artery as a man would have of swimming across the rapids of the St. Lawrence River. Furthermore, the patient's blood vessels would eventually become completely congested and his circulation would stop. And finally, why should the embryos hide from the prying eyes of the medicos?

An opposing theory says that all the mother worms give birth at the same time, once a day, every day, and that the infant worms live less than 24 hours. O'Connor found that in the morning the females were filled with embryos while about 2 o'clock all the young had been born. Now, *Culex quinquefasciatus*, the common tropical house mosquito, which transmits elephantiasis, bites only at night. It seems that the birth of the filarial infants is regulated by the habits of its godfather.

No sure cure for elephantiasis is known. Scattering the victims, however, is one method suggested for eradicating the disease.

In western India the people are attacked by huge guinea worms because, instead of drawing up water from their wells, they wade in to fill their jars. The huge three-foot guinea worm lives under the skin, only the very tip of her body protruding into a tiny ulcer. Whenever water touches the ulcer, the worm discharges a flood of embryos which swim right into the mouths of the nearest Cyclops, a tiny crustacean. The native swallows the Cyclops along with his drinking water and another human becomes a slave of the worms.

At first the patient is nauseous, vomits, feels giddy, has fainting spells. Attempts to extract the worm by native means may lead to blood poisoning, sometimes necessitating amputation. Doctors ex-



Courtesy United States Medical Museum

Pinworms from a human appendix, magnified 45 diameters. Your grandparents, especially your grandmother, who brought up babies, knew the pinworm ("worms"). Later, worms "went out of fashion" but now the United States Public Health Service has demonstrated that they are not to be laughed at

tract the worm in three sections by aseptic methods. Prevention is even simpler than cure but it will be years before the Indians can be induced not to wade around in their water supply.

In the Bible we read that Moses made the likeness of a "fiery serpent" and wound it around a stick to serve as an example to the people of Israel. The Elizabethean scholars who translated the Old Testament plainly didn't know their biology, for the "fiery serpent" is actually *Dracunculus medinensis*, the guinea worm. Even today native medicine men in Arabia and Africa often pull out the guinea worm by winding it around a stick.

THE oddness of worm diseases extends to the way they have been ferreted out. Sir Patrick Manson, the founding father of tropical medicine, once spent several years in China doing medical research. One day a Chinese visitor called on him and in the midst of conversation very rudely spat on the floor. As Manson stooped to clean up the mess after his caller had left, he noticed that the flecks of saliva were bloody. The excited doctor touched them with a slide, slipped it under a microscope and instantly identified a "new" disease—Paragonimus infestation which sickens millions of poor Chinese and Japanese.

Paragonimus is a half-inch long, leaf-like fluke that lives in human lungs, causing coughs, chest pains, and blood-tinged sputum. In fact, lung-fluke infection is usually distinguished from tuberculosis by discovering eggs in the sputum. Drugs are ineffective but transfer of the patient to a fluke-free locality enables Nature herself to heal the sufferer in five or six years.

The eggs spat out by the infested man hatch in water and once in a million times the embryo meets a little fresh water snail and burrows into its tissues. Passing through three bizarre transformations the young fluke emerges, crawls over the bottom of the stream or pond until it encounters a fresh-water crab, climbs up and pierces the leg joint, and buries itself in the leg muscles. The Chinese and Japanese unfortunately are fond of raw crabs. If they were to give up eating this delicacy, Paragonimus plague might disappear in a decade.

A similiar disease, caused by liver flukes, also troubles the Chinese. Here the chain of victims runs from carp to man to snail to carp. (Only a certain species of snail will do.) The willow-leaf-shaped, one-inch long parasite lives in the liver bile ducts where it can cause anemia, emaciation, diarrhea, and a fine case of cirrhosis of the liver. Khaw, a Japanese parasitologist, found that a dye called gentian violet would safely kill the worms. Prevention, of course, is obvious. As a matter of fact, the Chinese peasants themselves show how the disease can be eradicated. The flukes range over most of China yet the disease is confined to the vicinity of the cities of Canton and Swatow, *the only districts of China where raw fish is eaten.*

Eating infested food is just one means of acquiring parasites. In Australia, infested dogs disseminate a gruesome parasite, the hydatid. About two years ago, an Australian sheep rancher lost his little daughter because he was foolish enough to keep hydatid infested sheep dogs. They were dangerous to their masters, even though they weren't vicious, for they carried the seeds of death and these needed only the right environment to start their fatal career. Every day the dogs played with the little girl until one day she swallowed an invisible white speck, a hydatid egg.

Within four hours the egg hatched in the child's intestine and the infant worm penetrated an artery where the blood swept it to the brain in which it stuck fast. The speck grew until it was a hollow sphere or cyst the size of a golf ball, pressing relentlessly on the brain. Inside it was alive with thousands of infant worms.

As the months passed, the little girl complained of frequent headaches, then of failing eyesight. Later her memory and finally her strength declined. Once a lively, healthy child, she degenerated into a dull, paralyzed invalid. When her desperate parents brought her to the Melbourne Children's Hospital, it was too late. She died soon after the operation, a sacrifice to human ignorance.

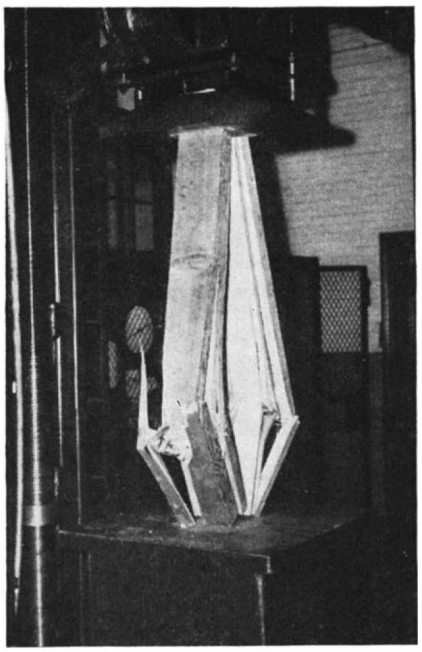
Hydatid cysts normally bulk no larger than an orange but they can expand to huge dimensions. In one case a cyst grew for 43 years until it was as big as a child's head. Another, the "monster" cyst, contained 11 gallons of fluid!

The rarest of all worm infections is also the most startling. *Dioctophyme renale*, the giant kidney worm, has been found a few times in human beings, in the process of autopsy. The worms usually occur in pairs, the female being about 40 inches long, the male about 10 inches long. They spend their lives in the kidneys, destroying the tissues until only a hollow shell is left and the victim dies of blood poisoning. Pleasant!

CAN the parasitic worms be defeated? The Rockefeller Foundation thinks so. In 1909 the Rockefeller Sanitary Commission was organized for the specific purpose of fighting hookworm in the deep South. The Commission made a survey of the hookworm belt and decided that about 2,000,000 Southerners had the worms. Within four years they treated 500,000 cases. Encouraged by their success, the Foundation extended its effects, establishing the International Health Board in 1913. The Board has fought the war against both germs and parasitic worms in over 30 countries. Their achievements have led to the establishment of national and health departments all over the world. Today in Egypt, in India, in the Philippines, in Africa, even in war-torn China, the doctrine of sanitation which stamps out parasites wherever it is applied, is being taught to the people. Clean food, pure water, cleanly personal habits—all these slash the routes by which the worms gain access to the human body. As the great Robert Koch once said, "It is possible for man to wipe out all infectious diseases." Universal sanitation will make Koch's prophecy a reality, for most of mankind has still to achieve a decent standard of cleanliness.

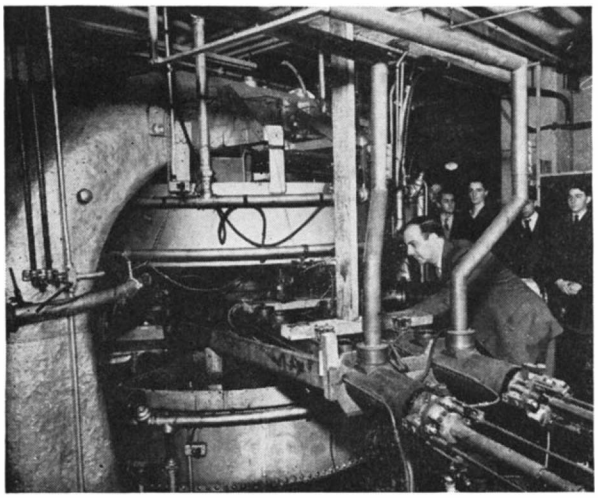
'Open House'

MEN of science of Columbia University recently staged an "Open House" session, to which the public was invited to inspect the various laboratories. Through the courtesy of *Science Observer*, official organ of The American Institute Science and Engineering Clubs, we reproduce on this page illustrations of some of the more spectacular laboratory equipment that was demonstrated.

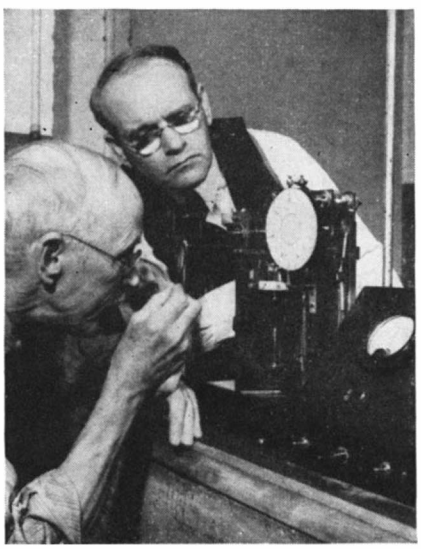


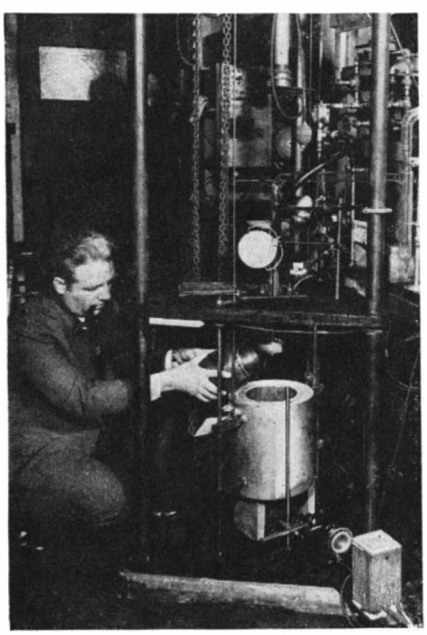
Determination of the forces necessary to shatter wooden posts (for example) gives data of value to construction engineers and others. The machine shown above, capable of exerting a force of 600,000 pounds, is splintering an eight- by eight-inch fir post at a pressure of 155,000 pounds

Right: Rear view of the cyclotron in the Pupiu Physics Laboratory. This tool of science is used to produce beams of high-speed ions which, when they strike targets of various materials, produce effects that give physicists new insights into the problems of atomic structure and behavior. With cyclotrons, transmutation of elements has been achieved, and radio-activity has been synthetized

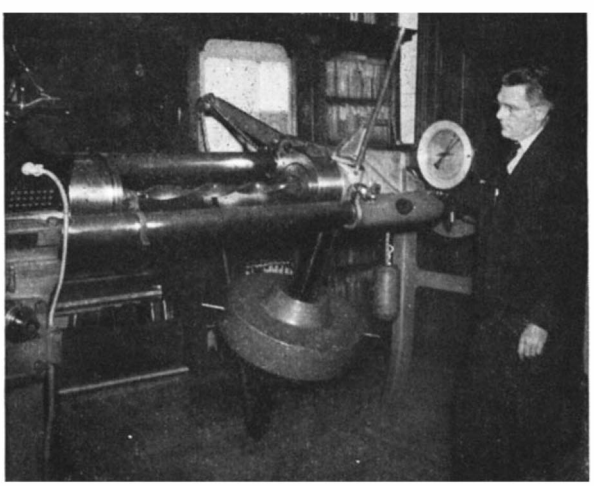


Below: With the ultra-centrifuge it is possible to subject small quantities of materials to immense stresses and to study photographically the effects. The rotor of the centrifuge is supported on, and driven by a current of air and can be revolved at such a speed that materials on its periphery are subjected to centrifugal force that equals 250,000 times the force of gravity. As the rotor spins, light is directed upward through it. Since the container for the material under study is transparent, the light going through it makes it possible to take instantaneous photographs at each revolution and thus determine effects of high rotational speed





Left: In a sub-basement, mounted on bed-rock to eliminate vibration, is a small piece of equipment built with the same accuracy as is observed in the construction of fine watches. It is used to test the value of lubricants in the following manner: A measured coating of lubricant to be tested is transferred to the surface of a polished metal disk from an absolutely level surface of water where the lubricant has been allowed to spread into a layer one molecule thick. A ball-shaped sapphire is now carefully adjusted on the oil layer that covers the metal disk and the disk is rotated. Pressure is applied to the sapphire ball until friction causes the ball to drag. When this happens, an indicator on the machine registers the fact. From the data so obtained can be calculated an index of lubricating properties of the oil



Right: A torsion machine in the Civil Engineering Laboratories determines how much twisting a piece of material will take before it breaks or loses its elasticity. Bars, rods, or flat strips of any material may be subjected to torsional stress, the indicator showing the load applied

OUR POINT OF VIEW

Whose Fault is it?

IN an outstandingly notable discussion of "The Scientist in an Unscientific Society," published in our June, 1934, number, Secretary of Agriculture Wallace raised a question which since then has been the subject of a great deal of debate in scientific circles. The question was "whether science, having demonstrated its power to transform the world, ought not have some responsibility, or at the very least, some interest in the social consequences of its handiwork." For example, science gives us high explosives, thinking only of the solid engineering work they will afford, and society perverts their uses to those of destruction: war. The scientist learns the technology of gases; others use this knowledge to maim and kill. No sooner is the airplane perfected by science than others turn it into the world's nightmare.

Science, according to Mr. Wallace, proceeds without moral obligation, and is neither moral nor immoral. "I should like to find our more articulate scientists," he says, "insisting that the benefactions of science be used only in ways that are plainly in the general welfare. The orthodox scientist either withdraws to his cloister, to mutter about the stupidity of mankind or, if given to public utterance, to indulge in an amazingly unscientific statement of a variety habitually used by the politicians he scorns." Science has been creating another world and another civilization, he adds in summary, that simply must be motivated by some conspicuous social purpose, if civilization is to endure.

From one of our readers, Mr. Arthur Jobson, has come a letter which, though not so intended, constitutes essentially an editorial reply to these arguments. We turn the column over to Mr. Jobson.

"Nearly six years have passed since Secretary Wallace's challenge to the scientist," he writes, "and, while this time is brief compared with the slow processes of social evolution, there has been time for the matter to ripen somewhat in our minds. That his views are still held by many laymen is evident. As an instance, I recall the comments of a noted newspaper writer who visited the New York World's Fair last year. This man said, in substance, that everything is there which demonstrates how man, with his capacity for precision and beauty, retains a preposterous incapacity to enjoy the fruits of his genius—to be as wise as he is intelligent, and to be as good as he is great. Though he has learned to do the vector analysis in mathematical physics, he cannot add and subtract in political economy. He can calculate the fineness of a machine to a millionth of an inch, but he cannot balance a government budget. The general implication is that science is much to blame for this, as Secretary Wallace has stated.

"Being an engineer and somewhat of a scientist myself," Mr. Jobson continues, " I am often amused at these outbursts. It is of course galling to think of the great advancement we have made in science, invention, and engineering while we have made so sorry a mess of our economic life, but these critics seem to forget that in matters dealing with a social system we are confronted always by the vagaries of humanity, entirely remote from the scientific approach. The politician and would-be social reformer, having failed to put our economy in order, tend to clutch at a straw. They reason that, since the exact mind of the scientist has attained great success in his chosen field, why shouldn't he be able to cure our social ills?

"I have a feeling that this would be impossible—this Utopia in the affairs of men. It cannot be done, for surely it would mean the most exacting kind of totalitarian state.

"No government can rise higher than its source. So long as this source is contaminated by human traits, we must expect the social body to suffer. The man trained in science, in endeavoring to correct this situation, would find most of his efforts of little avail, for he is vastly outnumbered by the rest of the population."

In our opinion, Mr. Jobson hits the nail on the head: science can plead and urge, but until man can remake his nature, the scientist's hands are practically tied. He is like an individual in a big cage of baboons, who occasionally discovers choice morsels: his chances of retaining control of those morsels is about on a par with the chances of the famous Celluloid dog. Nevertheless, he is essaying a start. Knowing well that he has no effectual direct way to hold off the other baboons, he has organized groups, both in this country and in Britain, for the study of indirect ways. These consist essentially of education and moral persuasion. Nothing stronger can be envisioned. And thus all he has to do is make a clean sweep of the three human lusts: for power, prestige, possession. A large order!—*A. G. I.*

Rising Intelligence

SOMETIMES we are in despair for the intelligence of the American people. But not now. For years a vociferous minority swayed the people with its propaganda for disarmament; and the people would not permit proper naval building programs. The times have now demanded a change of attitude. Before, it looked as though the people would never draw lessons from our past history which shows one war after another without preparedness. Assurance of proper preparedness to keep us out of war is seen in the current attitude of the American public as well as in present Congressional action. Even the professional pacifists have now taken up the cry for building up our defenses, even as Scientific American believed they would during all the years this magazine was urging that we prepare in times of peace.

Americans are insistent that we stay out of the present war abroad. Leaders agree to that dictate whole-heartedly. They agree also to the principle of making our military position as impregnable as possible. Hence, with a great naval building program now under way, we plan a further one which would increase our Navy by about 25 percent. This will mark a new high point in our naval construction which has moved upward rapidly during the last seven years after years of idleness in most of our yards.

Against this background, one important fact stands out. That is that naval design did not suffer so much from lack of orderly evolution as most people read into the record merely because we were not actively building ships. The drafting boards and the towing basin—where hulls are studied—the steam laboratories and general navy research were none of them as idle as the yards. In consequence, we can build ships that are as good as any afloat. Indeed, in some respects, our ships may be superior to the ships of other nations. And there is little doubt that we shall learn other lessons from the present war abroad, which, added to our present naval knowledge, will carry us far toward a navy so superior in design, operation, and general efficiency, and so powerful in its aggregate fighting ability that it will tend to prevent unwanted war from descending upon us.

And that brings us back to our first paragraph. The American people want to keep out of war and at last are using their intelligence to prepare in times of peace to make sure that we do keep out—or to assure quick disaster to any who may drag us into war against our will.—*F. D. M.*

New Engineering In The Navy

High-Pressure, High-Temperature Steam for Warships . . . More Reliable Machinery . . . Greater Speed . . . Economical . . . Equipment for Our New Warships

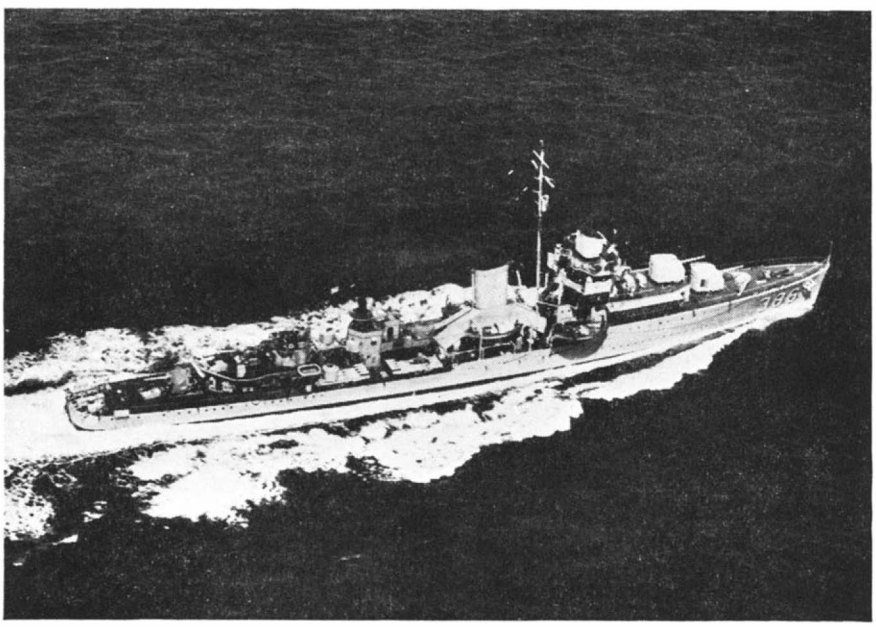
By CHARLES EDISON
Secretary of the Navy

THE new ships of various types which have joined the Fleet embody many advances and improvements in the fields of naval architecture, marine engineering, and naval ordnance. The result is increased military effectiveness. Modern warships are perhaps the most ingenious and complicated machines yet produced by man. From this fact it logically follows that any change must be well considered. But, in view of the long time required to build naval vessels, there must be a delicate balance between conservatism and adoption of advanced ideas if we are to have the maximum of military efficiency in a new ship when it comes off the building ways. This delicate balance we have striven to maintain.

An important factor in this military efficiency—where such a balance is necessary—is the machinery installation. It has been recognized for generations that we could reduce the size of our machinery and increase its efficiency if we could increase the pressure and the temperature of the steam. Such increases, however, had to await advances in metallurgy that would provide metals to withstand high-pressure, high-temperature conditions.

The Navy did not make the step to the present steam conditions in one leap, but has advanced in a series of conservative steps, raising pressures from 200 to 300 to 400 to 450, and then to 600 pounds, and increasing the superheat gradually. In fact, the last change was only from 600 pounds, 700 degrees, Fahrenheit, to 600 pounds, 850 degrees, Fahrenheit. These steps have lagged behind commercial practice ashore where 1200 pounds and 950 degrees, Fahrenheit, is not at all unusual for new installations; nevertheless, they have been enormously important, and a portent of others to follow.

NOW that the United States Navy is well launched upon a sensible construction program, Secretary Edison's article brings welcome news to Americans. Speed is vital to warships. If, on a given hull, more power can be installed, a greater capacity for speed results. If, moreover, the machinery is more compact and reliable than before, the result is greater military efficiency in several phases of the ship's design. The Navy is to be commended, therefore, for its persistent attack on the problem of ship power generation and propulsion which has culminated in the development of machinery that gives better speed and economy and is more reliable than older types.—*The Editor.*

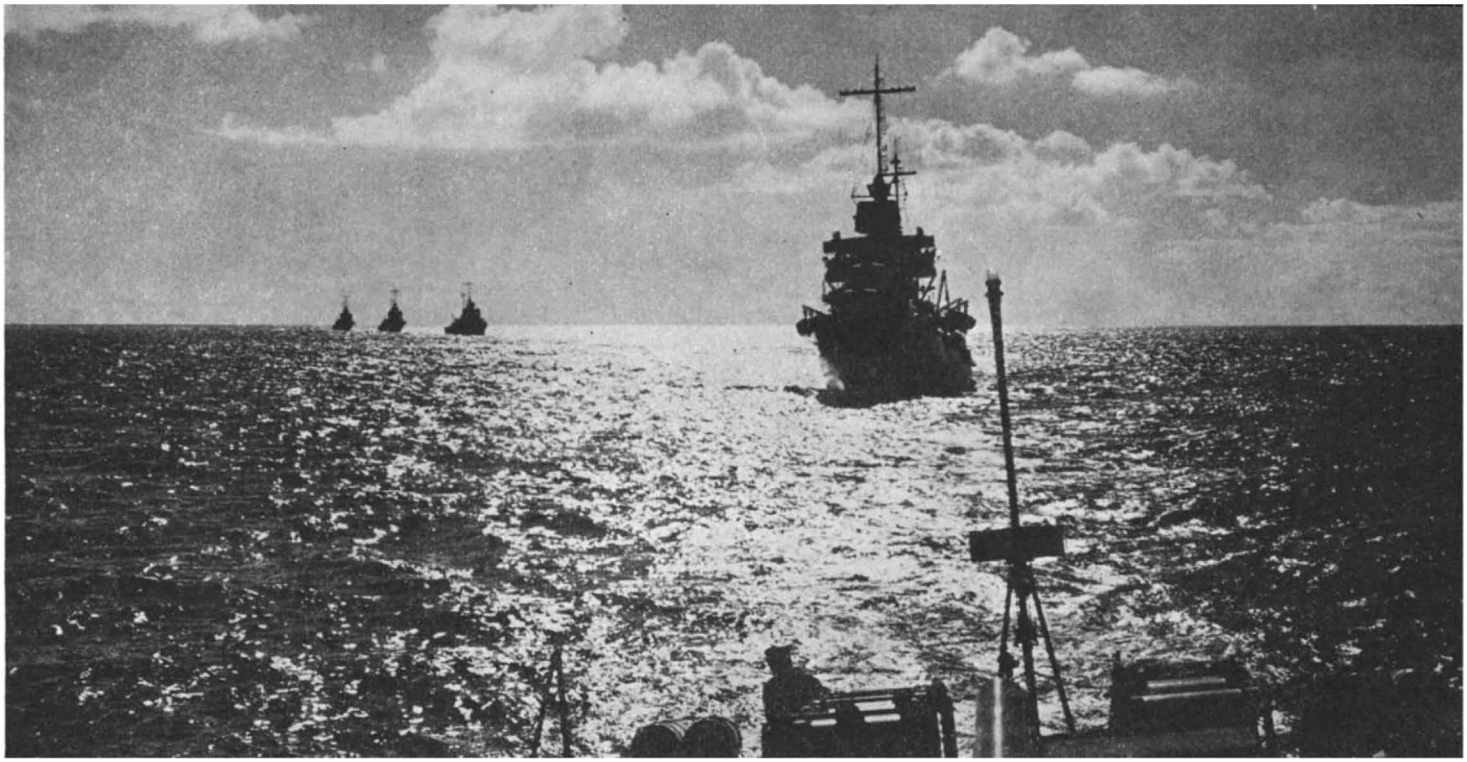


Speedy and highly maneuverable destroyers are vital to fleet actions

One of the first decisive steps taken in connection with the current building program was to serve notice to all prospective bidders that no contract would be awarded for the design or construction of naval vessels that would be out of date the day they were launched due to ultra-conservative design of main machinery and boilers. One of the by-products of this new policy has been to direct the shipbuilding industry of the country toward the development of an all-American design.

IN 1933, the Navy Department contracted for a number of destroyers. Into these ships went a distinctive American engineering installation consisting of high-speed turbines, double-reduction gears, an improved boiler feed system and a cruising turbine that is constantly in gear. The double-reduction gear permits utilization of higher turbine speeds with attendant increase in efficiency. High turbine speeds have reduced the number of turbine blades by 75 percent and the length of the rotor by 25 percent. The feed water of a modern, high-capacity, boiler installation requires the virtual elimination of oxygen in feed water. Due to the fact that the design was one of the major advances in naval engineering since the introduction of the turbine, some congestion in the engine rooms resulted. This design, however, showed an increase in fuel economy of about 25 percent with a corresponding increase in cruising radius. The first of these ships was delivered in 1936 and probably represents the greatest progress the American Navy has made in engineering in a generation.

This class of destroyers—the *Mahan* class, started in 1934—was followed in rapid succession by other modern destroyers in which were incorporated the same fundamental design features as had appeared in the *Mahan*, and in addition thereto, superheat control type boilers.



Photographs: Official, U. S. Navy

Destroyers of the Fleet participating in recent maneuvers held off the California coast

In the fall of 1937, the *Somers*, one of the destroyer leaders, ran her preliminary trials with exceptional results. In comparison with competitive designs, she showed an improved economy ranging from 9 to 22 percent when operating at 700 degrees, Fahrenheit. The *Somers* was the first vessel in the Navy to operate at 850 degrees, Fahrenheit, and when operating at that temperature increased her economy another 10 percent and increased her developed horsepower by 10,000. She was the first ship to be equipped with air-encased, separately controlled, superheat boilers.

As a result of the success with the *Somers*, all battleships, cruisers, and destroyers are being built today to operate at 600 pounds and 850 degrees, Fahrenheit; and so will be all the battleships of the present building program.

It is apparently no more difficult to train men to operate the new plants than it was to train them to operate the old ones. On recent trials of a destroyer operating at 600 pounds, 850 degrees, Fahrenheit, one of the outstanding comments of all observers concerned the smoothness with which the crew operated that installation and controlled the temperature. In fact, when it was desired to drop the temperature suddenly, on backing, it was changed from 850 degrees, Fahrenheit, to 700 degrees, Fahrenheit, in 40 seconds without difficulty.

The new machinery has been of equal or greater reliability than the old type machinery. This might have been expected, as old factors of safety have been maintained, or even increased, and the general design of high-speed turbines with small, comparatively short rotors, is more rugged. Service with the Fleet, of course, is fairly limited, but reports to date indicate that, as to reliability and maintenance, the new machinery is equal or superior to the old.

Taking any given ship and operating its machinery under two sets of steam conditions, gives some indication of the relative merits of the two steam conditions, but that indication is not as clear cut as might be expected. There are two reasons for this. The high-pressure, high-temperature steam goes only to the main propulsion turbines—with the possible exception of turbo-generators in some cases. The result is that at very low powers, say below 5 percent of full power, the auxiliaries take such a large proportion of the total power generated, that the effect of the high-pressure, high-temperature steam in the main turbines is masked. Moreover, all turbines at very low powers—for example, below 5 percent of full power—are relatively inefficient and do not reflect much change due to steam conditions. Nevertheless, at high powers, where the auxiliaries are not taking such a large proportion of total power generated, and the main turbines are able to take advantage of improved steam conditions, the improvement is shown very clearly.

TWO typical examples of such tests were the ones of a cruiser and of a destroyer. Trials of the cruiser were run with saturated steam and then repeated at the same pressure, but with the steam temperature raised about 200 degrees. At very low powers, below 5 percent, there was no appreciable difference in over-all fuel consumption between the two conditions, but at high powers—for example, 60,000 shaft horsepower—the higher steam condition made a saving of 12.2 percent in the fuel consumption for the ship as a whole.

The destroyer was tested on two steam conditions, namely, 600 pounds pressure in both cases, but 700 degrees, Fahrenheit, temperature in one and 850 degrees, Fahrenheit, in the other. Again at very low powers—below 5 percent—the over-all fuel consumption showed very little improvement; but, on operating at full power, a saving of over 14 percent was effected. In fact, under the higher steam condition, the ship actually developed about 10,000 more horsepower than designed at the lower steam condition. This extra 10,000 horsepower would mean that the ship could maintain its battle speed even with very much more bottom fouling than would be possible at the lower steam condition.

A better comparison of the effect of changing machinery and steam conditions is indicated when we consider what would happen if we put the complete machinery from one existing ship into another hull. For example, the machinery of either of a certain two of our new destroyers could supply the power of a certain one of our cruisers which, though new, did not have such advanced machinery design. The trial data of both the cruiser and the destroyers indicate clearly that if we should put destroyer type machinery in the cruiser, we could save 18 percent in cubic feet of space and 29 percent in the machinery weights, while making a gain in economy of 13 percent at full power, this gain increasing to 28 percent at a more moderate speed of 10 knots. Moreover, such data as are available indicate that the destroyer machinery is more reliable.

In short, as we have advanced steam conditions, we have developed machinery which is not only more economical, but is also more reliable and just as easy, or even easier, to operate, maintain, and protect in battle. The advances to these conditions have been by short, conservative, well tested steps, and the Navy has gained thereby.

A Famous Theory Weakens

The Encounter Theory of the Origin of Planets Has Now Become Shaky and May Pass into the Limbo Where the Old Nebular Hypothesis Went

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

THERE are few more difficult problems than the origin of our planetary system. Its isolation, and the common motion of the Sun and planets through space, practically compel us to suppose that they had a common origin. It is incredible that the many regularities within it — such as the motion of the planets in nearly circular orbits, all in the same direction and in nearly the same plane — can have been the result of accident. We look for some orderly process which might have produced it — but, so far, the inventive skill of a century of astronomers has sought in vain.

One encouraging hypothesis after another has been suggested, only to collapse before some simple and unanswerable objection. Most of these, as many of us may remember, were dynamical, and dealt with the angular momentum — or to paraphrase Newton, the "amount of rotational motion" in the system. No actions between parts of the system, once it is isolated, can alter the total amount of this — they can only transfer it from one part to another.

Laplace's original hypothesis was that the system was originally a great nebula, bigger than any of the planetary orbits and much flattened at the poles by its rotation. As it contracted, it rotated faster and faster, shed a ring of matter at its equator, which gathered into a planet, then later shed another, and so on till the remaining central mass shrank into the Sun.

But, at present, only one part in 60 of the angular momentum is in the Sun's rotation, and the rest in the motion of the planets. No one has ever been able to suggest an orderly process by which, in a system undisturbed from without, more than 98 percent of the angular momentum could get into one seventh of one percent of the mass. Moreover, Jeffreys and others have proved that a ring of matter equal in mass to even a large planet like Jupiter, but extending all around its orbit, would not be gathered into a single mass by its gravitation, though it might well break up into a number of small bodies like asteroids.

So this hypothesis went into limbo, and another took its place — the encounter theory. According to this, once upon a time another star, in its course through space, passed by accident very close to the Sun. The original form of the hypothesis (due to Chamberlin and Moulton) assumed that the star's attraction released eruptive forces within the Sun which ejected great quantities of matter, some of which cooled into big masses and the rest into innumerable little ones — "planetesimals" — which were picked up by the bigger ones as they grew into our present planets.

Later forms of the hypothesis attributed the expulsion of matter from the Sun to the tidal attraction of the star (Jeans) or to a direct collision between it and the Sun (Jeffreys). The last meets with the fewest dynamical difficulties, and gives us a picture of the two stars separating after the collision, but joined by a "filament" of matter resulting from the intermixture of the parts which actually collided. A mixture composed almost wholly of solar material would be moving slowly away from the Sun and later fall back into it; similar material would accompany the star; but there would be some fairly uniformly mixed portions which would not fall back into either one. Some of this stuff might escape into space — the rest would be good raw material for planets.

Angular momentum again turned out to be a stumbling-block — this time angular momentum per ton of material. The ultimate size of a planet's orbit depends on this. Calculating it for material knocked off the Sun by a collision, it comes out too small to get a planet even as far away as the Earth. So we seemed to be back where we started. But soon afterward, Lyttleton flanked the obstacle by suggesting that the Sun may once have been a double star, and that a visitor from space collided with its companion. Under favorable circumstances, the intruder might send the former companion flying off into space by its attraction, without being itself retarded enough to be captured by the Sun; and yet a part of the filament of matter between them might remain within the Sun's sphere of influence and form planets.

THIS gives us planets at any distance from the Sun that we want, and escapes the last difficulty. But Luyten has shown that the conditions required to let both the former companion of the Sun and the intruding star escape, and yet have planet-forming material which did not get away, are extremely difficult to fulfil; and the question is still in debate.

The objections which have so far been raised to the various forms of the encounter theory are purely dynamical. They depend on simple consequences of the law of gravitation, and could have been discussed as intelligently in the days when Neptune was discovered as at present.

But, even if all these difficulties had been fully removed, there would remain others, different in character, but quite as serious. One of these is that the matter ejected from the stars, whether by tidal action or collision, must at the start have been extremely hot. There is no sense in thinking of it as having about the temperature of the Sun's surface. A very simple calculation shows that, if enough material to form Jupiter were spread in a uniform layer over the Sun's surface, the pressure at the bottom, due to solar gravity, would be 880,000 atmospheres, and the average pressure throughout the layer half as great. At a depth where there was such a pressure, the temperature would also be very high. To estimate it accurately, we would have to know how the outer parts of the Sun were built; but there is no doubt that it must be several hundred thousand degrees. If this intensely hot gas were pulled out of the Sun by tidal action, it might be cooled somewhat by expansion, but if it were scraped off by a collision, the friction between the intermingling solar and stellar gases would heat the mixture to a far higher temperature.

If the filament of gas connecting the two stars remained anything like as hot as this, the velocities of the separate atoms would be much too great for the relatively weak attraction of the ejected matter to hold them back. They would fly away separately and the gas would dissipate itself into space. This has been realized for 60 years. But the

gaseous mass, radiating freely into space, would also cool very rapidly, which would slow up the atomic motions, diminish the internal pressure, and tend toward stability. In this race between expansion and radiation, which would win?

This is a problem not of dynamics, but of physics, and would have been unanswerable without the aid of modern knowledge of the laws of gas opacity.

If the ejected mass of gas were nearly transparent, so that heat could escape freely from its interior as well as from its surface, it would cool very rapidly — giving out at first a tremendous burst of remote ultra-violet light, and then settling down, perhaps to condensation. But if we consider such a layer while still in the Sun, we find that radiation can escape directly from only the thinnest kind of surface skin containing less than a millionth part of its whole mass.

The difficult problem of the behavior of the filament after its formation was attacked for the first time by Dr. Spitzer —a National Research Fellow at Harvard — and his results, just published, afford a definite answer.

To get the problem into mathematically tractable form, he has of course to make simplifying assumptions, treating the filament as a uniform cylinder in shape, and taking average values of the pressure, and so on, in the interior. It is possible to handle these approximations so that we are sure that we are not getting too small an answer — or too large, if we proceed differently.

Working in this way, Spitzer finds that, if no heat were lost by radiation, a filament of 1/500 of the Sun's mass, and a million miles long, would expand into a state in which the separate atoms were flying off so fast that the attraction of the filament could never bring them back in less than three hours. A better approximation, taking account of the fact that the filament must be growing longer as the stars separate, reduces the time to half an hour.

To calculate the rate of cooling is more difficult, but, for the same circular filament as before, it is found that direct escape of heat takes place only from a very thin outer skin, and that, if the filament could be held at its initial size by some imagined force, it would take at least a year to get rid of half its original content of heat.

THE disparity of these two numbers is so great that there is no room for doubt that an actual filament of gas would expand so fast that it could never check itself, long before cooling produced any perceptible effect. Straining every assumption in favor of the cooling process, Spitzer finds that it must, in the most extreme case, take more than a hundred times longer than the expansion. To assume that the original filament was flat like a ribbon instead of circular in section makes the disparity even greater.

This analysis — the first in which modern physical methods have been applied to the problem — looks as if it would send all the forms of the encounter theory to Valhalla. There is still one unexplored consequence. The filament would fade away by expansion; but the gases of which it had been composed must go somewhere. Part of them would fall back into the stars; part, near the middle, would be left wandering as lonely atoms in "the wind that blows between the worlds"; but the rest, and probably a good deal, would settle down into a gaseous atmosphere about the Sun, and another about the retreating star. These envelopes would not be held up by pressure from below, like the Earth's atmosphere; they would be in rotation about the Sun — an immense swarm of atomic asteroids, if the phrase may be pardoned — colliding with one another every few hundred miles, bouncing off into new paths, but, as a whole, forming an enduring gaseous shell.

Whether such a non-uniformly rotating atmosphere could condense into solid bodies has not yet been investigated. If it turns out that it could, the encounter theory may yet be revived — for the requisite angular momentum is there.

It is very hard, though, to see how most of the mass could be concentrated into a single large body which, like Jupiter, is rich in hydrogen. Those atoms or molecules which absorbed sunlight strongly would be driven away at once by radiation pressure; the others, which scattered light weakly, would be subject to the effect worked out by Poynting and Robertson, and would gradually spiral into the Sun. But, for such bodies, this action would be slow and there might be time enough for a good deal to happen.

If material enough to form all the planets were distributed uniformly inside a sphere as big as Neptune's orbit, the total amount of matter along a column a square centimeter in cross-section, extending from the center to the edge, would be about a gram. It might seem at first that so thin a layer of gas could produce no perceptible effect; but it amounts to a thousandth part of the whole atmosphere of the Earth. Such a layer of gas, illuminated by ordinary sunlight, would scatter 1/1000 as much light as a clear noonday sky, or 500 times as much as a clear sky under full moonlight — and hence be extremely conspicuous against a really dark background. Sunlight at Neptune's distance is approximately 1/1000 as bright as at the Earth's; but, even under this illumination, the shell of gas would appear half as bright as a moonlit sky, and hence far brighter than any ordinary nebula. The Sun, surrounded by such a gaseous envelope, and seen from Alpha Centauri, would appear at the center of a bright nebulosity, fading away gradually at the outside, and about 45 seconds in diameter. The glare of the Sun would probably obscure this on photographs; but it would be conspicuous in a reflecting telescope, with the central star hidden. If, however, the heavier atoms and molecules had coalesced into dust particles, the medium might form a fog thick enough to obscure the Sun from points outside it. But, in that case, the effects of light-pressure would appear and it would not last very long. — *Princeton, December 20, 1939.*

t_1 denotes the value of t for which the radial velocity outward, v, equals the velocity of escape from the filament, v_∞, then we have

$$v_\infty = \int_{t_0}^{t_1} a(t)dt\,. \qquad (7)$$

If we neglect $\bar{a}_2$, assume that a_1 is constant through time, and replace v_∞ by its value for a spherical mass M of radius R, we find from (5), (6), and (7) that

$$t_1^* - t_0 = \left(\frac{\rho_{st}}{\rho_0}\right)^{\gamma-1} \frac{\mu m_0}{kT_{st}} \left(\frac{MGR}{2}\right)^{1/2} \qquad (8a)$$

Substituting $M/\pi R^2 z_0$ for ρ_0, we have

$$t_1^* - t_0 = 1.70 \cdot 10^{10} (\rho_{st} z_0)^{2/3} R'^{11/6} M'^{-1/6} T_{st}^{-1} \text{ sec}\,, \qquad (8b)$$

In his monthly articles on astronomy, Professor Russell interprets for the average reader many professional papers previously published for the astronomer, hence in mathematical form. Above is a sample of the article behind the present interpretation, from *The Astrophysical Journal* of last December. *The Astrophysical Journal* is the outstanding publication of its kind for American astronomy, just as the *Monthly Notices* of the Royal Astronomical Society, on which some of Professor Russell's articles are based, is for Great Britain. Most of the important astronomical papers in the English language are published in one or the other of these two journals; in fact "most" might well read "virtually all"

DEBUTANTE METAL—BERYLLIUM

Large Supplies . . . Makes Extremely Hard Alloys of Copper, Other Metals . . . Low Percentage is Needed . . . Research Finding New Alloys, New Uses

By PHILIP H. SMITH

IF beryllium could boast no definite commercial accomplishments, it could still lay claim to a measure of fame. What other metal remained, to the man in the street, little more than a name for a century, only to win prominence overnight by strutting the Washington stage?

It is fact that beryllium was hardly known to the general public until hearings before the Temporary National Economic Committee revealed that it was a strategic material of war; that there was jockeying among nations to acquire the secrets of its use; and that Germany led in the race. So much was said at the hearings about beryllium as a metal of the future that one could hardly appraise it as a metal in present commercial use, much less figure out what is required to translate futures into actualities. Now that the coming-out party fades from memory, just what is there about this debutante among metals that makes it so important?

Until the Washington hearings, beryllium was tracing a perfectly normal, if little-known, course. There was its identification very long ago — 1797, to be exact. Then came its chemical isolation more than a century ago. Like many other elements, it remained a curiosity for decades before its value was recognized. Just prior to the great inflation in Germany, the firm of Siemens Halske put a staff of men to work probing this unknown metal, in the correct belief that one of the best ways to preserve capital is to plow it into productive research. That really dates the commercial beginning of beryllium, because at that time was discovered the extraordinary heat-treatable characteristics of beryllium-copper alloys — a discovery of immediate commercial value.

OF course, a lot of things had to be discovered to bring beryllium out into the open. Methods of recovery had to be devised, because research could not be widespread when only small amounts of the metal were available. As recently as 1922, the cost was $5000 a pound. As extraction problems were solved, the price fell steadily to reach today's figure of $15. As soon as increasing amounts appeared, researchers undertook to study physical characteristics.

The peculiar qualities that recommend beryllium at this stage in its development are: light weight — it is lighter than aluminum; durability; fatigue resistance; and a strong affinity for oxygen and sulfur. These qualities have been exploited to make beryllium valuable in a number of ways which require discussion.

USES FOR BERYLLIUM-COPPER

Fuse clips
Switch blades
Vibrator arms
Contact brushes
Appliance plug clips
Plugboard contacts
Switch jaws
Circuit breaker springs
Relay springs
Brush holder springs
Electric range switch parts
Thermostatic control springs
Leaf or helical springs
Contact springs
Bourdon pressure springs
Optical alloys
Spring washers
Sylphon bellows
Diaphragms
Fountain pen clips
Camera parts
Instrument parts
Gasoline- and oil-pump parts
Cams
Valve parts
Watch parts
Gears
Precision bearings and bushings
Plastic molds
Die casting dies
Welding electrodes
Non-sparking tools

Beryllium plays its outstanding rôle as an alloying metal, and beryllium-copper is out in front at the moment. Copper, as we know, is a soft metal, but add anywhere from 1.5 to 2.75 percent of beryllium, give it heat treatment, and it acquires hardness comparable with that of steel. The usual admix is about 2 percent. When beryllium is added in such amount, the resultant alloy shows a tensile strength of 70,000 pounds per square inch in an annealed, soft state, whereas cold-rolled and heat-treated strip will give a tensile strength of 190,000 pounds per square inch. By way of contrast, structural steel has a tensile strength of 60,000 pounds.

It is the peculiarity of this alloy that it can be formed in relatively soft temper, and in the ductile state can be rolled, forged, and drawn. After heat-treatment it acquires its extreme strength and hardness.

Beryllium-copper has very wide use as a spring material. A more uniform product can be made — because of the above-mentioned heat-treatable characteristic — than is possible with spring steel and phosphor bronze, and the alloy is virtually untiring. A beryllium-copper spring, for example, can be flexed 15 billion times as contrasted to 400,000 for phosphor bronze. In addition to imparting strength and hardness to the alloy, heat-treatment also increases the elastic limit, modulus of elasticity, electrical and thermal conductivity, and wear resistance. These added properties can be controlled through proper time and heat regulation. Finally, beryllium-copper is non-magnetic and will not spark when struck.

IS it any wonder that this new alloy has cut a wide swath in the manufacture of springs? The number and variety of applications is, today, so broad that reference had best be made to the accompanying table. But, at the same time, it would be an error to believe that simple substitution of beryllium-copper has achieved the desired result. Success has come as a result of keeping in mind the basic properties of the alloy when designing a product, as well as understanding completely the heat-treating process. With this backlog of knowledge, manufacturers have been employing beryllium-copper to produce, for example, springs having smaller over-all size for use in re-designed equipment featuring space saving. Such change-overs continue.

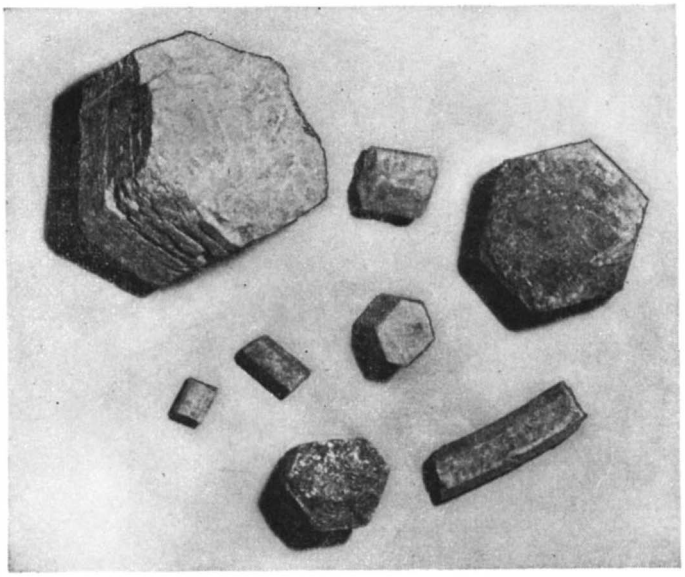
The high strength of beryllium-copper, coupled with wear resistance, has recommended the alloy for bearings, bushings, and certain types of gears. Its non-sparking quality, coupled with hardness, makes it suitable for special tools to be used in plants where there are explosives or inflammables. If the practical nature of such tools is questioned. doubt can be dispelled by dem-

onstrating that a beryllium-copper chisel can be driven through steel. As contrasted to bronze, beryllium-copper has a five times greater wear resistance when used in conjunction with steel, and the alloy has been used quite successfully with unusually high loads where there is small relative motion.

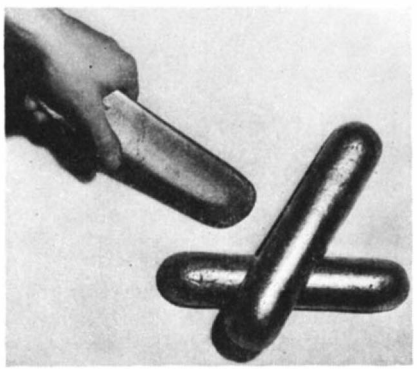
Within the past few years there has been considerable experimentation with beryllium-copper as a material for cast molds in the plastics industry. Some of this work has been fruitful, and cast beryllium-copper molds are in use today because they approach the ideal still being sought. The particular merits of the material are three in number: a low melting point and good flowing qualities which give excellent reproduction of detail; high compressive strength upon heat-treating, and a thermal conductivity twice that of steel, which permits a quicker molding cycle.

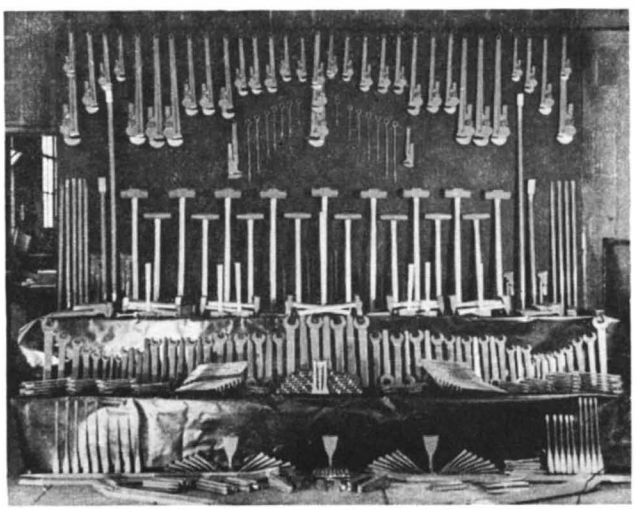
There are many types of beryllium-copper, but it will be sufficient to mention one more. This is an alloy formed with 0.4 percent beryllium, 2.6 percent cobalt, and the remainder copper. Wire of this alloy has been drawn to a tensile strength of 137,000 pounds per square inch, having a conductivity 50 percent that of copper. It has been used to make electrodes for resistance welding and has proved satisfactory in spot-welding stainless steel, in seam-welding wheels, and in electrode parts for projection welding.

THE amazing change wrought in copper by a touch of beryllium created an alloy with immediate practical use, but it remained for beryllium to touch nickel to set off a whole chain of verbal fireworks in Washington. The alloy, beryllium-nickel, has not been made in this country, because the method is unknown and experimenters are momentarily stopped. It has been made in Germany and the international patent situation was what brought beryllium into the Washington hearings. Testimony was presented to the effect that beryllium-nickel valve springs functioned in aircraft engines without showing the slightest fatigue and that bushings of the material never failed in German planes. It is known, further, that the alloy, heat-treated from the hard rolled material, acquires a tensile strength of 260,000 pounds per square inch as contrasted to 60,000 pounds for structural steel, and 90,000 for stainless steel. Here, again, 2 percent of beryllium does the trick.



Above: One source of beryllium—beryl crystals. *Below:* Master alloy —4 percent beryllium; rest, copper





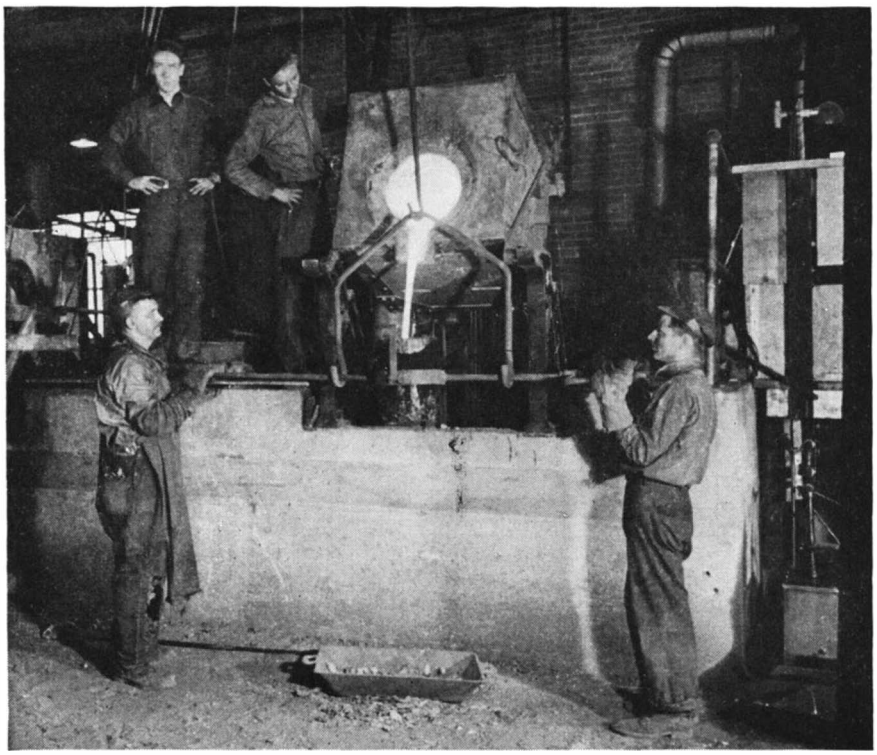
Beryllium-copper tools find use near explosives because they won't spark, will easily cut cold-rolled steel, *below*

This revelation — that there was a material available which would improve the performance of aircraft engines — touched off a series of questions. Is there an adequate supply of beryllium in this country? Can we make beryllium-nickel? Cannot beryllium be employed to make a strong, light alloy of aluminum or magnesium? These questions were raised in rapid succession and their answers will throw more light on this metal extraordinary.

THERE is no scarcity of beryllium. It exists plentifully in beryl and other mineral ores scattered throughout this country and the rest of the world. Its extraction in the pure state is difficult and expensive, but it can and is used readily in oxide form. Cost of extraction varies in accordance with the richness of the ores and, at the moment, most beryllium is obtained as a by-product of other mining operations. Having found how to use beryllium oxide in alloying copper, a short-circuiting of the process has led to lower costs, but problems arising in production of beryllium-nickel are not the same.

Beryllium-nickel will be made here under German license. One of the revealed difficulties is that alloying cannot be carried on with conventional methods without undue loss from oxidation, and that special equipment is required to do the trick, unless, of course, something hitherto unknown is discovered about the handling of the metals

The union of beryllium and aluminum to make a light, strong alloy, is still more of a hope than a reality, despite all published reports of success. When beryllium is used in high percentage to contribute its advantages of lightness and rigidity, the resultant product is too brittle in the cold state to be commercially useful. Some investigators claim that aluminum can be age-hardened, while others declare that alloys of the duralumin type alone can be so benefitted, and that small amounts of beryllium added to aluminum are inert or behave in the manner of silicon. At



Photographs courtesy The Beryllium Corporation

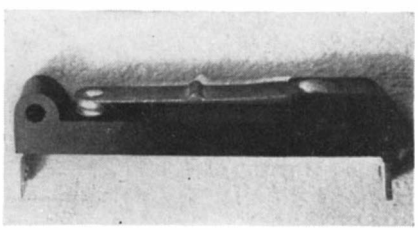
Pouring a master alloy of beryllium and copper

the moment, there is a hint that beryllium and aluminum can be combined to create an alloy having a high tensile strength and yield point at operating temperatures of 500 to 600 degrees, Fahrenheit. If this hint is substantiated, the aircraft industry may have a new material for pistons.

Magnesium, another hope, has not yet gratified experimenters by forming an alloy with beryllium, and the problem is complicated by the difference in melting points. Whether or not some way will be found to make the ultra-strong, light-weight alloys which hope has made "fact" in the news, remains to be seen. The value of such a discovery puts it in the not-impossible class of research projects. The mere suggestion that hope is not abandoned is a way of saying that probers will keep hard at work.

Among research men, there is speculation as to what might be done by employing powder metallurgy to combine beryllium and aluminum or magnesium. Significant results have been obtained by mixing the powders of other metals and heat-treating to produce hard materials, so why not try it here?

Some of the interesting successes in beryllium research are nickel-chrome-iron-beryllium and beryllium-gold. The former alloy has a possible elastic limit of 200,000 pounds per square inch, is highly corrosion-resistant and non-magnetic. Its commercial use is now limited to replacing watch-spring steel in high-grade watches. Beryllium-gold, formed with 1 percent of beryllium, is extremely hard and can be used as a dental inlay and for low-melting gold solders.

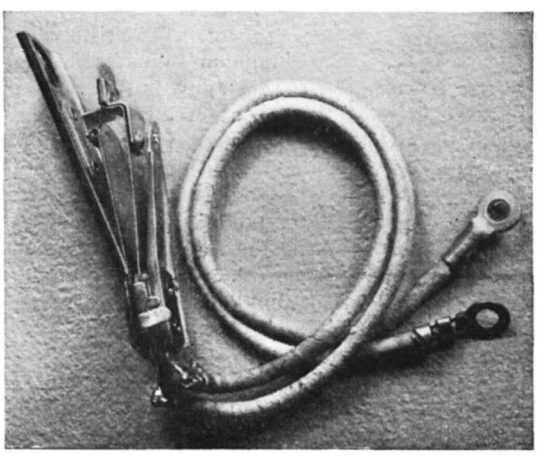


Typical use of beryllium-copper, for its fatigue resistance, in electrical contacts for time-control clock

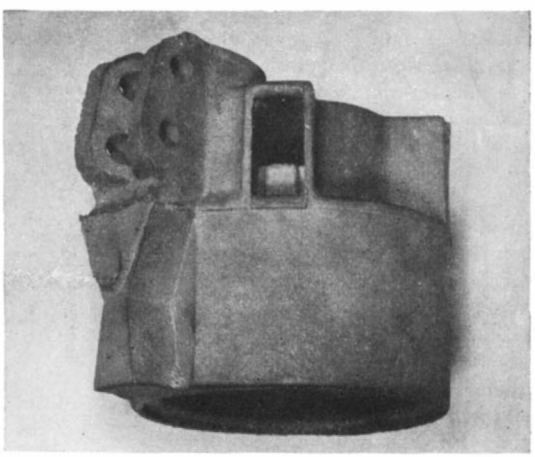
While beryllium's affinity for oxygen is a nuisance in the production of certain alloys, this affinity is an asset to industry. The metal reacts with all oxides at high temperatures and seizes upon nitrogen, sulfur, and carbon, as well. The deoxidizing and desulfurizing properties are now being used to permit production of high-conductivity copper castings and to remove the sulfur in steel melts. Even when a high sulfur content remains in steel, it is still possible to roll it if beryllium is present in small amounts. Pure nickel can be rolled without using magnesium and manganese if beryllium is added.

IT should occasion no surprise if beryllium makes more rapid commercial progress from now on. Aluminum, molybdenum, and the rest of the newer metals required a solid groundwork of research before they advanced far into industry. Beryllium production processes have been simplified to bring price within a range that warrants research looking to wider commercial application. The achievements of beryllium-copper have been adequate to answer skeptics, and resistance to adoption is now very largely overcome by the knowledge which fabricators have acquired as to its use. The metal is hardly obtainable in the pure state, but there are master alloys available with copper, nickel, and iron.

In many respects cost is still a deterrent to use, but when it is recalled that other metals began their careers from a high plateau and dropped lower as use expanded, the present course of beryllium is wholly normal. If, as many still hope, alloys with light metals can be produced, cost will be less of an obstacle because performance will be worth the price. Such an achievement would justify all the research work which could be brought to bear upon the problem, and would validate all the flaming headlines which have promised a revolution in metals.



Left: **The thermostatic control for an automobile heater uses beryllium-copper spring contacts as shown at left end of this double cable**



Right: **The same alloy, in cast form, is used in many kinds of electrical apparatus. The photograph shows the metal cast as a part of a circuit breaker**

Why Pure Science Pays

Time After Time Scientists Interested in Finding New Facts Purely for Their Own Sake – Intellectual Curiosity – Have Handed Fortunes to Industry

By A. CRESSY MORRISON
President of the New York Academy of Sciences

MICHAEL FARADAY'S discovery of the principle of electromagnetic induction, was, for him, the reward of an excursion into the unknown; the fruit of pure reason; an idea embodied ultimately in an experiment. To Faraday's contemporaries, his discovery meant little or nothing. To those of us who live in this electrical age, Faraday's toy has become the foundation of a new civilization. It showed the way to harness the vastly powerful forces of electricity. Light, heat, power, and all the wonders which flow from the millions of electric dynamos and motors, which lift burdens of toil from our shoulders, delight and amuse us, employ simply and directly the principles of Faraday's discovery.

Whatever may have been Faraday's gift of prophecy, it is certain that he was led to this discovery, as to others, by an insatiable desire to learn and to know. No hope of other reward was needed to goad his active imagination. No vision of immediate usefulness spurred him in the search for truth.

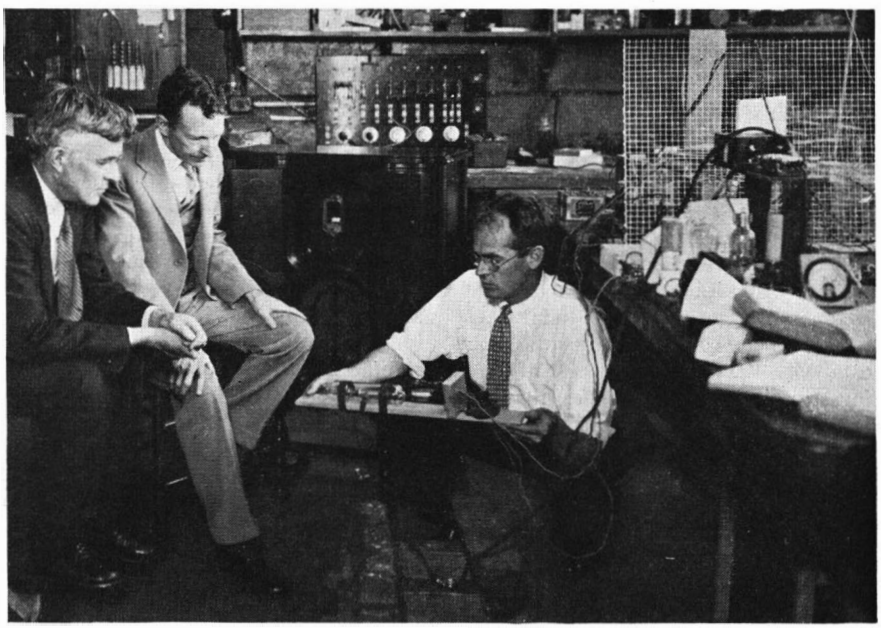
Quite obviously, in our fast moving age, the long gap between Faraday's discovery and its application to human needs has been materially shortened by the development of vastly intricate industrial machinery to feed upon and utilize the results of researches in pure science. Obviously, too, the wealth created by industry should supply the essential support and stimulus to research in pure science. President Conant of Harvard has described this relationship by a happy analogy drawn from the field of biology. He terms the mutual interdependence of pure science, pursued for the purpose of increasing human knowledge and industry, whose objective is the creation of wealth in the broadest sense of that word, as "symbiosis" (living together). To make this meaning clear, he illustrates symbiosis by describing the process by which lichens live. A tender green plant synthesizes food for itself and also for a strong colorless fungus whose hardiness protects both from destructive forces. The application of the figure to the present subject and its aptness in describing it are evident.

Each phase of knowledge is connected by strings, often invisible, to a previous state of knowledge. Hence, we must give considerable credit to astronomy for things that are now of everyday use. Let me give some instances of fundamental ideas essential to further development of science, which have come from astronomy. The connections are so remote as to have become practically lost.

A MATHEMATICAL equation devised by Clark Maxwell has given us radio and television. The velocity of light was first discovered by Roemer from observations of the eclipses of Jupiter's satellites, and the notion of velocity of light or radiation was essential to the formulation of Maxwell's laws. A second instance of a very remote connection is Newton's law of gravitation and the principles of mechanics, which were arrived at on the basis of the motion of the Moon. It is these principles that are the base of the entire complex of mechanical things that we possess at the present time.

Astronomy made necessary the study of optics. It has developed the strength of the human eye until it has become a 200-inch reflector. Optics has, in the other direction, aided in the development of the microscope, until all the beneficent results of microscopic investigation are now in our possession and the end is not yet. The development of the study of optics and the correction of the imperfections of the human eye has given us the universal use of ordinary eyeglasses which have become one of the great factors in safety, in human enjoyment, and the advancement of education.

We are indebted to astronomy for the spectroscope, which discloses with marvelous accuracy the constituents of mixed elements to be found throughout the universe, but few realize that this same instrument is now in practical use in hundreds of industries, and is disclosing immeasurably small amounts of impurities which may be useful or harmful in substances heretofore considered as pure. The majority of astronomers, if asked "What is the use of astronomy?" would probably quote Poincare, "*L'astronomie est utile parce qu'elle est belle*" (astronomy is useful because it



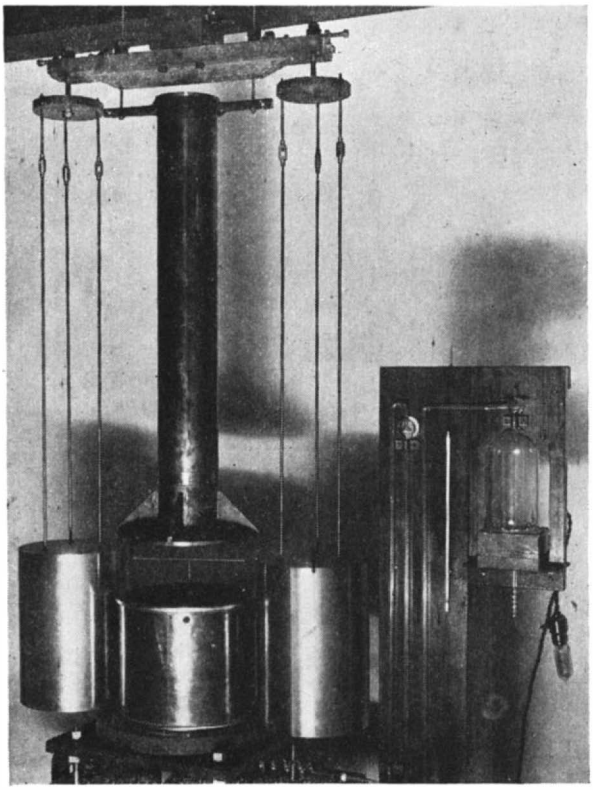
Research in pure science at the General Electric Company. Hard-headed industrial men have learned that research in pure science often pays fat dividends. Experience abundantly proves that, if research men are permitted to broaden the scope of their probings, unexpected insights and by-product facts turn up and can be converted into wealth exceeding by far the original research costs

is beautiful). If we study the work of Copernicus and the impact of Galileo's pronouncement that the Earth is not the center of the universe upon the ideology of the world, we find that it has changed and is changing the philosophy of every human being.

Daguerre discovered photography—step by step it has advanced. As early as 1869 the process which awaited only the development of the film and the proper chemicals to produce pictures in color was announced. The moving-picture industry rests upon his discovery, and its effect upon the world is already apparent. Who would have supposed that Daguerre's discovery, as now developed, would so improve the accuracy and facilities of astronomy that nebulae have now become island universes, space has grown from thousands to millions of light-years, new radiations have been recorded, and photography has become the handmaiden of astronomy?

PERHAPS no single scientific discovery has had today such enormous and so valuable use as catalysis, invaluable tool of chemistry. Indeed, there are few processes of chemical industry which do not employ such a promoter of one kind or another to accelerate and direct chemical reactions toward desired ends. Even the simple, universal reaction of combustion requires the presence of a minute amount of water vapor to allow it to proceed.

The ancients visioned the invaluable usefulness of the promoters of chemical reactions which we now designate as catalysts and sought a universally active substance of the kind under the name of the "philosopher's stone." The advent of chemistry as a science directed attention toward these traces of extraneous substances necessary to bring about certain chemical reactions, and, more than a century ago, Berzelius had accumulated enough information on the subject to give phenomena of this type the name catalysis. Berzelius and a host of other investigators in the decades that followed pursued these inquiries without expectation of reward, but no intellectual pursuit has had more significant consequences. Sulfuric acid, as universally valuable in chemical manufacture as pig iron is in mechanical industry, is produced in our own country by the millions of tons annually by processes utilizing platinum, vanadium oxide, and other materials as catalysts. Enormous tonnages of cottonseed no longer are wasted to clog streams and foul landscapes, since a catalytic process easily converts their oil content into a palatable, nourishing solid fat. The first World War was begun only after Germany was assured independence of imported nitrate for explosive manufacture by the perfection of Haber's catalytic process for making the air supply this military essential. Though a military essential, how much more important is the fact of an unlimited supply of nitrogen to fertilize our cultivated fields and ultimately save the world from starvation. Our now commonplace, but still amazing, conquest by air of immense distances over continents and seas depends upon catalytically prepared fuels and catalytically controlled burning of them in internal combustion engines. What is true of air-born commerce is quite as true of highway traffic in vehicles powered by similar fuels.



Apparatus used by Dr. Paul R. Heyl at the National Bureau of Standards, for "weighing the Earth," or determining the constant of gravitation. But why spend public funds for weighing the Earth? One of many practical problems to which this research is related is locating oil with similar apparatus

A classical case in organic chemistry serves to illustrate the development of a chance discovery by an actively inquiring intellect into a fundamental fact of incalculable theoretical and practical importance. This is "substitution" or the replacement in an organic compound, of an atom, usually hydrogen, by an atom of another element or by a radical (a group of atoms of two or more elements). Substitution was discovered by Dumas, when he was asked to find out why the candles at a ball in Paris gave off suffocating fumes when they were burning. Dumas learned that the wax had been bleached with chlorine, and he found that chlorine had evidently replaced some of the hydrogen of the wax, yet had not destroyed its essential nature. His published paper on what he had found is one of the classics of chemistry, but the idea in it was so new that it was met with jeers. It inspired the publication, in Liebig's *Annalen*, of an ironical paper written by Wöhler, but signed "S. C. H. Windler" (swindler).

In spite of the early disbelief and ridicule, the fact of substitution was soon well established and its application has influenced the greater part of the development of organic chemistry, in the factory as well as in the laboratory. Without substitution, the chemist could never have produced the synthetic dyes or the hundreds of invaluable medicines. It is commonly said that the dyes are obtained from coal tar. The truth of this misleading statement is that a few essential compounds obtained from coal tar are the raw materials from which are built up, step by step, with the aid of substitution, the complicated molecules which meet hundreds of human needs. The enormous development of synthetic organic chemistry is an outgrowth of a simple but fundamental discovery.

THE photo-electric effect was discovered by Hertz and Hallwachs in 1887 and 1888, respectively, more or less through difficulties with experiments carried out for other purposes. The photo-electric effect underlies the sound effects accompanying pictures and is absolutely essential for television.

"Marconi was inevitable," according to Abraham Flexner. "The credit for what has been done in the field of wireless belongs, as far as such fundamental credit can be definitely assigned to anyone, to Professor Clark Maxwell, who in 1865 carried out certain abstruse and remote calculations in the field of magnetism and electricity. Maxwell reproduced his abstract equations in a treatise published in 1873. Other discoveries supplemented Maxwell's theoretical work during the next 15 years. Finally, in 1887 and 1888, the scientific problem still remaining — that is, the detection and demonstration of the electromagnetic waves which are the carriers of wireless signals — was solved by Heinrich Hertz, a worker in Helmhotz's laboratory in Berlin. Neither Maxwell nor Hertz had any concern about the utility of their work. They had no practical objective. The inventor in the legal sense

was, of course, Marconi. But what did Marconi invent? Merely the last technical detail, the now obsolete receiving device called a 'coherer,' almost universally discarded." Yet no man will deny him the vast credit due him for making pure science in this field of supreme importance to the world.

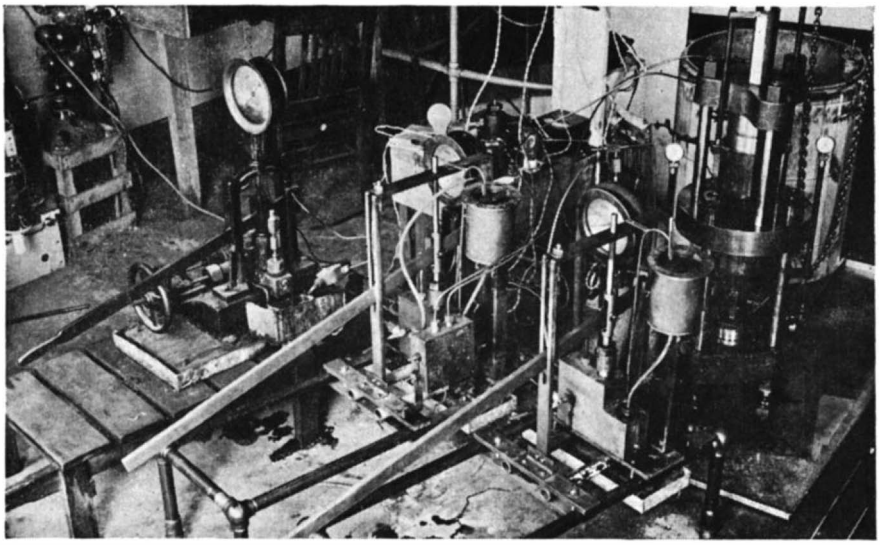
We may smile at the entomologists who measure the proboscises of butterflies and bees, but the practical application of their studies becomes immediately apparent, as is well-known in connection with that very useful plant, red clover. It seems that Australia set out to grow clover, imported the seeds, and had successful crops for a year or two, and then the crops failed. It was then that the entomologists came to the rescue and imported bumble bees, the only insect that can fertilize red clover, and now clover grows.

THE utility of geology as a means to the discovery of metals, minerals, oils, and to the location and physical characteristics of materials for dams and other structures, is so apparent that we cannot walk a paved street anywhere in the world without its geological relationship echoing with every footstep. The search for the remains of prehistoric animals has led to discoveries of prime importance in all directions. But civilization, while based on material things, is equally dependent upon the increase of human knowledge. The greater our understanding of the structure of the earth and the history of living creatures through an almost infinite past, with their ultimate relationship to man, the more the mind of every thinking person broadens, and better judgment develops into tolerance and understanding. These contributions may do more to the elevation of the mind of man, the real objective of human life, than can be gained from developments which add merely to man's security and comfort.

Early attempts to measure the constant of gravitation, using the torsion balance, provided experience which has made possible one and perhaps the most important form of geophysical prospecting now used to find oil.

Dalton's atomic theory and Mendeleeff's periodic law developed the idea that all matter was composed of a limited number of kinds of indivisible building bricks, known to us as the atoms of the elements, out of which all things are constructed. While these concepts were indispensable as stepping stones to a better understanding of the structure of matter, they seemed to close the door to the possibility of anything outside of the material.

The discovery of radium smashed these bricks and transformed them into little constellations, with a central nucleus about which revolved electrons at infinitesimal, but relatively great, distances from the nucleus. This opened the door to a better understanding of forces, probably enormously more important to the ultimate destiny of man than the material benefits which have already so magnificently followed the discovery of radio-activity in all its present applications.



Apparatus for placing matter under pressures of half a million pounds per square inch. This is research in pure science; the experimenters were not aiming at any particular financial gain but were activated by intellectual curiosity. Yet almost certainly industry will find applications for the new knowledge gained

Few know that the study of the locomotion of fishes has added to the speed of airplanes.

Gibbs' phase rule, as is well known, obtained in Gibbs' profound studies of chemical and physical equilibrium, is the guiding idea that has made possible a great part of our development of alloys and certainly had much to do with modern metallurgy. The real greatness of Josiah Willard Gibbs is slowly but surely becoming realized and as an American scientist he now takes his place as one of the first mathematical physicists of all time.

The Joule-Thompson effect deals with the change of temperature when a gas expands from a high pressure to a lower one. It is the basis of the process of liquefaction of gases, and of the air-conditioning and refrigeration industries we have at present. I doubt whether any reader of the original scientific papers describing this discovery could have had any idea of the tremendous potentialities of the simple "porous plug" experiments as originally carried out.

In 1917, helium was a chemical curiosity that had been produced only in small quantities by investigators in pure science. Its discovery on Earth had followed the finding of it in the Sun. Where it could be bought at all, it cost about $2000 per cubic foot. However, technical men saw the possibility of extracting helium from natural gas for use in lighter-than-air craft and suggested it for military aeronautics. An efficient extraction process was developed, by which helium could be secured in quantity at low cost. Helium is now produced at approximately one cent per cubic foot, and in quantities suitable for man's uses.

IN addition to the use of helium as a non-explosive lifting gas for airships, it is valuable for deep-sea diving and for medical purposes. Mixtures of helium and oxygen prevent caisson disease. Within the past year, new diving records have been made using helium. The medical profession now prescribes helium mixed with 20 percent oxygen as a breathing atmosphere for persons afflicted with asthma, and this gives almost immediate relief. This humanitarian use of a once rare gas offers wide possibilities of medical application, according to reports by doctors who are studying the effects of helium on respiratory diseases.

On the fine work of separating helium from natural gas rests our greatest chemical industry. By the use of waste gases from petroleum and natural gases, the use of coal and lime and ultimately, oil shale, we now or will produce an unnumbered variety of valuable chemicals, plastics, textiles like silk and wool, and possibly food and drink.

These examples, drawn from many fields of purely scientific inquiry, show in unmistakable terms the enormous value of giving the searching imagination free reign. Even the calculations of astronomers, accustomed to huge figures, could not evaluate the wealth of comfort, convenience, health, and happiness that stem from the researches I have mentioned. To forecast their effects on future generations is beyond human powers, great as these have been shown to be in other directions.

SOUNDLESS SOUND WAVES

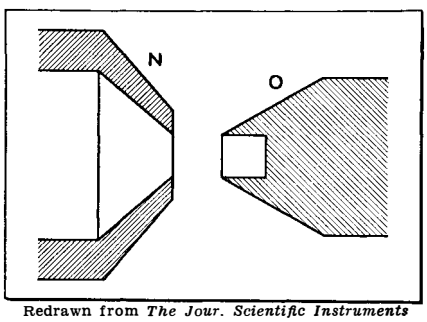
The Odd Realm of Supersonics—Inaudible, Versatile Vibrations—is Receiving Increasing Attention From Scientists . . . Paradoxical Behavior

By WALTER L. FINLAY, Ch.E.
Research Chemical Engineer, Remington Arms Company

(In Two Parts—Part One)

A PALM tree crashing to the ground on an uninhabited atoll makes not even the slightest break in the utter silence. This statement is correct, of course, only in the sense that no ear perceived the fall. So far as the adjacent air molecules were concerned, however, sound waves were generated because the crash set them into longitudinal vibration.

Yet even the presence of an auditor does not always insure that a sound will be heard. This follows from the fact that the eardrum of the average human being responds only to sound vibrations ranging from a floor of about 20 to a ceiling of perhaps 20,000 cycles per second. What goes on in this 20 to 20,000 range



Redrawn from *The Jour. Scientific Instruments*

Figure 1: **The simple principle of the Hartmann ultrasonic generator**

is, needless to say, of daily vital concern to everyone. Indeed, its omnipresence seems, on occasion, to be almost too much with us. What transpires in the basement below 20 and, more especially, in the upper stories above 20,000 is more inobtrusive but it constitutes one of the more interesting displays in the Curiosity Shop of physical chemistry.

The region of the subaudible, that is of sound waves with frequencies below 20 cycles, is of but little practical importance. The amusing story is told how by their use R. W. Wood, Research Professor of Physics at the Johns Hopkins University, once—and only once—panicked a theater audience. The author of the play planned a blackout punctuated by a shrill, drawn-out scream, to represent the turning back of 145 years. In rehearsal, however, the transition proved none too convincing. Wood therefore lugged a 40-foot organ pipe backstage and, timed with the scream, poured a flood of powerful but inaudible sound waves over the darkened orchestra. An eerie chill of unreasoning fear swept over the audience and when the blackout faded 145 years earlier the lights revealed that the audience had precipitously declined to make the transition and were safe in the 20th Century, outside the theater. Later, a shaken spectator observed that he had experienced much the same sensation just before the San Francisco earthquake.

Above the audible range is the region of the ultrasonics (ultra—beyond; sonics—sound). These soundless sound waves have recently become the focus for a flattering share of scientific attention.[1] The spotlight is well merited. The investigator is lured on not only by the potential importance of ultrasonics—both theoretically and practically—but also by their paradoxical behavior. The latter is particularly intriguing, for ultrasonic vibration is, among other things: A producer of dispersions of solids in liquids but a destroyer of dispersions of solids in gases; in liquids, a disperser of solids but a coagulator of gases; in electrolysis, a promoter of desirable but a suppressor of undesirable gas evolution; with pathogenic bacteria, in some cases an augmentor and in others a diminisher of virulence; and, when applied to a human limb, a heater of the marrow but a non-heater of the bone!

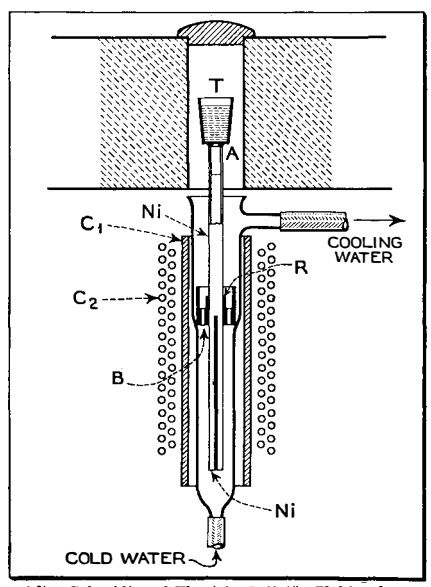
THESE are versatile vibrations indeed. Frequencies from 20,000 up to 500,000,000 cycles per second have been experimented with. In the higher ranges these vibrations take place so rapidly that the remark has been made that these vibrations are "*all* acceleration and *no* motion."

No very efficient producer of ultrasonic vibrations has as yet been developed. At present the three most popular ultrasonic generators are the Hartmann air jet, the piezoelectric oscillator, and the magnetostrictive vibrator.

The Hartmann generator (Figure 1) functions by directing a jet of air with a velocity higher than that of sound from a nozzle, *N*, into a special cup-shaped receiver, *O*. The frequency of the ultrasonics produced is a function of the dimensions. Professor Hartmann reports the relatively high efficiency of 4 percent for his device.

Piezo means "to press." A piezoelectric crystal is one which, when pressed, develops a voltage between the faces pressed. Since the value of the voltage is proportional to the pressure, the piezoelectric crystal affords a very neat and accurate means for the measurement of pressures. What is even more interesting and more to the point of this discussion is the fact that the piezoelectric effect is reversible; that is, if an alternating voltage is applied to the faces of a properly cut piezoelectric crystal, the crystal will alternately expand and contract in phase with the applied voltage, thereby producing sound waves.

The most commonly used piezoelectric crystal is quartz but there are many others. The feature which all these crystals have in common is the fact that they lack a center of symmetry. At the expense of some oversimplification one can consider an ionic crystal to be made up of an array (three-dimensional network) of positive ions interpenetrating an array of negative ions. In the uncompressed



After Schmidt and Ehret in *Zeit für Elektrochem.*

Figure 2: **Apparatus for making ultrasonic waves magnetostrictively**

[1] Over 500 single publications in the last decade and the recent publication of a textbook ("Ultrasonics," by L. Bergmann, 1938), also "Supersonics," lectures by R. W. Wood, 1939.

crystal the ionic charges cancel out completely throughout the crystal. Hence the crystal as a whole is neutral. But if a crystal, which is not symmetrical about its center, is compressed, the spatial relationship resulting in overall neutrality is not maintained, the ionic charges no longer cancel each other out completely and net charges appear on opposite faces. In the reversed case, when one face is positively and the other negatively charged, the crystal expands or contracts depending upon the polarity of the impressed voltage.

Equally useful and interesting is the magnetostriction effect—the third method. If a rod of ferromagnetic material is placed in a magnetic field parallel to its length, the latter is changed slightly —perhaps one part in a million—and a reversal of the field will reverse this change. Like the piezoelectric effect, this phenomenon is reversible. Compressing a nickel rod, for example, will increase its magnetization. And, if a coil is placed around the rod, the compression will induce an E.M.F. in the coil.

AN experimental magnetostrictive oscillator devised by Schmid and Ehret is shown in Figure 2. A water-cooled nickel rod, *Ni*, about 10 inches long, is used as the vibration generator. It is magnetized by the direct current coil C_1 and excited into magnetostrictive vibration by a high-frequency current in the water-cooled, copper-tubing coil C_2. The Bakelite collar, *B*, supports the rubber ring *R*. A crucible, *T*, is brazed to the nickel rod at *A*. Schmid and Ehret were investigating the effect of ultrasonics on metals, hence the crucible, in this particular example, is surrounded by a furnace.

When this crucible was filled with water and ultrasonically vibrated, the water was transformed into a very fine mist in less than one minute. Any liquid of low viscosity is similarly atomized. Professor Boys has pointed out an interesting analogy to this in the explosion of a depth charge. The first intimation to the observer at the surface that the charge has exploded is the sudden development of a fine spray some 10 to 15 feet high. Directly thereafter the familiar geyser, propelled by the explosion gases, lifts its tons of water gracefully from the sea and obliterates the mist. This mist is never noted after the explosion of a mine because the relatively large volume of air in the latter acts as a cushion between the impact of the exploding gases and the water.

Several interesting results were obtained when metallic melts were subjected to ultrasonic vibration in the magnetostrictive oscillator. Figures 3 and 4, for example, illustrate the grain refinement which can be obtained. The metal employed happened to be cadmium. When a metal freezes, solidification starts from a number of nuclei, or "seeds," and with further abstraction of heat these nuclei grow until the entire melt is solid. In Figure 3, which solidified without vibration, heat was removed from the top and the bottom of the crucible. Hence the nuclei formed at both the top and the bottom and grew into the center of the melt. Thus the interlocking, columnar-shaped crystals were formed. But, when the melt was ultrasonically vibrated, the nuclei were broken up and scattered throughout the molten metal and the fine-grained structure of Figure 4 was obtained.

By a similar mechanism, segregation is counteracted, and brittle grain boundaries can also be broken up. Thus Figure 6 illustrates the effect of ultrasonics on the continuous grain boundary material of the unvibrated specimen in Figure 5.

Lead and aluminum are no more miscible in the liquid state than are oil and water and their difference in densities is much greater. Nevertheless, even here the industrious ultrasonics can bring about a fair degree of emulsification. Figure 7 shows a dispersion of lead in aluminum. This dispersion is not very stable but if the ultrasonic radiation is continued until freezing is complete the dispersion is, of course, maintained.

The potential commercial applications of ultrasonics are interesting. A whole new industry, popularly known as powder metallurgy, has come into being in the past few years to fill certain definite needs which conventional metallurgical methods could not satisfy; for example, to make "forced alloys" for bearings of metals which are immiscible in the liquid and solid states. Perhaps the emulsifying power of ultrasonic vibrations offers an alternative process for effecting certain metal combinations otherwise unobtainable.

(To be concluded)

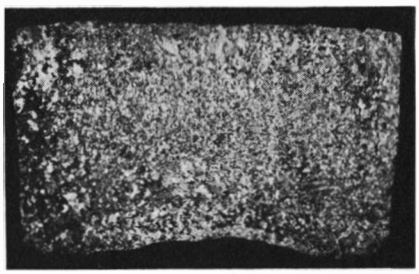


Figure 4: **Fine grain. Vibrated**

All photomicrographs courtesy Dr. G. Schmid and *Zeit. für Elektrochem.*

Left: Figure 3: **Coarse, unvibrated**

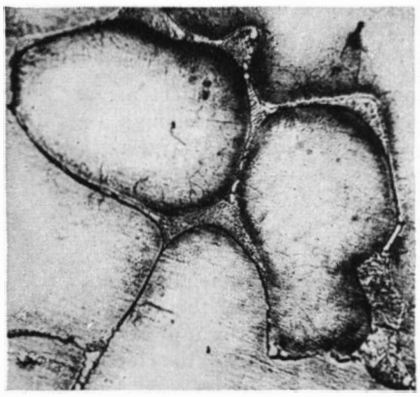


Figure 5: **An unvibrated specimen**

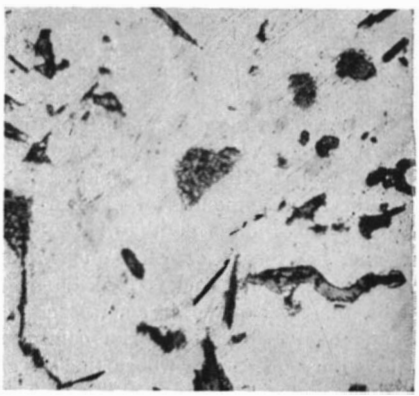


Figure 6: **Same specimen, vibrated**

The top pair of photomicrographs displays the contrast between the grain sizes obtained without and with ultrasonic vibration during the solidification of otherwise identical melts. The refined grain structure offers considerably enhanced mechanical properties. The next pair contrast a similar effect on an alloy with a brittle grain boundary. The latter is completely broken up. That at right shows a dispersion of lead in aluminum; with ultrasonic vibration maintained during freezing the dispersion is maintained

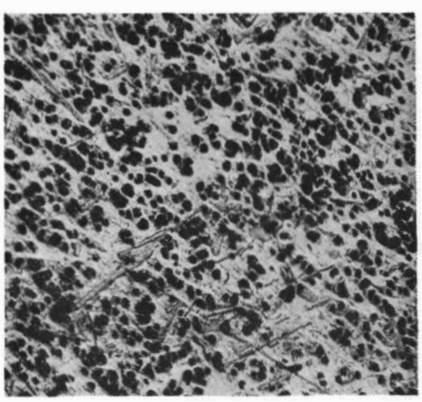


Figure 7: **A vibrated dispersion**

Restoring Rome's Colosseum

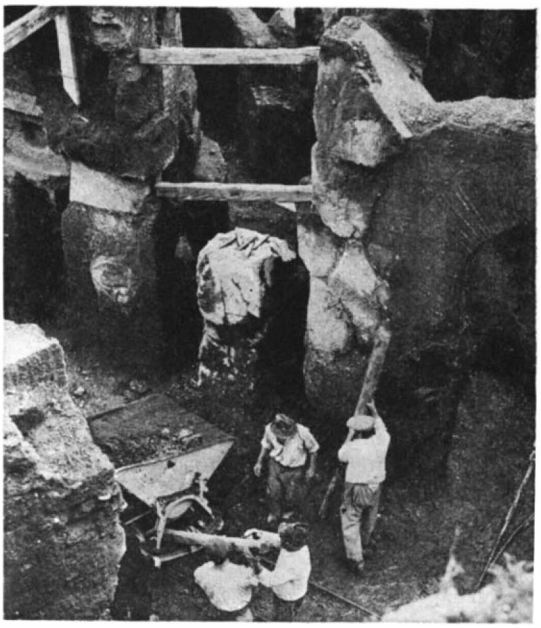
Recent Excavations Beneath the Ancient Arena Reveal Elevator Shafts for Raising Wild Beasts to the Combat Level by Means of Counterweights

By H. T. RUTLEDGE

HOW the lions, tigers, and other savage beasts were handled and liberated simultaneously into the arena of the great Roman Colosseum with a dispatch that would do credit to Frank Buck, Clyde Beatty, or any other famous animal director, has been revealed by the excavations of Prof. Guiseppe Cozzo, an Italian authority on that historical structure. For centuries, until recently, the lower half of the Colosseum has been buried and none of its lower parts has been visible.

After several months of excavations into the long-hidden depths of the Colosseum, Professor Cozzo has uncovered the *hypogeum* or "back" stage, 20 feet below the level of the arena, where the stage was set for gladiatorial combats with wild beasts, also where the stage settings and the cages for the beasts were kept.

The ancient *hypogeum* contained not only the cages of the wild beasts but 32 cells for lifting them simultaneously to the level of the arena. The animals, whipped by the keepers who followed them, were forced to pass from their cages to and along a passageway less than three feet in width to the elevator cells. In this narrow space they were unable to turn around to attack. The cages in which beasts were lifted are indicated by the discovered evidence to have been 38 inches wide, five and a half feet long, and almost six feet in height. This was large enough to permit holding the largest lions in these cages for several hours at a time, in order to have them ready when they were wanted in the arena. The cages themselves no longer exist but their dimensions have been approximated from the size of the elevator shafts. Similar cages probably will be constructed. The elevators were operated with counterbalancing weights — not alone by winches and pulleys as most authorities on the Colosseum had previously supposed. At a signal by the stage manager, the 32 keepers released the respective counterweights and the 32 cages rose simultaneously. The cages had no doors but, until they were lifted, they were shut off by iron gates immediately in front of them.



Workmen with dump cars of earth and debris to be removed from beneath the arena

As soon as the wild beasts reached the level of the arena, about 20 feet above, and found a free outlet they made their way, attracted by the light, through separated corridors and all appeared in the open at the same time.

As the arena was an oval 281 feet in length and 177 feet in width, the combat sometimes lasted a long time, since the battle probably was not immediately provoked, as it would have been in a small space. Indeed, the arena was so large that the contest with the beasts was called *venatio* — a hunt — and the men who hunted were called *bestiari*.

Eighteen hundred years ago a band of gladiators in the arena held their spears at an angle against the sand floor as they nervously awaited the entrance of the lions. At a preconcerted signal, the famished lions appeared from the sides of the arena, stalked the gladiators, and the battle with the beasts followed. Thrilled by this terrible spectacle which came to cap a program of cruelty, more than 50,000 spectators, often including the Emperor and always many of the nobility of Rome, looked down

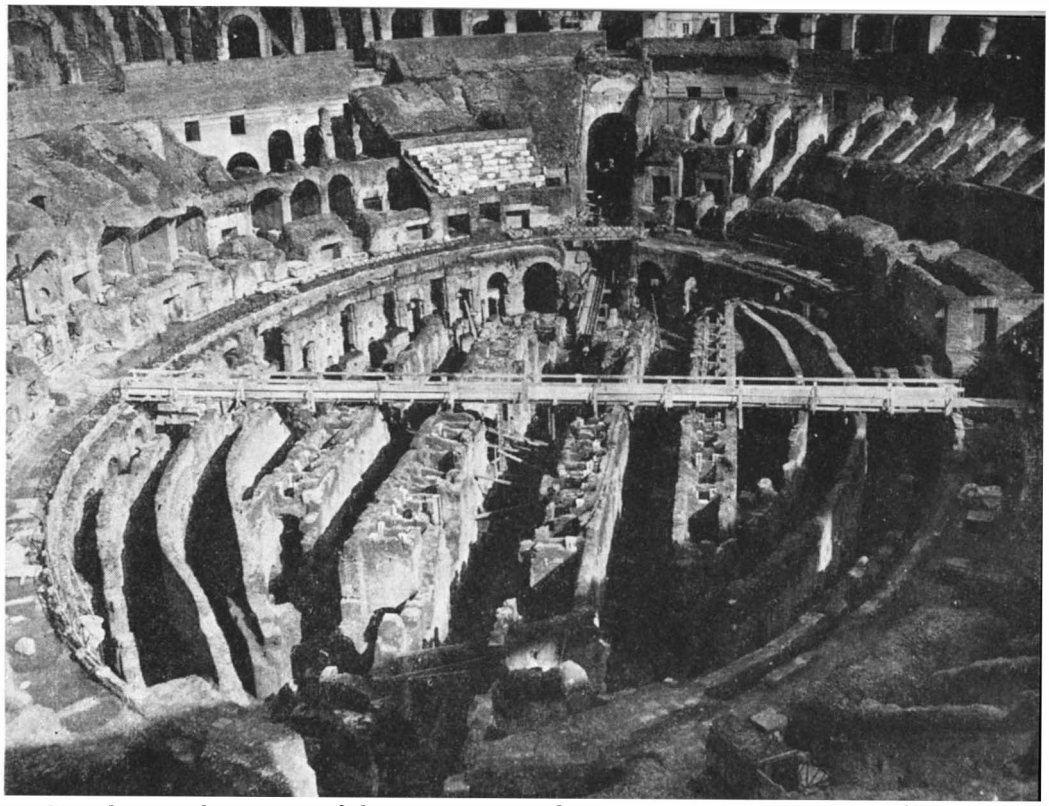
Partly ruined tiers that once supported the seats in the Colosseum. Seating capacity was about 50,000, though this is often exaggerated — was done so, in fact, by the Romans themselves

All photos by Andre La Terza

from the several tiers of the great Colosseum.

Although there were many amphitheaters in Roman territory, including the one so graphically described in Bulwer Lytton's "Last Days of Pompeii," none of the others had the elaborate equipment for such cruel mass performances as were held in the great Colosseum at Rome. In the hundred days of games held upon the opening of the Colosseum, 5000 lions, tigers, and other wild beasts and 3000 gladiators were slaughtered.

As the Colosseum was unique in many respects it is important to reconstruct the giant edifice as near like the original as possible. However, restoration will not involve completely rebuilding the structure as it originally stood, but will mean the reconstruction of all those parts that remain. Thus the floor of the arena will be reconstructed, not of pine boards as it was in the Romans' day, but of substantial concrete — though a part of the flooring may be of boards, in order to give the public an exact idea



How the central part of the Colosseum appears today after the current excavations, showing the complex structural details beneath the arena, which was carried on bridging planks

Laborers trundling a dump car along a light track 20-odd feet below the level of the ancient arena. Through these same passageways howled the lions of old Rome

of the maneuvers employed in setting the stage for gladiatorial combats or for great pageants and sporting events. It has also been suggested that sports be revived in this famous amphitheater.

Now that the plan for reconstruction is under way, it will be of interest to recall some of the more outstanding facts about the Colosseum. Even today it is a gigantic and impressive structure and not at all lacking in majesty because of its modern surroundings. It was begun by the Emperor Vespasian, who brought with him on his return from Judea 12,000 Jewish prisoners to do the rough labor. It is 159 feet in height, and in plan is elliptical with the major axis 615 feet, the minor axis 510 feet. It is composed of huge blocks of travertine rock, though the interior is of marble and brick. It is still possible to see, near the top, the holes to which were attached the canopies which completely covered the great structure to keep off the hot sun.

The arena was surrounded by a wall 12 feet high to protect the onlookers from maddened beasts or men. This wall now is largely ruined. The basement part which Professor Cozzo has been excavating is made of long, thin bricks (Roman bricks).

In the Colosseum the seats nearest the arena were reserved for the state officials, and above these were those for the nobles and the rich. Higher still were those for the populace. Exits (*vomitoria*) were efficiently designed to facilitate departure of the crowds; the Romans were just as aware of such matters as we are today, and perhaps a little more so than some of our earlier designers of large auditoria. The Colosseum seats were numbered and the "tickets"—inscribed clay pieces—have been found.

The first Christian martyrs to be thrown to the wild beasts died in the arena of the Colosseum and, because of these martyrs, who succeeded the gladiators, the Colosseum was venerated greatly during the Middle Ages. It was considered to be a monument consecrated to the martyrdom of the early Christians. Only for that reason was it saved and for the same reason the vast structure, partially in ruins but still impressive in character, is still revered by many in the civilized world.

FOR hundreds of years, through which degeneracy and sensuality and ill-won opulence helped bring about the corruption of once great Rome, the brutal combats persisted in the Colosseum. Only when Telemachus, a white-clad monk, on January first, 404 A.D., placed himself among the blood-stained gladiators and called a halt in the name of God to the shedding of blood, did the gladiatorial combats cease. Telemachus was stoned to death, but Honorarius, the Consul, issued an edict forbidding such combats.

Glass Takes On Color

New Fields Opened for Plate Glass . . . Decorative Mirrors . . . Sand-Blasted Designs . . . Panels Lighted at Edges . . . Careful Experimentation

By EARL AIKEN

NO longer is a mirror merely something to use for shaving or to check the tilt of m'lady's millinery. The hand of research has lifted us out of the old-fashioned Looking Glass era. Colored plate glass, for example, has stimulated new thought, opened the door to a mental gold mine of interpretive thinking in applying new types of flat glass to serve us better in utilitarian and decorative uses in every-day life.

One of the interesting trends among architects, designers, and interior decorators now becoming increasingly popular is the practice of facing an entire wall area with plate-glass mirrors. Thus, in rooms of restricted size, is given a sense of spaciousness by apparently doubling the size of the room and repeating furniture and fixture patterns by reflection. This idea received added impetus when plate glass became more and more available in large sizes, and it was accelerated particularly with the recent advent of colored plate glass.

The most extensive use of modern flat glass of any installation that has yet been made in this country is in a Chicago restaurant. One whole wall was faced in colorful opaque structural flat glass, with colored inlay worked into a series of scenes depicting the harvesting of food products throughout the world; sand-blasted designs in clear plate, the panels edge-lighted by indirect illumination to make the characters seem to float in space; and a whole wall in mirrors against which was built a stairway and semi-circular ceiling lighting fixtures. The restaurant seems double its actual size and the vast reflecting areas repeat design and colors in such a way that the surroundings strike a new high in practical fairylandia.

From the business man's standpoint this movement is thought-provoking. The Chicago restaurant just mentioned is not an exclusive rendezvous but a cafeteria where office workers are in the majority. Since modernization, the restaurant's business has tripled.

This new interpretation of what can be done with plate glass in the form of mirrors has lifted many prosaic commercial establishments to a new plane of utilitarian beauty. But the small gown shop, the little cocktail lounge, the drug store, and all the stores along Main Street Everywhere have no corner on the modern Magic with Mirrors; the modern home, from the colonial Cape Cods to the modern streamlined dwellings, reflect the fact that you can see far more than yourself if you'll look at a mirror properly.

Illustrations courtesy Libbey-Owens-Ford

Mirrored plate-glass paneling, placed at one end of a living room, reflects the dining room beyond, making the living room seem larger than it is in actuality

SCIENTIFIC development of a product often is visualized by the layman as a drably mysterious evolution among test tubes, bi-focal delving into volumes of chemistry data by scholarly gentlemen who talk in riddles and move in an atmosphere of pre-occupied self-sufficiency. Quite the contrary, of course, modern scientific developments sparkle with interest. Consider, for example, the development of plate glass. Its historic past and romantic present are rivaled only by its fascinating future.

In order to get a better appreciation of it, however, it is necessary to understand, first of all, the difference between plate glass and sheet or window glass. Most people, when asked for the answer, usually say: "Well, plate glass is thicker," and add an explanatory note that it's "heavier" and "larger."

That isn't the answer, of course. In chemical content and physical size, window glass and plate glass may be identical; the difference between them is that plate glass must have further processing to produce the characteristics which make it superior. When window glass leaves the lehr or annealing oven, it is a finished article, requiring only wash-

ing, cutting, and inspection before being boxed for shipment. But when a plate glass "blank" leaves the lehr it is still a semi-finished raw material requiring for completion even more work than has already gone into it. Its surfaces must be ground and polished to relatively close standards before it becomes plate glass ready for use as such. These processes, developed and improved over a long period of years, require both extreme care and large machinery investment.

On broad conveyors wider than flat cars and, like flat cars, moving on rails and in trains, the blanks, continuously bathed in water and sand which varies from coarse to fine, are carried under rotating grinders where the corrugated surfaces are ground away to parallel planes, thus eliminating distortion by taking off waves and surface irregularities. Then the conveyors carry the glass onward without interruption under the polishing machines, where, with fine iron oxide—rouge—as an abrasive, the glass is polished to high luster by felt-faced disks rotating at high speed.

The surface, therefore, rather than content or thickness, distinguishes plate glass from window glass. The grinding and polishing of plate glass give superior clarity, gleaming beauty, and uniformity of surface long recognized as a valuable factor in the manufacture of mirrors, in the display of goods in show windows and show cases.

THOSE applications, however, have been broadened into a vast field of amazing scope during the past five years, but to evaluate this development more completely it is helpful to look back briefly into the history of plate glass, an absorbing chapter in America's industrial history.

Although glass is one of man's oldest known materials, the invention of plate glass occurred in France in the 17th Century. The idea was conceived by Abraham Thevart and Lucas de Nehou, who contrived to pour glass while in fusion upon a table and to flatten it with a roller. Their goal was to produce larger and thicker sheets than was possible with the hand-blowing methods of that time. Apparently they had not conceived plate glass as a highly polished glass of great clarity as we know it today; their interest seemed to be confined to getting larger and thicker panes. (Window glass at this time was first hand-blown into cylinders of restricted size, then cut on one side and reheated so the cylinder would slowly flatten out. Large panes of window glass as produced today were impossible to make.) The first plate-glass plant began operations near Paris in 1668, and was soon duplicated in other countries, but the industry did not attain any commercial importance until the 19th Century.

It is done with mirrors. The mezzanine rail is built against the mirrored wall, adding a touch of spaciousness and luxury to the surroundings that would be difficult to obtain in any other way

For 100 years after Nehou and Thevart poured their first crude plate glass, the product languished, its market being mainly for small mirrors. High production costs, difficulties of transportation, and the many imperfections in the glass itself precluded its use during this period as a window glazing material.

In the 19th Century, improvements in furnaces and the substitution of coal, and later of gas, for wood as a fuel gradually stimulated manufacturing improvements until France and Belgium were making a vastly improved plate glass—yet very inferior in quality and volume production compared to the present.

It is interesting to digress here momentarily before high-lighting the American development of plate glass. The first attempt to make plate glass in America was in 1860, at Lenox, Massachusetts, but for many years it was such an inferior product that practically all of the plate glass used in this country was imported.

A representative of European glass interests boasted of this fact. Apparently unaware of rapid developments in the United States, he finally became the target for a Philadelphia glass jobber. Secretly marking three lights of plate glass, the Quaker City merchant asked the agent to select the best of the three plates, explaining that at least one was of European manufacture. Much to the representative's chagrin he selected a plate glass that had just arrived from a glass plant in Missouri.

Into the American glass picture, right after the Civil War, there strode a man who came to be known as the father of the plate-glass industry in this country. He was Captain John B. Ford, son of Johnathan Ford, pioneer Kentuckian who had left Danville in 1814 to join the Kentucky troops who journeyed down the Ohio and Mississippi to meet the British in the closing days of the War of 1812. John Ford, the son, had been born a year before and grew up to become a successful iron manufacturer and Mississippi River fleet operator before turning his eyes to the possibilities of plate glass. Eight years after the first American attempt to make plate glass had failed in America, Captain Ford became interested and, in 1870, began operation of this country's first commercially successful plate-glass plant—in New Albany, Indiana.

THERE followed 10 years of rapid expansion, climaxed by a financial collapse. Captain Ford had built several plate-glass factories, but a combination of circumstances found him, in 1880, a man nearly 70 years old and the fruits of his long years of labor completely swept away. What he did to overcome this situation at his age, when most men have retired, is not only an epic of American hardihood, but an integral part of this country's plate-glass history.

He had lost everything but an amazing energy and capacity for work. He boarded a train for New York City, hopeful of recouping some of his financial losses for a new start by selling a patent on sewer pipe made of rough glass to Peter Cooper. That famous inventor and philanthropist was 20 years the senior of Captain Ford, but the two veterans saw eye-to-eye and the Captain sold his patent for a worthwhile sum.

On the train en route to see Mr. Cooper in New York, Captain Ford, due to his habit of striking up conversation with strangers who seemed interesting to him, had met General John C. Fremont. He persuaded the famous soldier

Overhead lighting fixtures at the left are semi-circular; the mirrored wall gives full-circle illusion. Structural flat glass, with sand-blasted designs, used at right

to permit him to attempt to sell some lands held in the west by General Fremont. He made the sale and the commission he received from that, coupled with the sale of his patent to Peter Cooper, enabled Captain Ford to interest eastern capital in starting a plate-glass plant in Pennsylvania. This led to additional plants until all were merged into one large organization in Pittsburgh.

TWO sons, grown to mature business men, had joined Captain Ford about the time he built the Creighton plant and one of them, Edward, became the president of the Pittsburgh company. Edward Ford eventually resigned, and, in 1898, purchased a 173-acre farm site adjoining the city limits of Toledo, Ohio, and built what later became America's largest plate-glass factory under one roof.

Edward Ford, son of the "father of plate glass in America" (who passed on in 1903 at the age of 91) died in 1920 and exactly 14 years later the men who carried on helped to introduce a product—colored plate glass—that instantly made plate glass available in new fields.

Plate glass was first made about 275 years ago. Up through the years, scientific improvements in quality were the major goals as processes and equipment were improved, and its use by architects and designers increased accordingly, but there came a time when they said, in effect: "We can't use clear plate in any other way. Give us more color."

Colored glass had been made in Europe for many years, but, due to lack of demand in this country, little had been manufactured here.

Sand is a principal ingredient in all glass, but for plate glass it must be of the finest quality to insure clarity. Ottawa, Illinois, where much of the polished plate glass used for laminated safety glass is produced, is the hub for some of the best silica sand deposits in this country. Known as St. Peters sand, it received its name from surface deposits near St. Paul, along the present Minnesota River, formerly known as the St. Peter River. The deposits extend east and west, and from Minnesota southward into Arkansas. In many places the deposits are 1000 feet under ground, ranging upward in shallowness to surface exposures. Among the more important surface areas are those at Ottawa and Dixon, Illinois, 80 miles northwest of Ottawa, and in Calhoun County, Illinois, along the Mississippi.

This sand is very white, exceptionally uniform in quality and has a low iron content—between .01 and .02 percent. So high in silica content is this sand that it shines and sparkles almost like glass itself. Most of us think of "fine white sand" as that found at Atlantic City and along Florida and California beaches, but, compared with St. Peters sand, they would produce a glass of poor color.

Another fine grade of silica sand is quarried along the western foothills of the Appalachian range, from southern New York state into West Virginia.

In 1934, the Toledo glass scientists introduced a variety of shades of blue in plate glass. Three types of blue were selected—light, medium, and dark—and vision was possible through each. Color control? Well. the glass men licked that problem and the public reaction to the blues was so favorable that green plate was added, and then peach color. Was all this a great scientific problem? Well, it could be made to appear so, but it was more a matter of careful and tedious experimentation. And there were some laughs, too.

Take, for example, the time when some of the research group at the plant founded by Edward Ford were nosing around for the best ways to make golden plate glass, introduced commercially this year.

One day a truckload of sugar arrived at the main entrance gates to the plant. The driver wanted to know just which of the many buildings beyond the fence was to get it.

THE gateman, not having been instructed, assumed that such an item as sugar must have been ordered by the manager of the lunch room operated on the grounds for the convenience of the office workers. Some minutes later the lunch room manager, a rather quick-tempered chap, investigated the racket going on in the rear as the truck driver began unloading the sugar.

"What's that stuff?" he demanded.

"Eight hundred pounds of sugar," came the laconic reply.

"Eight . . . hundred . . . pounds," snorted the commissary manager. "Why you big blankety zam zowie, I only have five sugar bowls. I couldn't use that much sugar in five years. Get t'hell outta here with that."

After some unraveling, it was discovered that one of the research men had ordered the sugar. He had known that sugar, being a pure form of carbon, had often been utilized by bottle manufacturers to get an amber color.

After experimenting with 800 pounds of sugar to arrive at a golden color for plate glass, however, he had to discard the idea of using carbon in this form, inasmuch as the resultant glass had "bubbles" in it.

The terrific heat required to melt glass for proper handling makes it impossible to use some color ingredients ordinarily practical for other materials. Any one of several faults in glass quality can develop. No dyes can be used, of course; pigments are utilized exclusively and thus plate glass has only mineral coloring.

It would require considerable listing to record all the coloring agents that were tried and rejected, but some of the minerals that get results include cobalt, chromium, nickel, copper, sulfur, antimony, selenium, uranium, titanium, manganese, and cadmium.

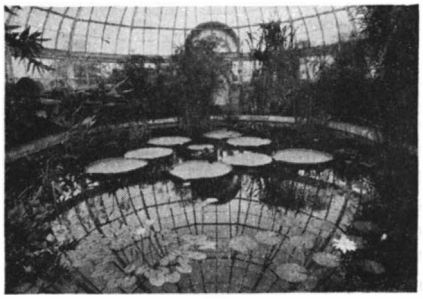
All in all, Mr. Webster's definition for glass seems inadequate. Glass is practically human. At least veteran glass men declare that during its manufacture glass has as many moods as some women . . . that you can never really be sure what it will do next.

An 'Engineered' Lily Pad

"NATURE was the engineer," said Joseph Paxton when describing his great design, the famed Crystal Palace in London. To prove this, he exhibited a leaf of *Victoria regia*, the great water-lily of South America, and explained that "Nature has provided the leaf with longitudinal and transverse girders and supports that I, borrowing from it, have adopted in this building."

From an engineering viewpoint, the enormous leaf, or pad, of this lily is so interesting that we quote below some of the details from a *Journal of the New York Botanical Garden* article by H. W. Rickett.

One who sees for the first time a leaf of *Victoria regia* floating on the water is likely to ask himself: "Would it hold me up?" It is said that the Indians, when they gathered the edible seeds ("water-maize") of the water-lily, placed their children for safe keeping on the leaves (known to them as the "water-platters"). It is only necessary to place a board on the leaf to distribute the weight evenly over the surface. Indeed, if this precaution is taken, a large leaf will support a man weighing 150 pounds. One investigator reported pouring sand on to a leaf to the amount of 400 pounds before it sank. Considering the strength and buoyancy which this represents, it is the more remarkable that the texture of the leaf is very delicate. It is easily punctured by a small object falling from a small distance. This delicate blade floats as gently as a film of oil on the water, yet resists the depredations of animals and the impacts of waves and wind, and can support weights of several hundred pounds, providing only that the load is distributed evenly over the surface.

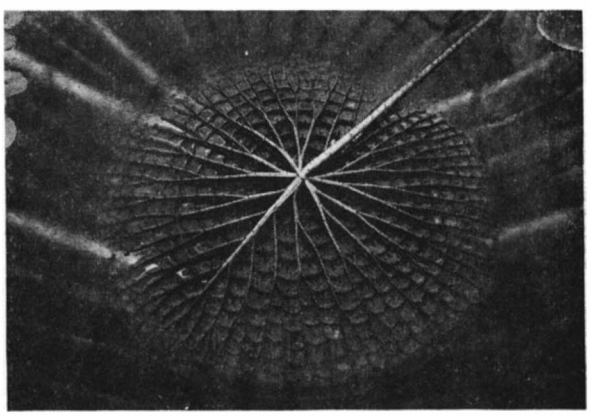


A group of the gigantic lily leaves at the New York Botanical Garden

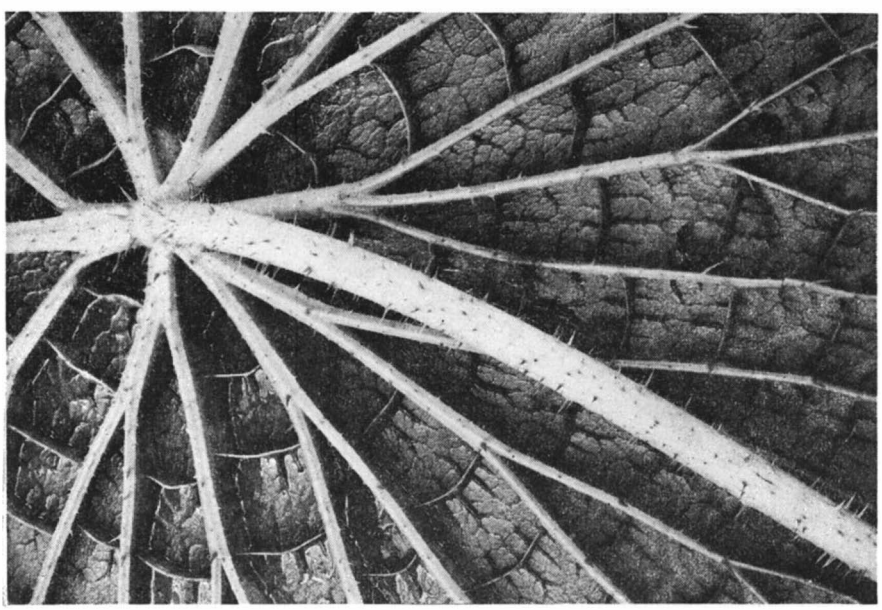
The clue to this curious combination of qualities is seen on the lower surface. Here we find the structure to which Paxton referred in the words quoted above. The delicate flat blade is spread over a system of large ribs, Paxton's "girders," which radiate from the point where the stalk is attached. The ribs are narrow but deep; the free edge is somewhat broadened, but the web which connects this with the blade is quite thin. The main ribs of a comparatively small leaf are more than two inches high at the center of the leaf, and their thickened margins are less than an inch wide. Half way to the circumference they are one inch high and the edges only ¼ of an inch wide. These ribs are supported in a vertical position by cross-ribs, which run parallel to the circumference of the leaf and thrust against the sides of the main ribs; many of them are an inch high. These, in turn, are supported by sloping narrow buttresses firmly anchored in the leaf-blade, and holding the cross-ribs upright.

This is the structure, a product of nature in a remote wilderness, which inspired the design for a great exhibition-building in a civilized country on the other side of the world. Ever since Paxton's day, the construction of greenhouses has involved similar principles.

Structural design does not cease with the gross arrangement of parts, but extends to minute internal details; the microscope is necessary to the understanding even of this enormous leaf. The ribs which appear so solid and massive are really structures of great delicacy. They are composed of air-filled tubes lying side by side, separated by thin membranes from their lateral neighbors and interrupted longitudinally by perforated partitions; the bulk of the great rib is actually mostly air.



To have its picture taken, one of the great leaves was turned over, as shown at right, so that its structure could be examined. Below is shown a close-up of the "longitudinal and transverse girders and supports" on the underside of the leaf. These ribs give the leaf such strength that it will easily support several hundred pounds



Each tube is a structual unit which resists bending far better than would the same amount of material disposed in a solid strand. Therefore each rib, which is a bundle of such tubes, possesses great strength combined with lightness.

The air-filled passages are of value to the water-lily not only for the strength which they afford to the leaf, but because they provide a means by which gases can circulate throughout the plant.

Mystery Of The Magnetic Mine

By C. E. MILBURY

BY this time, British naval authorities may or may not have solved the mystery of the so-called magnetic mine. Our own Navy is doubtless cognizant of its general mechanical characteristics. Whether or not its secret has been solved does not alter the fact that nations readily concede it to be one of the most formidable and diabolic instruments thus far to make its debut in modern warfare. It is practically immune from attack. It renders the convoy system a true hazard instead of a means of safety. It attacks the vulnerable bottoms of even the heaviest of armed battle cruisers Its presence cannot be effectively detected by any known device. The Burney or paravane method of mine sweeping is helpless against it. Several mines might strike the same target, insuring immediate sinking with heavy loss of life. It is light enough to be carried by planes.

It is easy to conceive the possibility of bottling up navies with mines of this type. Sinkings that are quick and certain are the specialty of this improved weapon; and unless effective ways and means are developed to combat its menace, the greatest navies in the world are at the mercy of the unseen, undetectable, and unattackable.

The mystery mines are of two types: First, the inert, shallow-water type; and, second, the mobile, deep-water type.

The mystery mine is comparatively light in weight since it requires no cables or anchors; this fact makes sowing by aircraft a practical possibility. Contrary to speculation, the present mine requires no parachute, but may be dropped into the sea from a height of 200 feet, without damaging its mechanism or without detonation. The detonator does not become "alive" until the mine has been submerged and surrounding water pressure actuates a spring-loaded hydrostatic trigger which sets the detonation circuit by piercing the seal on a small tube of mercury. This mercury fills a cavity containing the contact points of the detonation circuit.

One plane may carry a dozen magnetic mines and drop them as it flies low over the ocean shipping lanes of an enemy country. If the cargo is composed of deep-water mines, it will drop them from a height of from 100 to 200 feet directly into the sea, and they will immediately sink to the bottom at depths up to 400 feet. What happens then may best be understood by an examination of the mine's mechanism as shown in the accompanying drawing.

The mine has three distinct compartments within a casing of non-magnetic metal. The upper one contains a battery, a magnetic device, or grid, of the compass-needle type, several electrical circuits, and two hydrostatic diaphragms that work on opposite principles. The middle section contains the explosive with its detonation caps. The lower section contains an air flask that gives the mine its accelerated rising power after displacing its ballast water. Vent valves near the top of this compartment are held open by light springs; pistons close these valves when compressed air reaches them through small copper pipes connected with the air flask. At the bottom of the mine there is an opening through which sea water will enter when the mine strikes the water, the air being expelled through the open vents. The extreme upper compartment is connected to the lower or air compartment by a tube, the lower extremity of which is firmly screwed into the neck of the air flask, with its spring trigger-valve and its fuse seal.

THE mine's bottom is weighted for stability and the mine rights itself and sinks tail first. The mine descends rapidly toward the bottom, and, at a depth of 70 feet, a diaphragm in the side of the mine near the top, set to operate at an external pressure of 35 pounds, moves inward. As it does so, it pushes a tiny piston which forces the seal from a small metal tube of mercury. The mercury makes a connection between two electrical contacts. This same operation also operates the solenoid and releases the brake on the magnet grid. Thus the mobile and detonation circuits are set, but not completely so, for another hydrostatic valve, pushed inward by water pressure, keeps open the final detonation circuit.

The mine finally reaches bottom and sea floor ooze closes around it. A ship approaches, and, at a distance of half a mile, causes the magnet grid to waver slightly. As the ship approaches nearer, the grid slowly deflects upward, finally pointing to an angle of 65 degrees. Things begin to happen. At this angle of deflection, the magnet grid makes a light electrical contact which, in turn, operates the fuse seal that restrains a spring-loaded valve of the air flask. The fuse melts, permitting the air valve to open; the blast of air thus released rapidly displaces the water ballast from the lower compartment through the hole at the bottom of mine, the air vents having been closed by action of their pistons. The force of the water-and-air jet at the mine's bottom breaks the mud suction and the mine rises rapidly due to increased buoyancy and the jet's push.

Detonation occurs automatically when the mine reaches a level of 50 feet below the surface. This is caused by the outward bulging of the second hydrostatic switch which has been held in the open position by hydrostatic pressure. When that pressure is sufficiently released (at the 50-foot level), the switch closes the detonation circuit, and the explosion occurs.

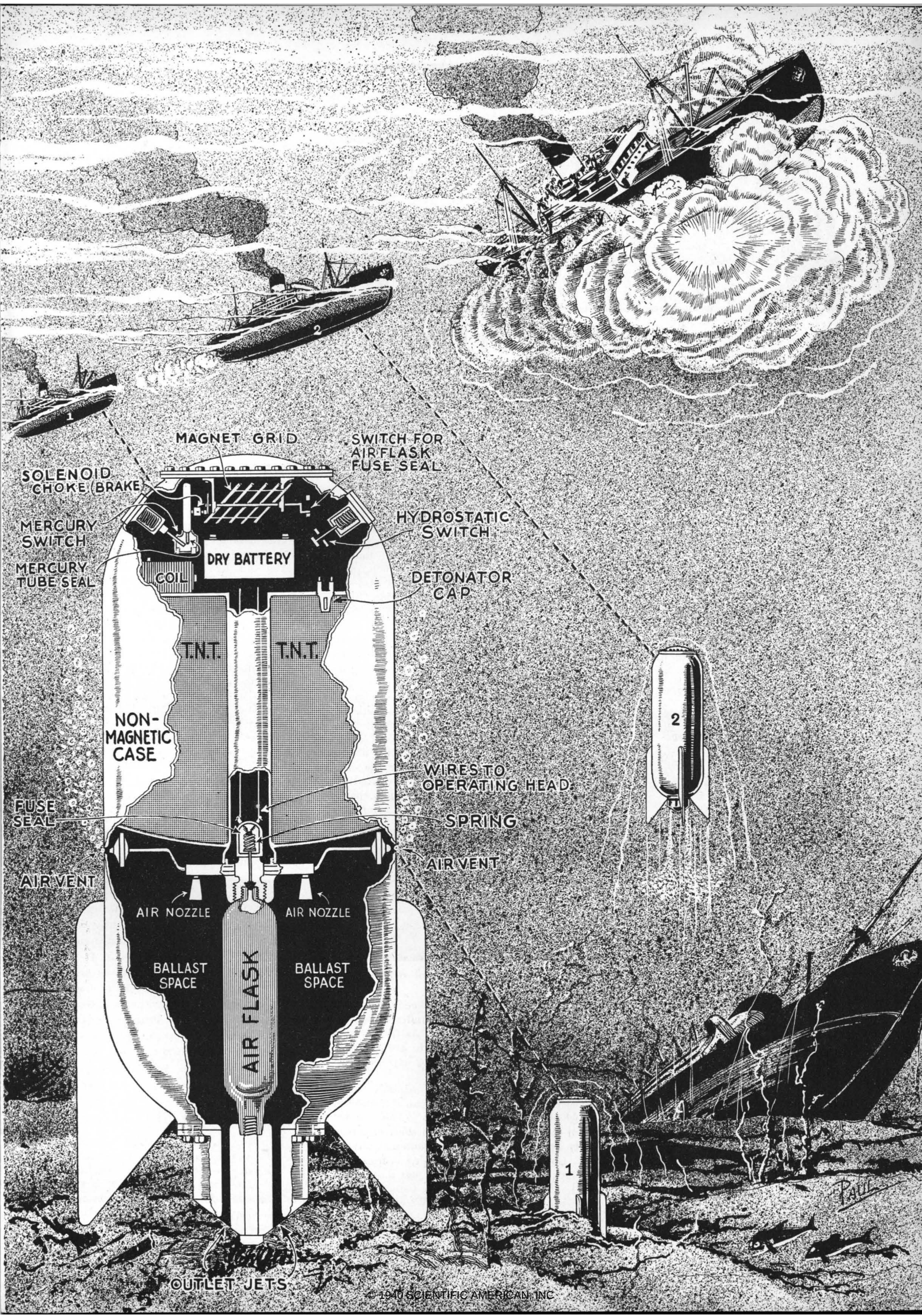
The possible elaborations that may be made in the way of further refining this mine are without possible limit and are to be gaged only by the cost of construction. The mine as now used positively does not follow a vessel by magnetic attraction, nor does not destroy by impact, its destructive action being like that of a depth bomb.

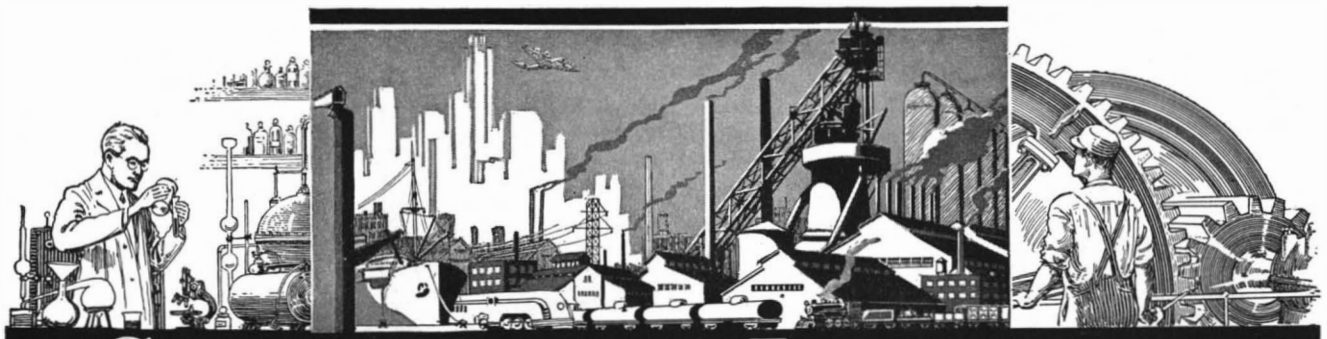
The inert mine, which is laid in channels and harbor entrances, is similar to the mobile mine, without the compressed air system and hydrostatic detonator. Being lighter, it may be more easily handled by plane. The inert mine creates all of its havoc without leaving its mud or sand bed, but the magnet in this case is adjusted to detonate at a deflection of 90 degrees. This insures its detonation only when a vessel is about to pass directly over it.

There will arise an important problem, after peace has been signed, as to how the menace of these mines will be removed. They cannot safely be swept by wire dragging, for the dragging vessels would be destroyed. Even wooden vessels have some machinery that is magnetic and would therefore actuate the mines. Sailing vessels might be used with some effect; but perhaps the safest, most effective method would be to drop barrages of small depth bombs from airplanes. The best solution would be to construct such mines so that the grid would be disintegrated by electrolysis after a reasonable time.

●

At right: **The ingenious, mobile, magnetic mine (German) powered by compressed air. The fish's-eye view shows approaching ship (1) affecting magnetic grid so the mine starts rising; at (2), mine rises vertically as ship approaches; and our artist's conception of the explosion near the ship**





SCIENCE AND INDUSTRY

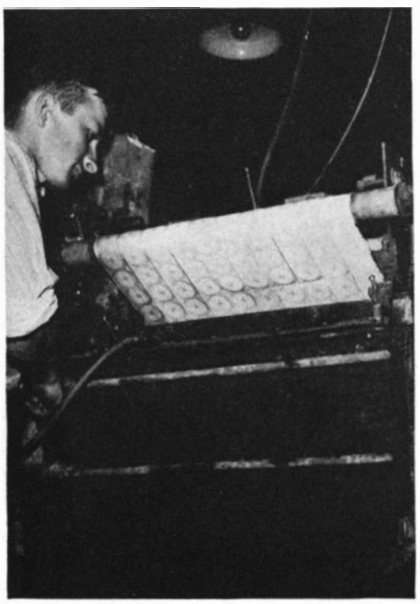
A MONTHLY DIGEST

Conducted by F. D. McHUGH

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

Screen Made by Electroplating

A NEW and unique development made possible by newly perfected electroforming methods is the production of metal screens, reports the magazine *Inco*. The fabric is built up as a one-piece metal product wholly by electro-deposition; no



Screen being stripped from cylinder

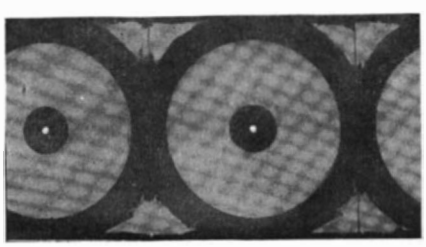
woven or other foundation structure is included in the deposit.

The product is designed to serve purposes lying between those now covered by perforated metals on one hand and woven wire screen on the other. It combines accuracy of hole diameters with the smooth surface characteristic of perforated metals. Its percentage of openings lies between 16 percent and 50 percent of the total area, depending on design. These figures are comparable with those obtainable in woven wire mesh. Generally, the electroplated screen is used in the fine meshes below the limits of perforated metal. Essentially, it supplements rather than competes with conventional woven wire.

The plated screen, known by its trade name of Lektromesh, presents a smooth surface and is readily fabricated by drawing, stamping, welding, soldering, and the like. It is stiff, tough, and strong. Another special feature is the latitude in design which it makes possible. The mesh can be of any shape and of a variety of sizes. It has a unique quality in the fact that in some sizes and designs a two-inch piece may be stretched to one foot. It also can be designed to avoid heat conduction. Since it is an integral structure, it will not unravel.

Continuous production methods are used with such success that screen has been made in rolls 36 inches wide and up to 1400 feet in length.

In manufacture, the desired design is transferred by a succession of sensitizing, etching, filling, and surface treating processes to a metal plate or matrix. These operations leave the metal surface of the matrix in a condition to receive the electro-deposit uniformly where desired and yet allow it to be withheld where open spaces are necessary. The matrix, when completed



Strip of electro-formed strainers

with its exposed and masked sections, is fastened to a circular cylinder which revolves in the plating bath. As the cylinder revolves, the metal deposits are built up evenly and uniformly on the exposed areas of the matrix.

Thickness of the deposit depends on the current density used and upon the speed at which the cylinder turns. The deposit in the form of a continuous sheet of screen is stripped off the matrix automatically.

Commercially, Lektromesh has been produced in sizes from 25 to 400 mesh, with the bulk of production to date lying between 25 and 150 mesh. "Wire sizes" have ranged from what in round woven wire would be .0008 to .025 of an inch in diameter.

The complete processes of production are covered by patents held by E. O. Norris, Inc., under which the C. O. Jelliff Company holds exclusive rights.

The Eskimo Goes Modern

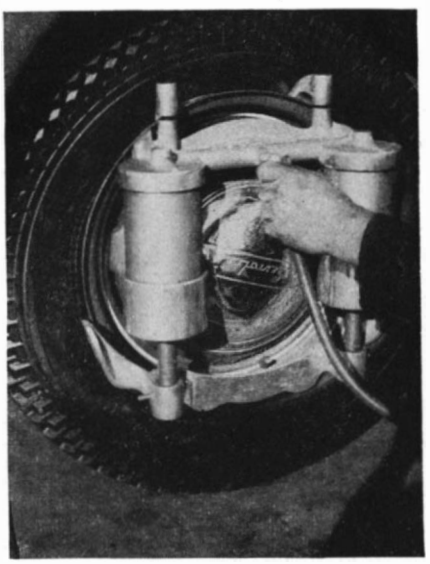
DENTISTRY has taken firm root among the Eskimos — literally.

A Mackenzie Delta Eskimo had a tooth knocked out by a harpoon handle. He had heard of the white man's false teeth and, after pondering the matter for a while, he carved a tooth from ivory, root and all, and drove it into his jawbone with a mallet.

According to Philip H. Godsell, who tells the story in an article in *Natural History*, the magazine of the American Museum of Natural History, the man was apparently none the worse for his painful but effective bit of dentistry.

Mounting Tires With Air Pressure

THE need for injurious pounding of tire beads in mounting tires on automobile wheels has been effectively eliminated by the Safe-Way Pneumatic Tire Mounting Tool, a product of SafeWay Tool Company.



Air mounts a tire

This lightweight aluminum tool uses air pressure to mount tires noiselessly and safely.

The tire is hung on the wheel in the usual manner, then the Safe-Way tool is hung on the rim, in contact with the lower exposed bead. An air hose is connected to the tool, and, in the short space of three seconds, the tire is in place on the wheel. No pounding of the bead, no missing the tire with the hammer and damaging the wheel paint. A noiseless mounting job is done in a jiffy.

To keep the weight of the Safe-Way tool down to a point where one man can handle it, aluminum alloy castings are used for most of the parts. The entire tool weighs only 18 pounds, and exerts a pressure of one ton when working on an air pressure of 125 pounds.

Pavement Roughness Recorder

IN constructing highways it is necessary to eliminate waves and humps which would affect motor-car speed and comfort. Hence, after a pavement is laid, these humps are hunted out and rubbed down. Many types of devices have been worked out for the hunting job but until development of the Viagraph there was no satisfactory recording mechanism.

The Viagraph, which was recently discussed in *California Highways and Public Works*, produces a graphical representation of the road surface. The present instrument is a further development of a surface meter first made by Mr. Claran F. Galloway. "Essentially, the road surface meter is the same as the original Galloway instrument," says Mr. Douglas H. Greeley, writing in the above-mentioned magazine. "Some improvement in design and construction was effected and a totalizer to record the travel of the graph pen has been added. In addition, an odometer was also added so that engineer's stations or distance might be observed."

As shown in the accompanying illustrations, the wheels of this instrument make a three point, in-line contact with the road surface. When this device is operated at a walking speed, it is steered by turning the handle in a manner similar to that of the throttle control on a motorcycle. The recording mechanism is operated by the middle wheel which is mounted in a "floating" position, the pen being raised or lowered on the graph paper as the instrument is wheeled over an irregular surface.

"During operation," says Mr. Greeley, "the chart paper progresses at the rate of one inch each 20 feet, the pen movement being at a ratio of two to one; that is, a bump one quarter inch in height will be drawn one half inch in height on the chart. As this process continues, the pen's movements, in a positive direction only, are measured by the totalizer and recorded by its dial. This is accomplished by an overriding clutch which allows the negative movement of the pen to occur without measurement. Also during this process, the distance is recorded on the odometer dial."

One-Eyed Spectacles

THE eyeglass of the future — a million years or so hence — will look like the model designed by Pitt H. Herbert, of the Bausch & Lomb Optical Company, if biologists are correct in the assumption that Nature is gradually working toward a single eye in the center of the face. Tests show that many people have a dominant eye which does most of the seeing, just as most people are right-handed. The dominant eye often does 90 percent of the seeing.

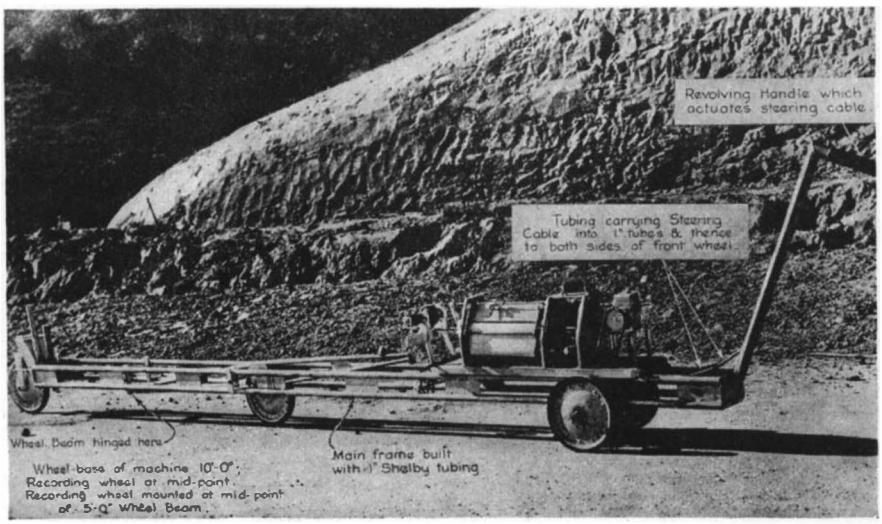
The effect of a dominant eye is to decrease stereoscopic vision. Things look flatter. Some biologists, looking thousands of years into the future, suggest that in time all our seeing may be done with one eye and that, in effecting the change, Nature will have moved the eye to the center of the face, perhaps in the middle of the forehead, turning us into a race of Cyclopes.

For the future?

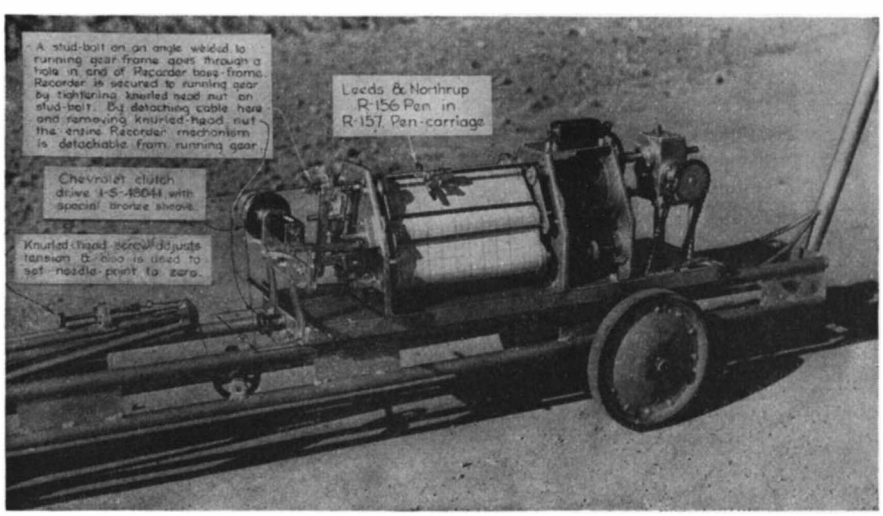
Fruit Flavors

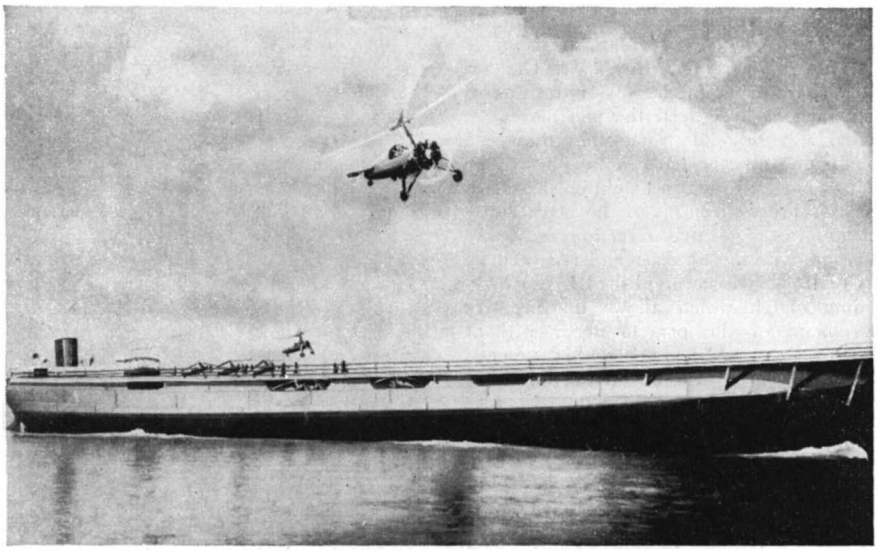
THERE are so many fruit flavors used in cakes, pies, ices, and soda-fountain drinks that it is usually taken for granted that these are natural fruit flavors. However, there are but few pure fruit flavors now on the market and most of these are not satisfactory. The processes of manufacture now in use permit undesirable changes to occur. These changes alter the flavoring and make it less desirable than the synthetic or imitation flavors derived from coal tar and other organic products. The problem presented here is not a new one. Many researchers have endeavored to perfect a process of extracting the unchanged flavors.

In announcing that a study of the preparation and manufacture of pure fruit flavors from strawberries, raspberries, and cherries has been undertaken at the New York State Experiment Station, that station announced that it might even be necessary to blend new flavors of fruits which will yield especially potent flavors that can be easily extracted. This new project has been set up under the terms of an industrial



General view of pavement roughness recorder and *(below)* close-up of chart





Above: **A proposed type of autogyro carrier for protection of shipping.** *Below:* **Artist's drawing of a 'gyro patrol plane landing on a platform built on a freighter**

fellowship sponsored by one of the large food corporations; Fletcher Chase, a chemical engineer, is now engaged on this project. Should success attend his efforts, new and larger markets for flavors might be found than that now commanded by the synthetic flavors trade, estimated to be in the neighborhood of one million dollars a year.

New Rubber-Metal Adhesive

THE sharp demand for bonding agents that enable manufacturers to wed rubber to metal and Thiokol "synthetic rubber" to iron, steel, lead, and the like, is producing real results. Latest result is Ty-Ply—a non-tacky adhesive marketed by the R. T. Vanderbilt Company. This adhesive is of two types: Ty-ply "R" for rubber and Ty-Ply "S" for Thiokol.

Using this adhesive, manufacturers can brush or spray practically every metal with a thin film. Within a very few minutes, this Ty-Ply film dries sufficiently to receive the layer or sheet of rubber or Thiokol to which it is to be bonded. The assembled product is then placed in molds and inserted in a vulcanizer. Upon completion of a short vulcanizing cycle, the mold is emptied to reveal an exceptionally strong single unit. Besides being non-tacky, the new adhesive is economical to use because the thinnest film gives the best bonding results with metal.

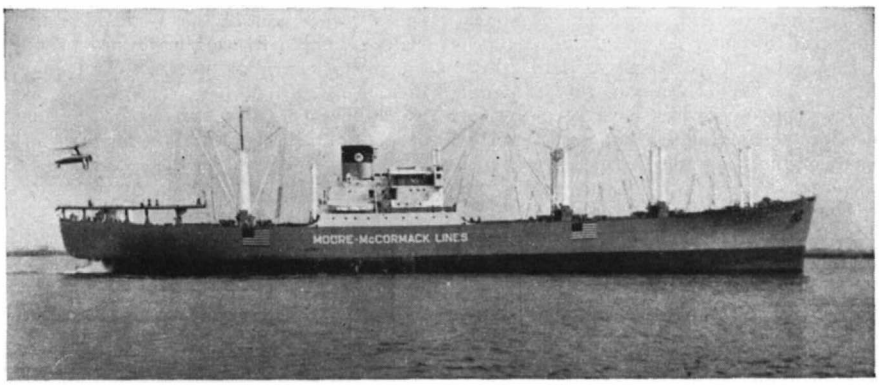
The development of such adhesives, researchers contend, is hastening the day when it will be practical to protect tank cars, vats, and other metal equipment with linings of oil-proof, grease-proof "synthetic rubber."

Battle for "Kerosine"

WEBSTER still insists that it be spelled "kerosene," but for 15 years the American Petroleum Institute, the American Society for Testing Materials, and a few hardy publications and individual converts have weathered mild and sometimes bitter abuse by joining in an orthographic adventure to promote the spelling which they believe is correct: "kerosine."

Proponents of "ine," slowly growing in numbers, point out that gasoline, benzine, and kerosine all are coined words having no strict chemical meaning. The "ene" ending, as in toluene, benzene, and other words, indicates a definite chemical compound. Since the ending of kerosine should have no chemical significance, they say, it is much to be preferred that the ending correspond with those other coined, non-chemical words, than that it have an ending which might possibly be confused with the chemical "ene" words. Gasoline began its life with both endings, but finally settled down to the more logical spelling. For some unexplained reason, however, the "ene" became firmly attached to kerosine.

Even if Webster and other official arbiters of orthography do adopt "ine," however, the present proponents feel certain that for decades the mails will continue to carry a steady flood of letters beginning, "I liked your article, but why don't you spell that word right?"



Germ-Free "Blood Banks"

SULFANILAMIDE, powerful chemical remedy for a host of germ diseases, is now being used to make blood transfusions safer. A small amount of sulfanilamide added to blood that is to be stored in blood banks for future transfusions prevents the growth of bacteria in the blood for from 10 to 15 days and may even make the blood completely germ-free. Details of the method were recently reported by Dr. Milan Novak, of the University of Minnesota.

Some of the serious reactions occurring after blood transfusions may be due to unsuspected germs in the blood given, Dr. Novak points out. Blood for transfusion is always tested for syphilitic infection before use. Tests for other germs which may lurk in the blood of healthy donors are not always made. Germs can also get into the blood when it is drawn from the donor or in preparing it for storage, in spite of precautions that are always taken against such contamination. — *Science Service.*

Rotorcraft Patrols for Merchant Shipping

EXTENSIVE studies of the possibility of protecting merchant shipping by the use of autogyro patrols has been made by R. G. Kellett of the Kellett Autogyro Corporation. The results of these studies were made public at the recently held Second Annual Rotary Wing Aircraft Meeting in Philadelphia.

Modern autogyros, with jump-off characteristics, can operate on platforms no greater than 40 by 60 feet, which can be installed on most sea-going craft. One of our photographs shows an artist's conception of such a platform. Tests with conventional aircraft indicate that visibility can be obtained to a considerable depth below the surface of the sea. A 'gyro patrol could therefore readily locate mines or submarines, and its pilot destroy them with depth charges or bombs. Under such a plan, surface vessels would carry patrols of two or three 'gyros, so that there would be constant protection even when one or more of the aircraft were being serviced or refueled. (See also page 339, December, 1939, Scientific American.—*Editor.*) An alternative proposal, shown in another illustration, would be to use a converted tanker or freighter as an autogyro carrier.

The suggestion is timely and deserves full consideration by the navies and merchant marines of a number of countries.—*A. K.*

Lessons in Military Airplane Design

WHAT is the best possible way of learning the requirements of the military design of aircraft, short of taking part in aerial warfare? Answer: To study every bit of news that comes through the censor's hands. Is the speed of the Messerschmitt useless in comparison with the greater maneuverability of the Curtiss Hawk? Then too high a speed, and too high a wing loading (militating against maneuverability), must be avoided. Is the new Messerschmitt, equipped with two 1000-horsepower engines, and carrying a really

long range cannon more than a match for the Spitfire? Then we must give attention to twin-engined pursuits, similarly equipped with cannon. Can bombers, with adequate machine-gun fire, reach their objectives and fight off a swarm of enemy fighters? If not, the long-range bombers must be supported by single seaters having a similarly long range. Needless to say, combatants in the present struggle are ardent in such studies. If the British and French missions have delayed a little in placing large aircraft orders, then it is because they are studying reports of this character before deciding on policy and types.—*A. K.*

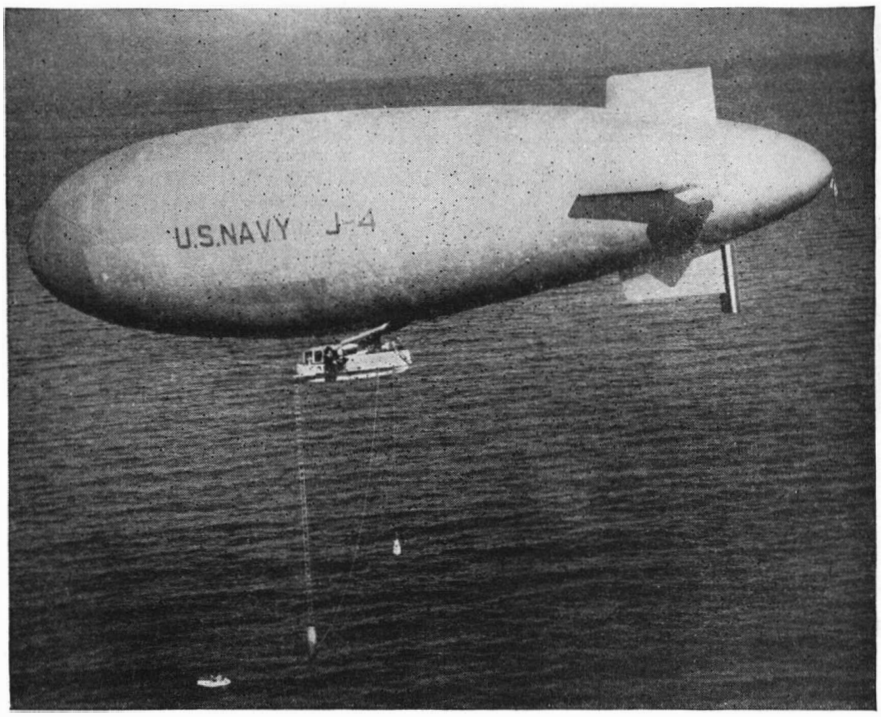
Anchoring Small Airships at Sea

FROM Commander J. L. Kenworthy, Jr., of the Lakehurst Naval Air Station, we have received a first-hand account of the excellent methods which have been developed by the Navy for anchoring small airships or "blimps" at sea.

There are two main problems in anchoring the blimp; one is to achieve static equilibrium, the other to hold the ship at rest against the action of the wind with engines not running, or merely idling.

At the end of a journey, the airship has consumed a certain amount of fuel, and is therefore light. To release helium from the gas bag is too expensive. In a large rigid airship, the exhaust gases are cooled; the vapor condensed by cooling adds ballast to the ship and restores equilibrium. But a water recovery process is too bulky and clumsy for use on a small airship.

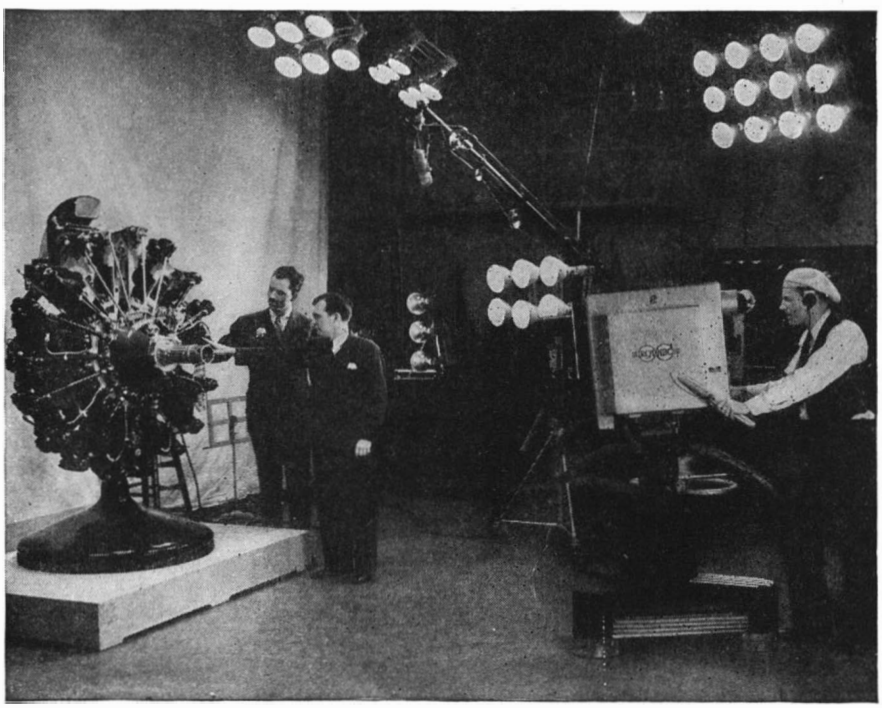
So the problem of making the ship heavy at the end of a voyage has been solved in a novel and ingenious manner. Suspended from the front of the airship car by two vertical cables, there is a large, conical shaped water ballast bag. The lower tip of the bag is connected with the rear end of the car by a haul-in rope of suitable strength. By a method which is still regarded as confidential, the conical bag can be filled with a desired quantity of water, and then drawn above the surface of the water. At the same time, ballast is dropped from the airship to about 50 percent of the weight in the conical water bag. The buoyancy of the gas bag itself now holds the ship in taut equilibrium.



Rubber boat approaching a blimp moored at sea

Thus the first problem is solved in a simple yet effective manner. The second problem was solved by an improvement in the use of a drogue or drag anchor. The drogue consists of a flat, metal cone which is payed out by a wire from the front of the ship. The nose mooring-point seems to be best suited for the drogue wire. The drogue is connected to the pay-out wire by a four-legged bridle, and is kept in the proper position, free from the influence of surface waves, by a weight below and a rubber float on top. By adjusting the legs of the bridle, the pull can be adjusted in direction and to some extent in magnitude. With this drogue, the ship can be kept at anchor; it can also be steered and the airship can be maintained at rest at various angles to the wind direction.

The story does not end here, however. The top opening of the water-ballast bag is closed by a heavy wire mesh on which a person can stand, but through which water can escape or enter freely. The two vertical cables (which are partly ordinary cable and partly shock absorbers) are connected with ordinary ladder rungs to permit communication between the surface of the water and the airship car. The freedom of action of the blimp is further enhanced by the fact that fuel, provisions, and so on, can be hauled on board from a surface vessel, by means of an electric winch. — *A. K.*



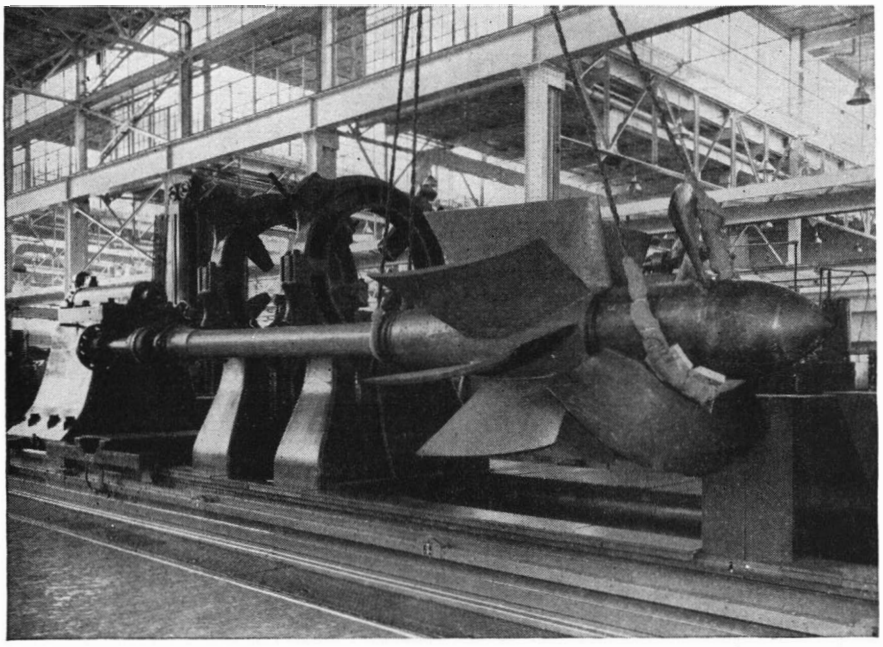
Demonstrating, by television, the operation of an aircraft engine

Television Broadcast of an Aircraft Engine

ONE of our photographs shows Ronald S. Gall, of the Wright Aeronautical Corporation, busily demonstrating for the first television broadcast of the operation of an aircraft engine. The Wright 1100 horsepower, nine-cylinder Cyclone was cut away and revolved by an electric motor. N.B.C. actually staged the show under the auspices of the Air Transport Association. Such television broadcasting has real possibilities of an educational nature. — *A. K.*

100 Horsepower, 100 Pounds, $100

WE do not always agree with William B. Stout, noted aeronautical engineer and designer, in his conceptions, and he does not always bring his brilliant conceptions to commercial fruition, but no man has a more vivid and stimulating imagination in technological matters. Writing in *Aero Digest*, he gives us a slogan which is fascinating: "An engine of 100 horsepower; weighing 100 pounds; at a cost of $100."



. . . a capacity of 157,750 gallons per minute

This is a splendid goal to shoot at; we are badly in need of inexpensive and light engines of 100 horsepower for private flying. High revolutions per minute, in a six-cylinder opposed, flat or pancake type of motor, which, if desired, can be hidden inside a wing, is Mr. Stout's solution. — *A. K.*

CANDLE-POWER

SOMEONE has estimated that a half ton of candles would be required to produce the amount of light used monthly by the average family. The cost would be about $350 as compared with the electric light bill of that average family, which is about $2.50.

Slush Molding Phenolic Resins

WHITE metal and other materials have long been slush molded — that is, poured into a mold and agitated until a shell of the material cools in all parts of the mold and a hollow casting results. This process has now been adapted in the plastics field so that hollow castings of plastics may be obtained.

With metal, slush molding is relatively simple because the metal chills and hardens quickly on the inner surface of the mold. The problem with plastics was more difficult, for a hardening accelerator had first to be discovered. This has now been found and a large variety of hollow plastic castings can be made, including advertising displays, lamps, souvenir novelties, and a number of other products.

Latex rubber is sprayed on the model to be reproduced, and allowed to cure to the proper consistency. Then a fairly heavy coat of plaster of Paris is spread over the entire outer surface of the rubber. This plaster-and-rubber mold is cut away from the model, fitted with dowel pins, and assembled as a rubber-lined plaster slush mold ready for production.

Liquid resin, properly accelerated, is then poured into the orifice of the mold and agitated by revolving or slushing the mold for a period of 15 to 20 minutes. The accelerator cures the resin to the necessary hardness in this time, after which the mold is disassembled. The resultant casting faithfully reproduces detail, and has a sectional measurement of $\frac{1}{8}$ to $\frac{3}{16}$ of an inch. The casting is found to be light, tough, and translucent. The natural ivory color of the resin (the only color which is available) may be complemented by the addition of such lacquers or spray paints as will emphasize its best characteristics.

If properly handled, the mold can be used for about 150 castings.

Gun Fires Wire on Parachute

MUCH has been written of the balloon barrage over London, the cables of which are intended to entangle enemy bombers. In our December issue we described a further entangling device consisting of small free balloons supporting a wire at the end of which was attached a bomb. Both of these defenses should prove very effective.

The United Press reports a third entangling device which consists of a steel ribbon hundreds of feet long which is supported by a parachute after being fired in a shell from a big gun. This is an American invention but is now being experimented with, says the United Press, in France. The trick of the invention is said to lie in the method of coiling the wire within the shell. That shell is described as being about 6-inch caliber, and is fired from guns in regular fashion. When it reaches its highest altitude, the nose falls away, uncoiling the wire as it falls and dragging out the parachute which then supports it for a slow descent to the earth.

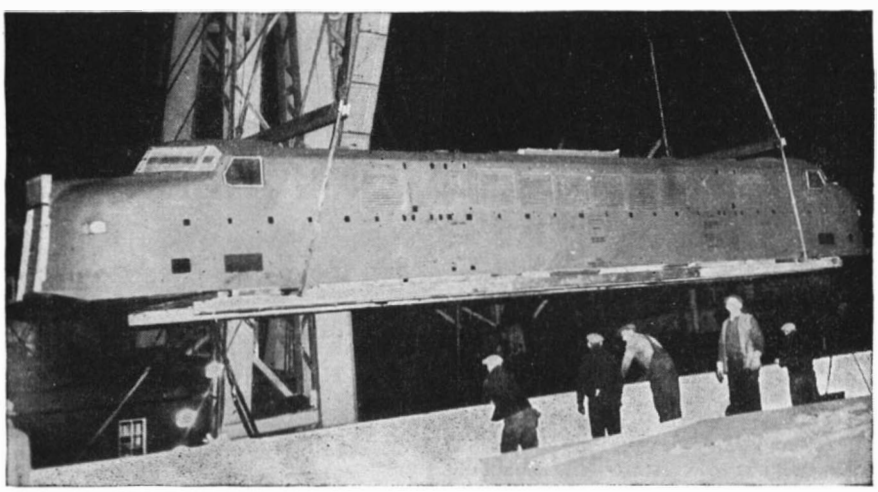
It is easy to see that a barrage of shells of this type would quickly form a veritable network of wires dangling in the air, unseen by enemy bombers. Any one of those wires, caught in a propeller or on some part of the plane itself, would bring it down.

A Match for Eighty Fire Engines

EIGHTY of the largest fire department pumpers, working at full speed, could barely produce a torrent of water equal to the stream the strange-looking device in our illustration lifts into the main powerhouse at the Rouge Plant of the Ford Motor Company in Dearborn, Michigan. It is the impeller of a vertical lift pump which has a capacity of 157,750 gallons of water per minute, compared with a maximum capacity of 2000 gallons per minute in a fire department pumper. Every 24 hours four of these huge pumps bring as much water to the steam condensers in the power house as is used in the same length of time by a great city. The water comes from a 15-foot tunnel which connects the plant with the Detroit River, two miles away. The impeller was photographed recently while undergoing a minor repair in the Ford tool and die shop. It is six feet in diameter and more than 20 feet long.

D. C. Locomotives

THE accompanying illustration shows the first of the four most powerful D. C. locomotives in the world, built by General Electric for Paulista Railways of Brazil, being loaded on the S. S. *Santos* in Brooklyn for shipment to Santos, Brazil. For high-speed passenger service, this locomotive and the three to follow weigh 185 tons each and have a top speed of 93 miles per hour. They have a continuous rating of approximately 4200 horsepower, and a one-hour



Loading a powerful D. C. locomotive for shipment to South America

rating of 4560 horsepower—a rating higher than any other direct-current locomotive now in use either in this country or abroad. They are powered by 3000-volt motors.

The Paulista locomotives have a gage of five feet, six inches, and in order to test them, the Erie G-E Works was required to lay a special wide-gage track. Paulista Railways has a large number of electric locomotives in service.

RESEARCH

DURING 1939, approximately 2000 individual companies spent some $215,000,000 for industrial research. Two leading companies in this work for progress were du Pont with a research budget of $7,000,000 and Dow Chemical Company with one of $1,400,000.

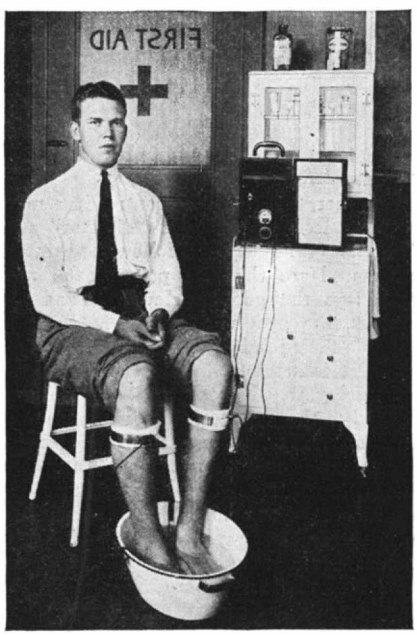
Milkweed Enzyme Makes Steak Tender

THE lowly milkweed can be made to yield a rare derivative that aids digestion and makes tough steaks tender, it has been revealed.

Asclepain, the new derivative, is a proteolytic enzyme, which breaks down the protein in foods into more simple, easily digestible substances, it was reported. Only one other plant has been found to yield a similar substance—the papaya, source of papain.—*Alcohol News.*

Machine to Cure Athlete's Foot

KNOWING that it has long been established that copper is an excellent fungicide, researchers A. G. Conrad of Yale University and Dr. Howard W. Haggard worked out in the laboratory some months ago a process for what amounts to an impregnation of the skin of the feet and hands with electrolytic copper to destroy the fungus which causes "athlete's foot." This impregnation was accomplished by an electrolytic method of depositing copper



To destroy athlete's foot fungus

Treating fungus infection of hand

under the skin from a solution, and was discussed in the June, 1939, issue of Scientific American.

This process has now been reduced to practice in a machine made by Mine Safety Appliances Company and called the M.S.A. Rheoderm, which treats fungus infections of the hands and feet by the iontophoresis of copper. This machine is a relatively simple electrical apparatus that can be operated by any doctor, and is absolutely safe. It introduces metallic copper into the deeper layers of the skin without injury to the skin or discomfort to the patient. The majority of patients so far treated with the instrument have experienced prompt and gratifying relief from all symptoms of athlete's foot, indicating that the method possesses efficacy that will be widely welcomed.

Naval Gun Controls

AFTER the recent battle between the *Graf Spee* and three British ships off the coast of Uruguay, so many newspapers commented on the fact that guns had to be hand-pointed after certain controls had been smashed that some readers have asked us for details concerning the manner in which guns are operated on naval vessels.

There are two methods of controlling the fire of the guns of a capital ship. One of these is called "director" fire; the other "pointer" fire.

The normal method of control in a modern battleship would be "director" fire. This is essentially a "follow-the-pointer" system. Here the gun pointer, the man who lays the gun in elevation, and the trainer, the man who lays it in azimuth, both do their job by matching pointers. One of these is actuated by an electrical transmission gear, the other is mechanically geared to the gun-elevating or gun-training mechanism. The electrical impulses for elevation emanate from the plotting room, down deep in the ship, where ranges and spotting data are analyzed, and sent out over this repeating system to the various gun mounts. The impulses for training come from the particular "target bearing transmitter" that has control at the time. This latter is merely a master sight, generally in a position of great elevation, that is kept

constantly trained on the target manually. The actual firing is done from the control tower or whatever unit has control. The work of the gun crew is mainly to load and unload the guns. Of course, each gun or turret has its own switch, and the guns can not be fired until these switches are thrown, at which time the "ready" lights will show in the control tower. The check sights are manned, however, to be sure the "follow-the-pointer" system is functioning.

The impulses for training, in the "director" fire method, do not flow directly from the "target bearing transmitter" to the gun mount. They are fed into range clocks — more often called rangekeepers — in the plotting room. The whole fire control problem is analyzed on these rangekeeping machines, and the impulses for both elevation and train are sent from the rangekeeper to the gun mount. The other data that are fed mechanically to the rangekeeper are the ranges, which come from the range-finders, and the spotting data (corrections) sent down by the officer who does the spotting. The latter is available, of course, only once the battery has opened fire.

"Pointer" fire is essentially individual operation of the guns. This would be necessary were the control tower shot away, or the fire control system generally put out of commission. The plotting room sends out its ranges and deflections over electrically operated visual signal systems. The sightsetter sets his sights to these values, the effect of this being to displace the axis of the gun from the telescopic sights by amounts calculated to take care of the range and deflection. The pointer puts the horizontal cross wire of the telescopic sight on the target, the trainer puts the vertical wire on. It is the pointer who fires when the firing signal is given — or as soon thereafter as he is "on" the target. Should the plotting room cease to function, the officer in charge of the battery, or the gun captain, would call out the ranges and deflections as best he could, and continue the fire on his own control.

In addition to these, it may be stated that some experiments have been made with what is called "remote control" direction of the guns. Here the control extends actually to laying the guns in elevation and in train by power mechanisms, eliminating the "follow-the-pointer" personnel and leaving only the loading and unloading of the battery for the gun crews. This has not generally been applied to large turret mounts, being used more for the lighter anti-aircraft guns.

Aluminum Tinning Flux

THE difficulty attending the job of soldering aluminum has become traditional. Of great significance, therefore, is a new tinning flux for aluminum, which makes possible simple soldering with commercial solders. Called Amco, this flux is a product of the American Solder and Flux Company.

To tin aluminum, using Amco, it is necessary that the metal be properly cleaned and preferably roughened. On thin sheet metal, either a clean source of heat or an extra hot soldering iron may be used. On cast aluminum or aluminum alloys, the heat is supplied around the surface or from the opposite side. When the flux is applied to the surface and heated, the action is at

first the same as with ordinary flux, but as the heat is continued, a heavy white vapor is given off. With this action, the deoxidizing and tinning of the metal takes place, after which ordinary tin-and-lead solder may be used.

MEDICINE

THE dried and powdered bodies of five poisonous creatures are still used as medicines in China. According to *Natural History* magazine, these creatures, often depicted in jade carvings, are: the lizard, the snake, the toad, the spider, and the centipede.

Swedish Instrument for Locating Cables

A NEW instrument, which makes it possible to locate accurately and rapidly underground cables and piping, has been constructed by a Swedish firm, the L. M. Ericsson Telephone Company, of Stockholm.

The device consists of three separate parts: a transmitter buzzer, a cable finder with built-in frame aerial, and a finder coil. The measurement is based on the principle that an electro-magnetic field produced by an alternating current in a metallic conductor can affect a telephone receiver circuit. The alternating current is produced by the transmitter buzzer, which is connected to one end of the cable or pipe to be investigated, and also to the earth. By carrying the cable finder in the direction of the cable, the exact position of the latter is easily determined through the intensity of the sound in the ear phones, which is strongest right above the cable.

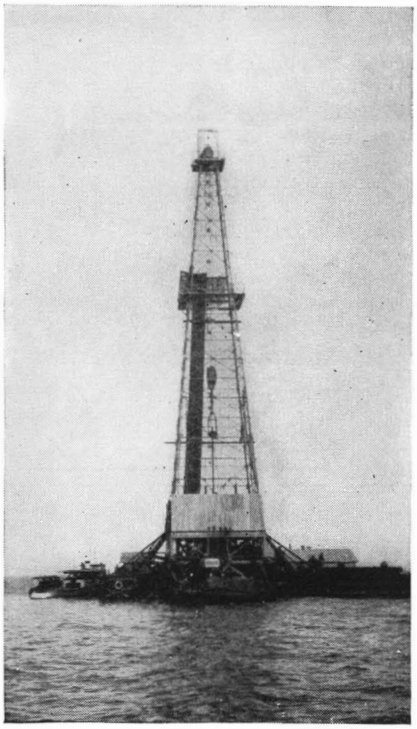
In this way can also be fixed the exact place of an earth leakage, since the electromagnetic field, and therefore also the sound, disappear at such a place. It sometimes happens that an earth leakage has arisen without it being possible to discover any visible injury to the cable armor after excavation. It is then that the third part of the instrument, the finder coil, is employed. With its aid, the precise point of the fault is fixed. Experiments also have shown that in cases where several cables were lying together, the one connected to the transmitter buzzer could be found without difficulty through the coil. Another feature is that a low-tension power cable without a fault does not need to be put out of service if its route is investigated by means of the new method.

The cable finder also can be used with success in locating gas and water mains. — *Holger Lundbergh.*

Oil From Under the Ocean

MORE and more oil is being taken from wells drilled under the ocean some distance from shore. Large numbers of wells have been drilled on the California coast from the extreme ends of piers stretching out into the water. However, in Galveston Bay this under-water drilling needs no connection with the shore, mainly because of the shallowness of the water.

According to the *Standard Oil Bulletin,*



Discovery well in Galveston Bay

seismographic surveys were made on the floor of Galveston Bay covering an area of 236,000 acres. Later, a detailed survey was made of 48,000 acres of the original 236,000. Both jobs were done by crews living in a houseboat and working from special barges and boats. This work resulted in the discovery of a buried dome and the first wildcat well drilled on this dome became a discovery well at a depth of 6030 feet. Two more wells were drilled — these being drilled from pile foundations as was the first. It was then found advisable to change the method of drilling, and so a barge was put into use. By this method a large barge, to provide a drilling platform, is filled with water and sunk over the location for a well. Drilling is done from a rotary table which stands up above the surface of the Bay. Throughout the work area, the water is not more than 12 feet deep, and when one well is completed, it takes only from 12 to 18 hours to lift the barge and move to a new location.

There are now 11 wells completed and two are in process of drilling. The discovery well is about one mile from shore and the others vary in distance from three quarters of a mile to two miles.

New Pneumonia Treatment Announced

A NEW chemical treatment for pneumonia, using a new drug, sulfathiazole, has been announced to the medical world. Physicians who tested it experimentally on human patients, reports *Science Service*, pronounce it even better than sulfapyridine, widely hailed in recent months as the chemical conqueror of pneumonia.

The new drug is safer than sulfapyridine, and it does not make the patients sick. Nausea and vomiting, which have been a distressing feature of sulfapyridine treatment, are practically absent when sulfathiazole is given, physicians report.

Laboratory experiments on hundreds of mice show that the toxicity of sulfathiazole

is much less than the toxicity of sulfapyridine, except in doses far larger than are needed to cure pneumonia.

In the body, sulfapyridine is rather rapidly combined or conjugated with acetic acid. This unfortunately makes the drug inert and useless in its effect on the infection, only the uncombined form being active. The new drug, sulfathiazole, however, combines with acetic acid to a much smaller extent, so that most of the drug given is effective until it is excreted. This means that doctors do not have to give as much sulfathiazole as sulfapyridine to treat a pneumonia patient. Chronic poisonous effects from accumulation of the drug in the body are much less apt to occur because sulfathiazole is excreted more rapidly than sulfapyridine.

FILTERS

"BLACK-OUTS" in warring countries usually necessitate painting factory windows, so that electric lights are necessary in the daytime. In England, complete obliteration of windows is obviated by use of blue windows and orange lights inside. During the day some daylight is transmitted, but at night the blue glass will not transmit outwardly the inner orange light.

"INVISIBLE" GLASS CAMERA LENSES

A METHOD of coating camera lenses with evaporated metallic fluorides, which greatly increases the effective speed of lenses, produces a marked improvement in contrast under adverse lighting conditions, and eliminates flare and ghost images, was recently announced by Dr. C. Hawley Cartwright of the Department of Physics of the Massachusetts Institute of Technology.

Dr. Cartwright presented a paper in which he reported studies of a highly corrected *f*/2 lens composed of five separate elements on all surfaces of which a fluoride film had been deposited. The effective speed of this lens was increased nearly 100 percent. The extent of the improvement by coating, he reported, depends on the complexity of the lens. The increase in speed obtained by coating a three-element *f*/3.5 lens was much less than for the *f*/2 five-element lens.

The method is an outgrowth of Dr. Cartwright's earlier work with the help of Dr. A. Francis Turner, which resulted in reducing reflection and adding to the transmission of light through glass. It is well known that faster and more highly corrected camera lenses require a large number of separate elements. Each separate element reflects about 10 percent of the incident light. Thus, good camera lenses ordinarily have transmissions of only about 60 percent.

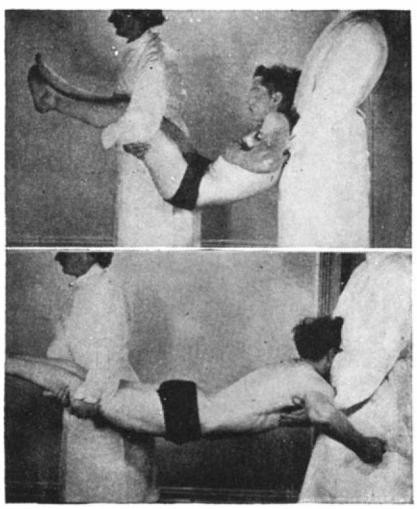
Dennis Taylor observed in 1892 that tarnishing of camera lenses tends to increase their effective speed. The tarnished surfaces of the glass elements of high refractive index diminished the reflection of light from the air-glass surfaces and thereby increased the transmission of the whole camera lens. Various methods were devised for artificially tarnishing glass, but

apparently the results were not sufficiently effective to justify their adoption by the manufacturers of camera lenses. It is now evident that the tarnish is actually a film of a transparent material having a lower index of refraction than that of the glass and to be most effective should fulfill specific conditions which can be better satisfied by the evaporated films of the metallic fluorides.

The evaporated metallic fluoride film, Dr. Cartwright said, has proved effective for many optical instruments. Since the film must be deposited in a vacuum and since each of the many elements in a camera lens should be so treated, the method is much more easily applicable in the manufacture of new lenses than in the treatment of ones already in use.

In Case of Accident

IN motor accidents alone, one spine is fractured every hour of the 24, according to H. Earle Conwell, M.D., a Birmingham, Alabama, physician, writing on "The Automobile and the Fractured Spine" in the *Journal of the American Medical Association.* The most common type is the compression fracture, and, "without a doubt," Dr. Conwell says, "certain lives ended in



Wrong . . . and right

the past by motor accidents could have been saved and permanent disabilities prevented by proper first aid."

Witnesses wishing to be helpful after an accident sometimes rush up excitedly, hoist the injured into the air as in the upper photograph of the pair on this page, and carry him away. The correct way to transport a person in whom an injured spine is suspected or possible, and when no stretcher is available, is shown in the lower photograph. The reason is explained by Dr. Conwell.

In riding, the torso of a passenger is usually braced somewhat at the lower end by the legs. When the accident comes, the chest and head are thrown forward. This often causes a jackknifing at some part of the spine and the effect is often to crush or partly crush the *front* side of one or more vertabrae. Obviously, the carrying position shown in the upper photograph further forces the crushed vertabrae together, but the second position, the correct carrying position, has the opposite effect.

Many fractures of the spine are not recognized, Dr. Conwell states, because the patient is able to walk after the accident.

The patient often under-estimates his injury, frequently stating that he has a "kink" in his back and that the disability is of no importance. Frequently there is no deformity of the back, though there is always a backache of varying severity. Regardless of the insignificance of the injury, he urges, one should feel suspicious of a spinal fracture when pain in the back is present.

Dr. Conwell goes on to state that to many laymen a broken back or neck is a broken back or neck, which results in sudden death or paralysis—total disability. This gloomy point of view is the heritage, he adds, of days before the introduction of the X-rays. With existing treatments most patients may be expected today to recover and return to their occupations.

Cellulose Pulp From Australian Tree

WOOD pulp for use in paper, guncotton, textiles, and the thousand other uses of cellulose may be grown on "tree farms" of limited acreage in the warmer parts of the south, through the adoption of a fast-growing Australian tree, casuarina, is the belief of Prof. Donald D. Bodé of the University of Tampa chemistry department.

Casuarina trees will grow 35 feet high with nine-inch trunks in six years; 56 feet high with 17-inch trunks in 12 years. They will produce from four to six cords per acre per year, as compared with one cord per acre per year for southern jack pine. Moreover, a cord of casuarina wood is one fourth heavier than a cord of jack pine.

The Florida state forestry service estimates that to supply a 200-ton mill with slash pine, 120,000 acres under forest management are needed. The same mill could be supplied by a 24,000-acre tract of casuarina.

The tree can be grown on poor soil, down to the very edge of salt water. It must not be attempted, however, except where winter temperatures do not drop below a mean of 54 degrees, Fahrenheit, for the coldest month, and it must be carefully protected against fire, to which it is unusually sensitive.

The casuarina is a strange-looking but beautiful tree. It has no leaves; their place is taken by extremely slender, long, jointed green twigs, somewhat resembling the common horsetail or scouring-rush. — *Science Service.*

CRYSTALS

THE tiny crystals which are regimented, line after line, to make Polaroid, are so small that three billion of them would just about cover the head of a pin 1/16 of an inch in diameter.

Dry Method, Positive "Blue Prints"

SINCE the beginning of blue printing more than 40 years ago, there has been a constant search for a dry method of making positive prints. Blue printing is a five-step process employing wet development, necessitating such operations as washing, fixing, drying, and the like. Moreover, blue prints fade when exposed to light. They

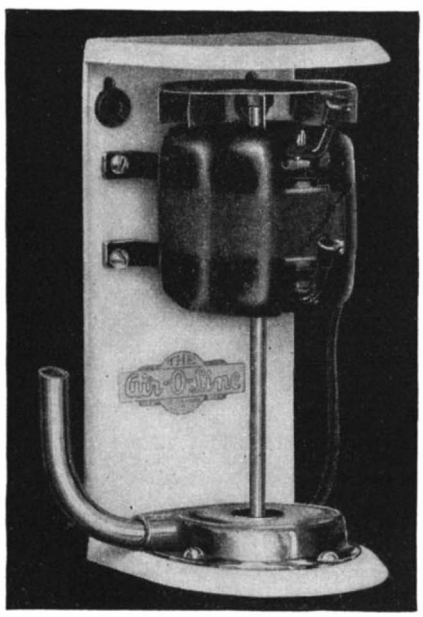
are negative in type and therefore hard to read.

A new method called the Ozalid process provides not only a positive print but also utilizes dry development. The resulting prints consist of dark lines on a white background. They are contrasty, sharp, and easy to read. Since no liquids are used in developing prints, they do not wrinkle or shrink and are true-to-scale of the original.

The Ozalid process is a contact method of reproduction and, as such, depends upon the transmission of light through the original for the reproduction of prints. Ozalid sensitized materials can be handled in daylight. It consists of two simple steps—exposure and dry development. Exposure is made in sunlight or by an arc or mercury-vapor lamp. The actinic light rays given off by these types of light sources convert the yellow sensitized surface to a colorless salt except where the surface is protected by the lines or opaque image of the original subject. The subject matter may be pen or pencil lines, typewriting or printing. The exposed print is developed dry in a few seconds by the application of ammonia vapors in a dry-developing machine.

Acid-Resisting Pump

A NEW pump designed for use in evaporative coolers, chemical laboratories, and industries requiring an acid-resisting pump has been developed by The Air-O-Line Company. Made of stainless steel and



mounted on a vitreous porcelain enamel stand, it is made in three sizes ranging in capacity from 140 to 360 gallons per hour.

This completely self-contained unit has a height of only 8½ inches, and in operation the impeller unit is to be submerged from two to four inches. The motor is for 110 volts, 60 cycles alternating current.

Replacing Carnauba

THE American chemical industry has been shown to be elastic and adaptable in many cases since the present war in Europe began. The latest evidence to that effect is the successful replacement by Foster D. Snell, Inc., of a large proportion of the carnauba wax in water waxes by other materials having a free and open market. Car-

nauba wax is an important ingredient in many widely used formulas, particularly for making floor waxes. Yet carnauba is hard to get because of the war and there has been erratic fluctuation in prices.

One specific replacement product has gloss and other properties similar to the usual gloss drying waxes, yet it contains only 34 pounds of carnauba wax per 100 gallons.

Oiled-Earth Paving

ONE day back in 1929, Paul E. Tignor, field engineer for The Glenn L. Martin Company of Baltimore, accidentally upset a small can of lubricating oil which he was using on his lawn-mower in the back yard at his home. The oil penetrated a mass of red clay and Tignor, always of an inquisitive turn of mind, bent down to examine the oil-soaked mass of earth. He found that, in its oily condition, it could readily be mixed into a sort of dough.

This gave Tignor an idea, and from that simple beginning he developed a wholly new paving process particularly designed for use on airport runways and which has subsequently been adopted as a standard surface in many municipal airports.

At that time Tignor was seeking a long-wearing, water-proof surface for a 1600-foot airplane runway which he was about to construct for the Martin company at its Middle River plant near Baltimore. He continued his experiments by mixing various types of oil, asphalt, and the like, with the native sand, clay, and gravel of the area until he found a satisfactory combination. That the formula was a good one has since been evidenced by the fact that the runway he laid down in 1930 is still in an excellent condition.

Correction

IN giving the dimensions of the roadway on the pontoon bridge across Lake Washington, at Seattle, in our February article, "A Bridge That Floats," it was stated that there would be 24-foot sidewalks. This was a typographical error; it should have read "two 4-foot sidewalks."

Trichinosis and Pig Inspection

A PRACTICAL plan for the eradication of dangerous trichinosis, at a cost of from 25 to 50 cents per pig slaughtered, was presented recently by Prof. Thurlow C. Nelson, of Rutgers University, before a meeting of the American Association for the Advancement of Science. The plan depends, according to *Science Service*, on widespread use of a new, simple skin test for trichinosis developed by Drs. G. W. Bachman, D. L. Augustine, and Hans Theiler. It has been used successfully by the New York City Health Department during the past 18 months.

"Every seventh to tenth garbage-fed pig slaughtered in this country today is wormy, infected with the most dangerous worm known to man." Prof. Nelson declared.

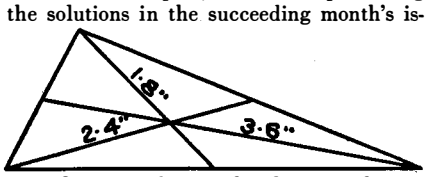
Humans eating the meat of such animals, unless it is thoroughly cooked, may develop the serious and often fatal malady, trichinosis. Federal health service estimates show that the trichinosis problem involves some 17,000,000 people, several

hundred thousand of them suffering the disease, and probably several thousand dying from it every year.

By Prof. Nelson's plan the new skin test would be made on every hog slaughtered, both in commercial packing houses and on farms slaughtering for home and local consumption. The cost of this, once arrangements are made, need not be more than 50 cents per animal, and may be as low as 25 cents. The New York experience with the test shows it is accurate to within less than 3 percent, and the error is in the direction of safety since, with one exception, all the mistakes made were diagnoses of trichina infection where it did not exist.

PROBLEM: THE MEDIANS

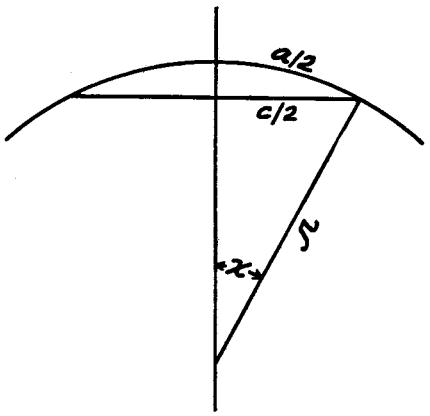
HERE is another of Lieutenant-Commander Kaplan's little problems such as we have been offering our readers for several months past, each time publishing the solutions in the succeeding month's issue: Construct by graphical means the triangle whose medians are 1.8", 2.4" and 3.6". Compute the lengths of the three sides of the triangle so constructed.



That ought to be easy. Send your answers or any letters about the problem to Lieutenant-Commander Leonard Kaplan, in care of Scientific American, 24 West 40th St., New York, N. Y. and they will be forwarded, unopened, to him.

SOLUTION TO THE PROBLEM OF THE CHORD AND ARC

LIEUTENANT-COMMANDER Kaplan's problem last month read as follows: Find the radius r of the circle in which a 24′ chord subtends a 25′ arc. Also, if that seemed pretty elementary, try taking the following sequel to it in high gear: Deduce a series which defines the radius r *explicitly* in terms of the chord c and the arc a—a series, that is which will permit numerical computation of r by direct substitution of the known values of c and a.



How much real trouble one man can start with just a few little words! Well, here are the solutions.

The conditions of the problem are expressed by the following equations:

$$2r\sin x = c \quad (1)$$

$$2rx = a \quad (2)$$

Dividing (1) by (2), we have

$$\frac{\sin x}{x} = \frac{c}{a} = \frac{24}{25} = .96000 \quad (3)$$

The value of x which satisfies this equation may be shown to lie between .492 and .493 radians. An interpolation may be made for the next two figures to obtain five place accuracy, as shown in the table below.

x (radians)	sin x	$\frac{\sin x}{x}$
.492	.47239	.96014
.49288	$14/16 \times .00100 = .00088$	.96000
.493	.47327	.95998

Substituting this value of x back in equation (2) gives

$$r = \frac{a}{2x} = \frac{25}{2(.49288)} = 25.361 \text{ ft. (ans.)}$$

To evaluate r without the use of trigonometric tables, $\sin x$ in equation (3) is replaced by its series equivalent,

$$\sin x = x - \frac{x^3}{\lfloor 3} + \frac{x^5}{\lfloor 5} - \frac{x^7}{\lfloor 7} + \frac{x^9}{\lfloor 9} \quad (4)$$

yielding

$$\frac{c}{a} = 1 - \frac{x^2}{\lfloor 3} + \frac{x^4}{\lfloor 5} - \frac{x^6}{\lfloor 7} + \frac{x^8}{\lfloor 9} \quad (5)$$

Rewriting (5) and using the new variable z to denote the left hand side of the equation,

$$z = 6\left(1 - \frac{c}{a}\right) = x^2 - \frac{x^4}{20} + \frac{x^6}{840} - \frac{x^8}{60{,}480} \quad (5)'$$

The series shown in (5)′ may be reversed*—made explicit in x instead of z—by setting

$$x = z^{\frac{1}{2}} + Az^{\frac{3}{2}} + Bz^{\frac{5}{2}} + Cz^{\frac{7}{2}} \quad (6)$$

then substituting this value for x in (5)′, and placing the coefficients of the different powers of z separately equal to zero, thereby obtaining the values of A, B, and C. The series thus reversed will be found to be

$$x = z^{\frac{1}{2}} + \frac{z^{\frac{3}{2}}}{40} + \frac{107\,z^{\frac{5}{2}}}{67{,}200} + \frac{3197\,z^{\frac{7}{2}}}{24{,}192{,}000} \quad (7)$$

To get a series which expresses r directly instead of x, the value of the latter as given in (7) is substituted back in equation (2). The capsizing of the series required by this operation may be accomplished by ordinary division. The resultant series is

$$r = \frac{a}{2\sqrt{z}}\left(1 - \frac{z}{40} - \frac{13z^2}{13{,}440} - \frac{1649z^3}{24{,}192{,}000}\right) \quad (8)$$

where, as already indicated in (5)′ above,

$$z = 6\left(1 - \frac{c}{a}\right)$$

For the specific values given in the problem,

$$z = 6\left(1 - \frac{24}{25}\right) = .24$$

and

$$r = \frac{25}{2\sqrt{.24}}\left(1 - \frac{.24}{40} - \frac{13(.24)^2}{13{,}440} - \frac{1649(.24)^3}{24{,}192{,}000}\right) = 25.3610 \text{ ft.}$$

*See Horatio N. Robinson's "New University Algebra"—1867—Ivison, Phinney, Blakeman & Co.—p. 328 et seq.

YOUR FIREARMS

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; science has so developed them that millions yearly find sport and recreation in their use. Hence this monthly department presenting a wide variety of discussion regarding firearms, their handling, and their accessories. Suggestions from readers will be heartily welcomed.*—The Editor.

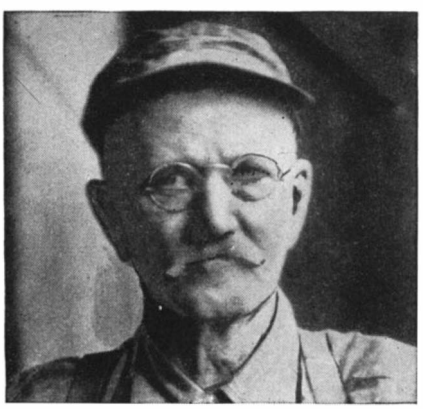
Exhibits of Old Guns

ATTENTION, you gun collectors! There's a treat in store for those of you who live in or near St. Louis, Missouri, and Seattle, Washington. During the month of March The International Studio Art Corporation will exhibit a considerable number of the ancient firearms which were formerly a part of the William Randolph Hearst collection. They will be shown in St. Louis at Scruggs, Vandervoort & Barney's, and in Seattle at Frederick & Nelson's. These guns are well worth seeing.

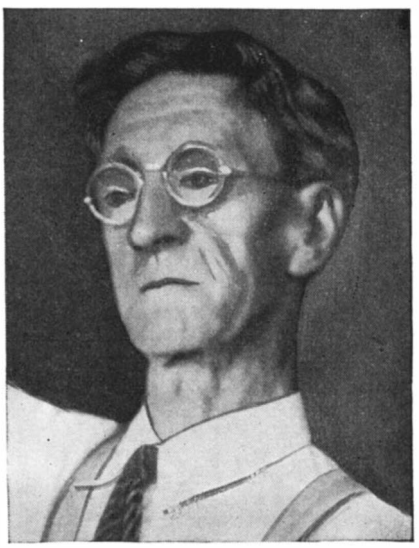
Gun Plant Gossip

IT was recently our pleasure to visit several of the New England small arms manufacturers and among this cordial group not only were the latch keys out, as usual, but also we were let in on a few little secrets concerning gun developments which will be disclosed later in the year. One thing we can tell, however, is that the proposed "History of Colt Revolvers," by Charles Haven and Frank A. Belden, *will* be published. The response to the inquiry addressed to collectors and lovers of firearms by Colt's Patent Firearms Manufacturing Company as to whether the book would be well received was so spontaneously gratifying that it was determined to proceed with publication. From advance information it will indeed be a splendid volume of some 600 pages, 250 illustrations, and a 250 page appendix—one of the most complete books of its kind ever to be published.

At the J. Stevens Arms Company plant, Superintendent Frank T. Green exhibited some interesting developments for future Stevens products, details of which we hope to be able to tell you next month. At the home of the Marlin Firearms Company, A. P. Curtis, Coordinator of Production, took us through the plant and showed us "the works." It's too bad that every owner of a rifle, shotgun, or revolver can't have that same privilege. When you begin with the raw steel and wood and follow them through each of the hundreds of operations and processes to the completed product, beautifully finished and thoroughly tested, you not only have a great deal more respect for your own firearms, but you also come out with a feeling of increased confidence in the men who make guns. The care and precision which has gone into the manufacture of your favorite firearm is something which has to be observed within the four walls of a gun factory to be truly appreciated.



Pat Murray — bores barrels



Fred Sloane — trained eyes

For example, we watched Fred Sloane align a Marlin barrel. Fred, it seems, had been around gun factories for a number of years before he came to Marlin in 1902, and he's one of the few men in the country who can be depended upon for the delicate and precise work necessitated in barrel alignment. We asked A. P. Curtis how it was done, and the explanation was as simple as the job was persnickity. The barrel is held up toward a specially prepared light and Fred Sloane looks through it. If the barrel isn't quite straight, there will be a shadow which only trained eyes can see. The quirk is removed by a machine process and then Sloane sights it again. This time it's clear, clean-cut, so Fred passes it on and it eventually becomes part of a Marlin gun.

Then there's Pat Murray, who started working in the Marlin plant away back in 1886, and he not only doesn't look it, but the barrels he bores from the raw tubes of steel prove that his 54 years with his present employer have made his eye keen and

his hand deft. Go where you will in American firearms manufacturing plants, you will find the Fred Sloanes and the Pat Murrays, symbolic of that precision, that care, that accuracy which has distinguished American gun making from the time of the early Revolutionary flintlock to the present day Garand rifle. In these days of international unrest it's comforting to know that we've got men in this country who can and do make some of the finest guns in the world.

Sportsmen's Shows

WHEN any one of the chaotic propensities of this weird world appears to choose our particular self on which to vent its spleen, we usually find soul-satisfying surcease by smashing a couple of dozen "birds" on the skeet field, wading a rippling trout stream, or, mayhap, imagining we are drawing a bead over the rifle sights on our pet peeve of the moment. But through winter months this panacea is not too easy to achieve, so we say: "Bless the man who thought up the idea of the sportsmen's show!

There, for one glorious week in February or March of each winter one can utterly lose oneself among the myriad of guns, fishing rods, and everything that goes along with them. We heartily recommend a visit to your local outdoor show. It will sweep away the cobwebs of too much business strain and put you in tune with the open-air activities soon to be with us. As this copy reaches print, New York and Chicago, between February 17 and 25, will simultaneously be admiring new gun models or longing for that 4-ounce trout rod. On the heels of these exhibits will come shows in Philadelphia, February 26 to March 2; in Detroit, March 2 to 10; in South Bend, March 6 to 10; in Indianapolis, March 16 to 24; in Minneapolis, March 23 to 31; in Buffalo, March 30 to April 7; and in many other cities and towns hundreds of things to gladden the sportsman's heart will be on display.

From the Mailman

R. C. R. asks if barrels of second-hand shotgun, 1912 vintage, will withstand modern high-power loads. . . *Ans:* Be careful of ancient barrels, especially twist, laminated, or Damascus. Many ammunition makers now enclose slips of paper in shell boxes warning against use of heavy loads in old types of barrels.

P. R. L. wants suggestions for authoritative books on firearms for beginner. . . *Ans:* "American Shotgun" (Askins); "In The Gun Room" (Burrard); "The Rifle in America" (Sharpe); "Guns and Gunning" (Curtis); "The Bird, The Gun and The Dog" (Sands).

Pot-Shots

AT THINGS NEW

Books of the Moment include Dr. John B. May's revised edition of "Natural History of the Birds of Eastern and Central North America," Ray Camp's "All Seasons Afield With Rod and Gun," and "Hawks in the Hand" by the brothers Frank and John Craighead. And speaking of books, if you haven't copies of the "Handbook on Shotgun Shooting" and the "Handbook on Small Bore Rifle Shooting" in your library, your bookshelf really isn't complete. Both of these inexpensive books are published by The Sporting Arms and Ammunition Manufacturers' Institute; we'll gladly tell you more about them if you're interested.

Belding & Mull (Geo. McG. Fryberger, Successor) have published a handbook (50 cents) on reloading and handloading of ammunition for revolvers, pistols, rifles, and shotguns which provides the powder putterer, both novice and old-timer, with practical suggestions on why and how to reload, on primers, powders, bullets, ballistics, tools, tables of charges, and accessories. For beginners' benefit, unduly technical phrases have been omitted, but advanced handloaders will also find much of interest.

Ithaca Gun Company, in answer to field trampers' plea for a light, yet safe shotgun, has replied with Model 37 "Featherlight" pump gun in 12, 16, and 20 gage at respective weights of 5¾, 6, and 6½ pounds, with every piece proof-tested at loads developing 7½ tons pressure. "Featherlight" is available in any choke, has 5-shot capacity (with plug to conform to 3-shot Federal Migratory Bird Law), 2¾ inch chamber, 14 inch stock, drops of 1⅝ inches at comb and 2¾ inches at heel, full pistol grip with gripcap, hand checkered stock and fore-end, and engraved receiver.

International Research Corporation, makers of the Argus cameras, have announced a new 55mm prismatic spotting 'scope which has been acclaimed the "hottest" thing on the market. It is 14⅝ inches long, weighs 43 ounces, comes with standard magnification of 20X and offers 14mm eye relief, thus providing comfort for gunners who wear glasses. Optional eye pieces of 12.8X and 26X may be had at slight extra cost and both are interchangeable with the 20X. At 100 yards the Argus "Spotscope" offers a field view of 11.4 feet with the 20X; 16.5 feet with the 12.8X; 6.3 feet with the 26X. Metal caps protect both eye piece and objective lens during transportation.

Harrington & Richardson Arms Company, for convenience in carrying, protection against lost pieces, speed in preparing to shoot, offers a finely balanced single barrel shotgun in two frame weights, both equipped with black walnut stock, semi-beaver-tail fore-end and auto-ejector. The 4½ pounder has a 22-inch barrel, is chambered for .410 and 28 gage, while heavier model, in 12, 16, 20, 28 and .410 gage, has 26-inch barrel and varies in weight from 5¾ to 6½ pounds, depending on gage. The .410 in both models takes a 3-inch shell.

Redfield Gun Sight Corporation offers to "X-ring" devotees a new streamlined (no projections to catch on gun case or clothing) precision rifle target sight with 60-minute elevation adjustment, eight individual quarter-inch positions in a two-inch extension from front to rear and an 18-minute windage scale in each direction. When sight radius is changed by moving sight from one position to another, correct elevation is automatically maintained. Scales are shown by dark figures on polished surface in 3-minute gradations with opposite side blank for individual markings.

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

Mount Your Prints

AFTER you have gone through all the steps involved in turning out a photographic print in which you take particular pride, the job will remain incomplete unless you take the final step to give it proper display in a suitable mounting. The print does not have to be as large as 11 by 14 inches nor does the mount need to be a 16 by 20-inch exhibition size. Suit the mount size to the area in which the mounted picture is to be hung. A relatively small space may require a small mount, perhaps only 11 by 15 inches, in order to allow "breathing space" all around it. For about the same reason, a small print may look right on a large mount. It is all a matter of studying the needs of the particular print you are mounting, coupled with your own personal tastes.

The simplest method of mounting prints

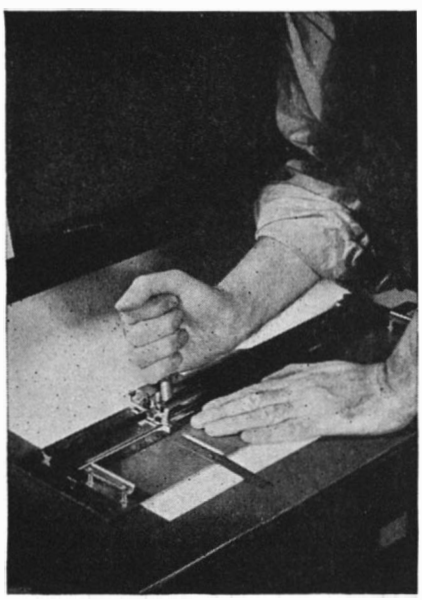


Figure 1

is in an album, but the mountings we have in mind are those of exhibition caliber—the type than can be hung on the walls of one's home—ranging in size from about 10 by 12 inches up to 16 by 20 inches. For the best results, it is advisable to purchase the regular mounting boards available in photographic stores in several thicknesses and, as a general rule, in the regulation 16 by 20-inch size. Some stores sell these mounting boards in smaller sizes. The most popular boards are white on one side and buff on the other, permitting a choice as the occasion arises, without having to purchase a number of boards of each color.

Pictures may be mounted on single boards

Figure 2

or between two boards, with an opening cut out in the top board to the dimensions of the print. In the first case, the white print border, if any, is trimmed off and the print mounted so that it adheres firmly over its entire surface. Adhesion is effected by using rubber cement coated on both the mount and the back of the print, allowing both surfaces to dry before laying the print down, or by employing some other adhesive, such as mounting tissue.

The second method of mounting, now very much in vogue, has a good deal in its favor, although it entails a little more trouble than the first. These double mounts can either be purchased ready made or cut at

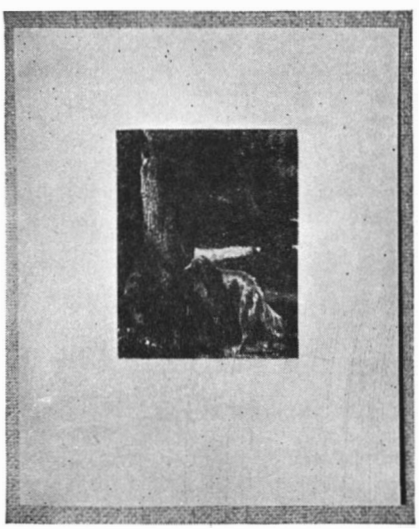


Figure 3

home. The ready-made type are provided with an opening either for 8- by 10-inch or 11- by 14-inch prints. These may serve in most cases, but many workers will find it more satisfactory to cut their own for two reasons: they can cut the opening to any size they may wish without being restricted by the two sizes commercially available, and, secondly, they can vary the effect of the opening by using top boards of varying thicknesses to obtain different beveling effects.

The opening is cut with a sharp knife held at an angle against a guide of some sort. This provides the attractive beveled edge. A straight edge and a knife will do the job, but in order to assure against the knife "wobbling" down its course, it is

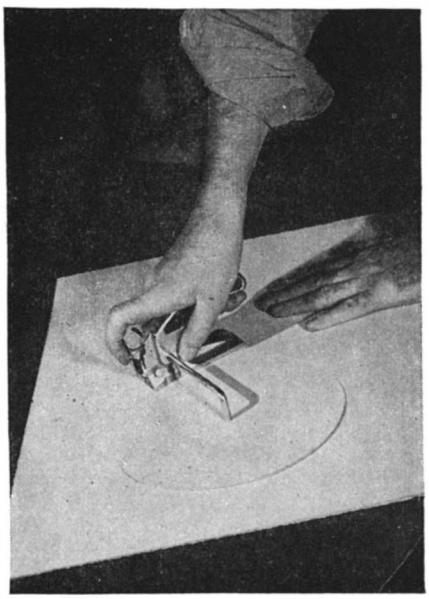


Figure 4

necessary to lay down a sheet or two of cardboard under the mount being cut. Due to the popularity of the cut-out mount, two mount cutters have been introduced on the market, the Xacto and the Cut-A-Mat, the latter making it possible to cut circular openings. (See Figure 4.)

Conventionally, prints are usually placed on the mount so that the top and two sides are the same distance from the edge, leaving the space below the print about twice, more or less, the top dimension. This rule, however, cannot always be followed, as in the case of a long picture or a rather small print on a large mount. In such cases, the worker's personal judgment must guide the proper placing of the print.

As a general rule, the color of the printing paper dictates the color of the mount to be used. For white prints use the white side of the mount, for buff or ivory, the buff side.

Figures 1, 2, and 3 illustrate the principal steps in mounting a print with a cut-out opening. Figure 2 shows the top board being set into place. The print is first centered on the bottom or base mount so that it will fit properly into the opening, and some dabs of rubber cement are applied all around the print on both mounts as well as a dab or two under the print itself. In this type of mounting, the white border need not be removed from the print because the top mounting board effectively covers it.

When the job is finished, use a block of art gum to clean marks off the surface of the mount. Hang in an appropriate place either by using a gummed tab provided with a hole for hanging on a picture hook, or some such device as the Braquette adjustable picture frames.

Quantity Printing

WHEN a number of prints from a single negative are desired, particularly when the prints are quite small, as when making greeting cards, it becomes a laborious and tedious job to develop the prints individually. Normally, prints are exposed and dropped into the developing tray one at a time. However, if care is exercised it is possible to develop three or four small prints at a time. After determining the proper printing time, expose a number of prints and keep them under cover. Take up three or four and immerse them in the developer solution at intervals of, say, five seconds. Thus, the second would be immersed five seconds after the first, the third five seconds later, and so on. It is not too difficult a task to keep tabs on the prints and know which one went in first. Besides, in a minute-and-half developing period, five seconds or so is not going to make much difference. Also, it does not have to be five seconds; the prints can be immersed rapidly one after the other so that all three or four are in within five seconds or less. If the five-second interval scheme is employed, the prints will be pulled out at the end of the developing time in the order in which they went in.

Pre-Setting For Action

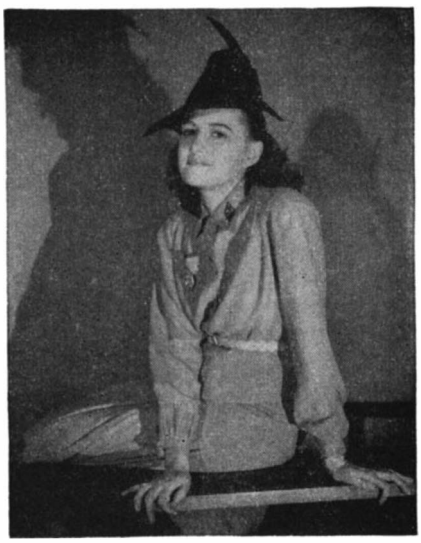
MANY photographic workers frequently experience difficulty in stopping the action of a moving object as it approaches the camera. Usually, the reason is that they attempt to focus the subject as it is moving. This has two disadvantages: you have to keep focusing up to the actual exposure, and the concentration on focusing causes you to forget the composition and pictorial interest of the subject itself. In other words, you are so absorbed with the mechanics of the camera that you have no eye for the picture. The better way is to set your focus in advance on some given object which the subject is due to pass. When the subject

"Bumpety-Bump"

reaches this point, snap the shutter and your picture will be sharp, particularly if you have stopped the lens down somewhat to provide depth of field. "Bumpety-bump" was made in this way by pre-focusing on the post. When the pony reached the post, the shutter was snapped. Due to the dullness caused by an overcast sky, a longer snapshot exposure was required than was necessary to stop all movement. However, the result was satisfactory.

Portrait Background Shadows

PORTRAITS that include three quarters of the figure usually give considerable trouble because of the problem involved of how to balance the subject, where to put the hands, and so on. Illustrated here is one way to do it. A bench was used, al-



"Ruth"

though a box or similar object would serve as well. In addition to a suitable pose and lighting, a shadow of the figure was projected on the background by means of a low-placed spotlight. Observe how this shadow not only aids the composition but also imparts a certain gayety to the picture that seems entirely suitable to this particular subject.

Focusing by Guess

MANY cameras are of the inexpensive type, which usually means a lack of any type of automatic focusing device, such as the range finder and reflex focusing conveniences. So their owners must learn, at the very beginning of their photographic hobby career, how to estimate distances by sight. For close distances, such as those required with close-up supplementary lenses, it will doubtless be found necessary to use a measure of some kind; for work at longer distances, distance-estimation by guess must be resorted to.

Some persons get it quickly; others require considerable experience before they catch on. A standard method of learning to estimate distances is to look towards a subject a certain distance away, make a guess at the distance and then measure the distance to see how close your guess was. Another way is to look at a piece of furniture, such as a sofa or a long table and

make a guess at its length. Another is to master a basic distance estimate of say five feet and judge all distance in units of five feet. Each worker discovers some little method of his own. The fact is that most amateurs do pretty well at guess focusing, even though it is considered that medium small stops are used.

Is Chrome Alum Stable?

THIS question, propounded in *Foto Review*, and one frequently asked by amateur workers, is answered fully and authoritatively by Mr. LeRoy Roselieve. The answer follows:

"Chrome alum in its dry chemical form is fairly stable and may be kept for a long time in the original container. However, short-stop baths and fixing baths containing chrome alum do not keep well as the hardening and physical properties of chrome alum break down very rapidly in solution in the presence of an acid. Hence, solutions containing chrome alum should be changed often in order to realize the full benefit of the hardening properties of chrome alum itself. Particularly stop baths used between development and fixation of negatives should be freshly mixed each time before use and discarded after treating a small quantity of film."

Candid Photography Is Still With Us

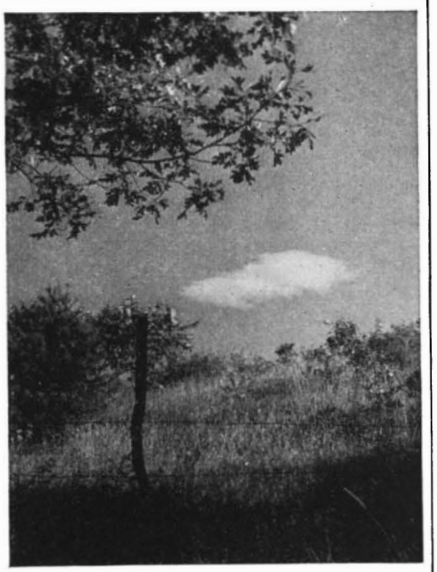
THE miniature camera started out years ago as a convenient medium for shooting pictures of people candid-wise, and it appears that the magic of the word "candid" still fills the air. A great many persons still look upon the miniature camera as a dandy way of getting pictures of people when they aren't looking. We know that today many so-called candid pictures are taken not only with the awareness but also with the co-operation of the subject, and this arrangement has, in fact, proved to be the better method in a great many cases, particularly in the matters of suitable lighting arrangement and posing.

The accompanying illustration is an example of pure candid and was shot at f/2.8, 1/50th of a second, during an outdoor benefit. Both subjects were absorbed in their separate tasks, the one at the easel, the other posing, so that the photographer was able to shoot without disturbing either, yet under suitable conditions, both as to lighting and pose.

"The Artist"

The Intimate Touch

WE don't know how the print "New Hampshire" will strike our readers; we are reproducing it as a bit of self-indulgence in the hope that it may strike a response in others of our readers with like interests. Why did we select this subject during a leisurely walk along a country road in New Hampshire? Well, chiefly because it was a piece of landscape removed from all the surrounding territory yet characteristic of the whole countryside. Here we had a comfortable viewing angle that, in a small, intimate space, told the whole story of the uniquely beautiful New Hampshire countryside. The lighting was delightfully right and the small cloud strategically "stopped" in the only place in the picture where it fitted best. Somehow even the size of the cloud, and its shape, are appropriate. A bigger cloud or a smaller one, or one of different shape, might have seemed out of place.



"New Hampshire"

Amidol Developer for Paper

FOR greatest transparency in heavy shadows and a rich blue-black color when enlarging on bromide papers, a developer that has been the favorite of many earnest workers for years is made up from the amidol formula. One of the principal reasons why it does not enjoy the wide popularity that it deserves is its perishable nature. It does not keep and must be made up at the time of using. For those interested in trying the formula, here it is:

AMIDOL DEVELOPER

Sodium sulfite, dry	3/4 oz.
Potassium Bromide	10 grains
Water to	20 oz.
then add:	
Amidol	50 grains

Develop at 65 degrees for two to three minutes.

Dust Specks On Gevaluxe Prints

As everyone probably knows, Gevaluxe prints cannot be handled as freely as prints made on other papers because of the unique surface. This surface, which resembles a sort of hardened velvet, the result of an emulsion mixture which consists of finely ground rabbit fur mixed in with the gelatin and emulsion, has a way of catching lint and dust which is difficult to remove by the usual method of blowing or wiping the dust away. An effective method is to use a small sable brush, bone dry. Push the end of the brush against the individual bits of dust and lint until the latter have been dislodged. Then simply blow the dust away. It is only a matter of dislodging the dust from the surface "carpet."

Panorama Without Tripod

One of the most interesting pictures made by amateurs during the course of the New York World's Fair last year, was a panoramic shot taken without benefit of tripod or angle calibrations. Mrs. Dora K. Howe, of the London Terrace Camera Club (New York), who made the picture, says she used the surface of a stone ledge, swinging the camera around from left to right of the Court of Nations area, halting for exposures at each turn. In all, she made four exposures which, by overlapping slightly at the edges, gave her a continuous panorama of the scene with the exception of one joining, where the clouds failed to mesh. This she plans to correct with pencil work.

Posing Tips

Here are a few hints that will help you to determine camera position, lighting, and so on, for various types and situations.

Long Face: Camera should be above the head, with latter at three-quarter angle.
Broad Face: Camera level, shooting almost profile.
Pug Nose: Camera above head, nearly full front, with head bent.
Long Neck: Camera above head; bend head.
Bald Head: Camera below, front lighting, reflection from below at one side.
Furrowed Face: Diffused light, flat lighting.
High Cheek Bones: Broad front lighting.
Hollow Cheeks: Front, side lighting.
Full Length and Group: Flat top lighting, screened toward floor.
Babies: Camera low, flat lighting.
Hands: Edgewise to camera or nearly so; shade with screen.

Keeping Developer Solution

For ideal preservation of developer stock solution, it is recommended that the bottle be kept full at all times. The usual method of achieving this is to have on hand a supply of marbles and drop in a sufficient number to keep the solution near the top. Another method recently suggested to us by a druggist is to turn the bottle upside down. The liquid seals the opening and makes it air-tight. Sounds reasonable enough. The only difficulty would be in keeping the bottle upright when standing

on its narrowest end. This can easily be accomplished, of course, by standing the bottle in a corner, in a box, between two standing objects, or by other means.

WHAT'S NEW
In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please send a stamped envelope with your request.

FILMO MASTER 8 PROJECTOR: Features: rack-and-pinion tilt, whereby picture is positioned on screen by turning knob; centralized switch panel, with separate controls for lamp and motor mounted on projector base; radio interference eliminator, allowing radio music in same room during projection; lens-lock permitting projection lens to be locked in position after focusing. Finished in ebony black, with chromium trim. Has Bell & Howell film-protecting, side tension feature, framing device; takes 300, 400, or 500-watt lamps.

NIKOR PRINT WASHER ($4.75, $7.75): Prints (and films) washed by device between leaves of vertical "book" made of specially processed absorbent fabric. Prints cannot touch each other. Filtering action of cloth assures clean water. Rubber hose, approximately 3 feet long, attached to faucet by means of tapered connection. Supporting frame made of stainless steel. In use takes one-third space of tray; not in use, folds flat. Available in two sizes: 8 by 10 inches and 11 by 14 inches. Size 8 by 10 accommodates fifteen prints this size, or equivalent area of smaller prints. Size 11 by 14 takes 15 prints this size, thirty 8 by 10, and so on.

SUPERFLASH SUNLITE NO. 2: Incorporates own daylight blue color-correction filter to change color temperature of light source to equivalent of bright sunlight. Its use with any regular daylight color film, indoors or outdoors, without a filter, said to produce natural color reproduction with all colors in their correct relation to each other.

AGFA TEXTURE SCREENS, 5 by 7 inches, $1.50 per screen or $6 for set of four, which also includes 8- by 10-inch border mask with 4½- by 6½-inch etching edge opening. Size 11 by 14 inches available separately at $4 each; in sets of four $12.50 per set. Border mask for latter not available.

KEL GREETING CARD KIT ($1): Designed for producing greeting cards photographically. Includes 12 different greetings: Christmas, New Years, Valentine's Day, Birthday, and so on.

F-R HI-SPOT ($9.95): Designed for all types of photographic lighting, especially portraiture, modeling, and natural color work. Small, compact. Features: finger-tip focusing from large to small spot; heat dissipating fins; perfect centering of filament in relation to reflector; ample ventilation on all sides; special 150-watt projection lamp rated 3200 degrees Kelvin (required for color photography). In conjunction with lamp announcement, makers add that new

booklet on photographic lighting, "Third Dimensional Portraiture — How to Get It," by John Hutchins, A.R.P.S., is available on request.

MINI-FLASH FLASHGUN ($12.50): Compact flashgun featuring folding reflector, aplanatic type. Reflector of adjustable type made of eight sections folding together, fan-like, when synchronizer not in use. Will not throw "spot" of light. Uses "fountain-pen" type flashlight batteries. Synchronizer may be used on any camera. Shutter-tripping and bulb-flashing mechanism entirely mechanical. May be attached to camera by means of "shoe" or directly on tripod socket, connection for which is furnished with each gun.

RAYGRAM PRINT PRESS ($1.95 to $3.95, depending on size): Made in three sizes, 5 by 7, 8 by 10, and 11 by 14 inches. Dries prints evenly, eliminates buckling of heavy-weight papers, prevents blisters and uneven contraction of emulsion. Made of laminated hardwood, reinforced. End grain panels protected with plated strips of metal. Entire unit waterproof.

KEMP ADJUSTABLE PRINT WASHER ($1.50): Designed on scientific principles for thorough print or negative washing. Constantly replaces hypo-laden water drawn off from bottom. Equipped with three-foot hose easily attached to faucet and held securely to bottom of sink by vacuum cup, creating gentle whirlpool action, keeping prints apart.

AGFA EVEREADY TRIPOD CASE ($1.75): Eveready-type carrying case for use with No. 1 and 2 Agfa metal tripods. Permits use of tripod without removing entirely from case. Case made of selected top grain leather provided with slide fastener closing device.

BESBEE TITLE SET ($5.50): Letters made of new kind of plastic. Will not chip, crack, or break. Pressure molded into clear-cut outlines. Set comes in special, grooved panel case, providing compact storage. Because of thickness, letters cast striking shadow effects. Can be cleaned as often as desired. Set comes in white, black, or red.

F-R CUT-FILM-PACK DEVELOPING TANK: Reduced from $9.95 to $5.95 owing to "many new factory developments and increased facilities for manufacturing."

SUPER ELECTROPHOT ($14.50): Photo-electric exposure meter made entirely of American materials, including photo cell. For universal use, movies and stills, all black-and-white and color films. Quick readings by finger-tip conversion for all conditions. Vibration-tested before leaving factory. Readings in both Weston and Scheiner ratings. Enclosed in black Bakelite case, with silk carrying cord attached. Imitation morocco leather case.

FOTOCRAFT DOUBLE PRINT ROLLER (75 cents): Double roller wipes surface of paper and eliminates air bubbles, insuring positive contact with squeegee plate. Made of sulfur-free rubber, mounted on waterproof, non-shrinking wood dowels.

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

***Q.* I have a . . . camera and the regular . . . Photoflash attachment, but I have had trouble from the start with the flash equipment. I am using Wabash Press 40,000 bulbs, speeds of 1/50 and 1/100 of a second, at about *f*/5.6 and *f*/8. My pictures lack detail mostly in faces and are also lighter on one side than the other, as you can see by the enclosed pictures. What am I doing wrong? Incorrect flash lamp, time, or lens opening? My camera has a focal plane shutter. What do you advise?—A. D.**

A. From the looks of your prints, we would say that, for one thing, all of them are completely out of focus. Secondly, the bulb you are using is not recommended for focal plane shutters; you should use the No. 2, which has a longer "peak light" to allow ample time for the focal plane shutter to slide across the film while the light is at its peak. The lack of detail in the faces is due both to over-exposure and poor focusing; the uneven density of the negative is probably due to the wrong type of bulb. Use the No. 2 and if you still have this latter fault, return the camera to your dealer and have him check it.

***Q.* Out here on the desert I am constantly being "fooled" by the light, over-exposing negatives. Then I think I must be over-developing them for they are extremely dense. To illustrate: My printer has 160 watts of light within three inches of the printing frame and with average negatives I expose the paper from two to eight seconds, yet with these dense negatives I must expose them for two or three minutes before even a faint print is obtained. Is there any process by which I can reduce the density of these negatives?—C. S., Jr.**

A. For reducing over-exposed negatives, the following two formulas are generally recommended:

Permanganate Reducer

Stock Solution A
- Water ..... 32 ounces
- Potassium Permanganate ..... 1¾ ounces

Stock Solution B
- Water ..... 32 ounces
- Sulfuric Acid, C.P. (add acid to water) ..... 1 fluid ounce

For use take 1 dram (4 cc.) A, 2 drams (8 cc.) B, and 8 ounces (250 cc.) water. When negative has been reduced, place in fresh acid fixing bath for few minutes until yellow stain disappears; then wash.

Farmer's Reducer

Stock Solution A
- Water ..... 16 ounces
- Potassium Ferricyanide (Red Prussiate) ..... 1¼ ounces

Stock Solution B
- Water ..... 64 ounces
- Hypo ..... 16 ounces

When ready to use, add 1 ounce of A to 4 ounces of B; then add 32 ounces water. Pour over negative and watch progress.

For correcting over-developed negatives, the following is recommended:

Proportional Reducer

Stock Solution A
- Water ..... 32 ounces
- Potassium Permanganate ..... 4 grains
- Sulfuric Acid (10% solution) ..... ½ fluid ounce

Stock Solution B
- Water ..... 96 ounces
- Ammonium Persulfate ..... 3 ounces

For use, take 1 part of A to 3 parts of B. After reduction, clear in 1 percent solution sodium bisulfite. Wash thoroughly. To make 10 percent solution sulfuric acid, add 1 part acid to 9 parts water while stirring.

Before treating negatives to any type of reducer, negatives must be thoroughly washed free of hypo and if allowed to dry should be immersed in water until limp.

***Q.* Will you kindly tell me what is the approximate amount of silver on a thousand feet of 35mm film, unused?—H. A. S.**

A. About an ounce of silver is used in the emulsion on a thousand feet of this size film, the exact amount varying with the different emulsion formulas.

***Q.* I am contemplating building or purchasing an enlarger and want to use in it the lens from my camera. Would the light from the enlarger damage the lens?—C. L. H.**

A. If a normal enlarging bulb is used in the enlarger and there is provision for proper ventilation, your camera lens may safely be used in the enlarger. As a matter of fact, this is a regular practice with several well-known makes of cameras, the lenses of which are generally used interchangeably on both camera and enlarger.

OUR BOOK CORNER

THE Book Department of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

SUPERSONICS

By R. W. Wood, Prof. Experimental Physics, Johns Hopkins University

WOOD, a noted physicist who is also part inventor and who has done much original research on supersonics, has compacted into this small volume a great deal of data on the science of inaudible sounds in their every aspect, both physical and biological. The organized bibliography at the end contains date and page reference to all the important original articles on the same fascinating subject, published in technical and scientific journals in past years. (158 pages, 4¾ by 5½ inches, 42 illustrations.)—$2.10 postpaid.—*A. G. I.*

HAWKS IN THE HAND

By Frank and John Craighead

BEGINNING with their youthful experiences in the capture, training, and photography of various species of hawks, owls, ravens, ospreys, falcons, and eagles, the co-authors lead the reader through a series of thrilling and interesting adventures in photography and falconry, all told with a simple, invigorating freshness. (290 pages, 5½ by 8¼ inches, 57 illustrations.)—$3.60 postpaid.—*A.D.R., IV.*

THE VICTORY OF TELEVISION

By Philip Kerby

A RUNNING story of television developments, stripped of technical terms, that will bring the reader up to the present day, is presented in this book. The author makes little attempt to explain the fundamental theories underlying television transmission and research but rather stresses television as a means of communication and entertainment. Concluding chapters deal with the vital questions of who will pay for television services and what we may expect of television in the near future. (120 pages, 5½ by 8 inches, a few illustrations.)—$1.10 postpaid.—*A. P. P.*

GROWING PLANTS WITHOUT SOIL

By D. R. Matlin

FOR the professional grower as well as the amateur, this new volume not only gives full details of plant chemiculture but also discussions of proper plant environment; how to make cuttings; root-growing substances, or hormones and auxins; budding and grafting; construction and operation of greenhouses; symptoms of plant food deficiency and excess; what to plant in various types of environment; flower, bulb, and vegetable planting calendars; insects and their control; and many other related subjects. The author draws on his experience as a professor of plant chemiculture, and makes a valuable contribution to the slowly growing literature on this subject. (137 pages, 5½ by 8¾ inches, illustrated.)—$2.10 postpaid.—*F. D. M.*

GROWING PLANTS IN NUTRIENT SOLUTIONS

By Wayne I. Turner and Victor M. Henry

RATHER more technical than the volume reviewed above, this study also gives complete instructions for making the equipment and mixing the solutions for hydroponics and for growing many different kinds of plants without soil. These authors, however, go into such deeper phases of the subject as the chemistry and mathematics of nutrient solutions, sources of chemicals, analysis of chemicals, technique of the nitrogen-potassium balance, fundamentals of plant physiology, and the like. This volume is for the grower who is not afraid of a little chemistry or for the chemist who wishes to become a grower. (154 pages, 6 by 9¼ inches, illustrations include several color plates.)—$3.10 postpaid.—*F. D. M.*

DISCOVERY OF THE ELEMENTS

By Mary Elvira Weeks, Assoc. Prof. of Chem., Univ. of Kansas

ONE by one the author takes up the separate chemical elements and weaves around each a tale of its history, the personalities surrounding its discovery, and factual data about the elements themselves. Yet this is no ephemeral story book but is a standard reference work for the professional or student chemist, now in its fourth edition. Authentic, sound science. After the discussion of each element there is a long list of references to further scientific literature. (470 pages, 6 by 9¼ inches, richly illustrated.) — $3.60 postpaid. — *A. G. I.*

A DIGEST OF THE BIBLE

Arranged and edited by Peter V. Ross

MILLIONS who wish they knew the main trends of the Bible never get around to reading it through, because the task seems so formidable. The great length, the extensive detail, the largely obsolete English and confusing typography with its cluttered up arrangement, together provide high hurdles over which many stumble, bog down, and give up. Versions nowadays available largely surmount the obstacles of obsolete language and confusing typography but leave the length at about 800,000 words, so that the reader, unless willing to make a protracted study, can scarcely see the woods for the trees; he may call for a more rapid preliminary reading facility. That is what this digest provides. It is not a Bible "story" but is made up almost wholly of well-selected extracts from the original language of the King James version, skilfully pieced together to make a continuous whole about one tenth the length of the original. (293 pages, 6 by 9¼ inches.)—$2.85 postpaid.—*A. G. I.*

PRACTICAL MECHANICS HANDBOOK

By F. J. Camm

WHILE this particular volume is prepared especially for the mechanic and engineer, it will also appeal widely to the average home craftsman who has gone a bit beyond the stage of making simple footstools and whatnot shelves. Here are covered such practical subjects as blue prints and how to use them; use and care of various tools, ranging from drills and files to lathe equipment; soldering of various metals; riveting; hardening and tempering; rust-proofing; and so on. A large number of tabulations contain standard data in compact form. (400 pages, 5½ by 8 inches, 379 illustrations.)—$3.10 postpaid.—*A. P. P.*

MAKE YOUR OWN MOVIES

By Arthur Gale and King Pessels

OWNERS of amateur motion picture cameras, regardless of their past experience, will find here a wealth of practical information on not only the various aspects of photography but also what to do before taking pictures and how to prepare the finished film for interesting projection. Includes: how to splice and edit; when to use filters; accessory lenses; how to prepare scenarios; how to write and photograph titles; and how to lend the professional touch to your amateur movies. (230 pages, 6 by 8 inches, well illustrated.)—$3.60 postpaid.—*A. P. P.*

100 PACKAGING CASE HISTORIES

Compiled by Albert Q. Maisel

MANUFACTURERS have learned in recent years that the package in which a product is wrapped and displayed for sale very often makes all the difference between success and failure of the product. So conclusive has been the evidence on

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that score that serious attention has been given to large numbers of packaging problems which, when solved, have boosted the sales of many well-known products. This volume tells the story, in word and picture, of exactly 100 such cases, each case history giving data on the product, on the old and the new package, plant changes that were necessary, and sales increases achieved as a result of the improvement in the package. (223 pages, 9 by 6 inches, about 200 illustrations.)—$2.10 postpaid.—*F. D. M.*

PHOTOGRAPHY BY INFRARED

By Walter Clark, Ph.D., F.I.C., F.R.P.S.

ADVANCED amateur photographers have often expressed interest in photography by infrared but have, in the past, been at a loss as to where to find really accurate technical information that would permit them to do this type of work with a minimum of failure. Now the information is available in one compact volume, written by an authority in the field, which delves deeply into the technical aspects of the subject and gives the background which is so necessary for satisfactory work. The chapters cover such phases as general practice, darkroom practice, characteristics of materials, sensitizing for infrared, sources of infrared, applications of infrared photography, penetration through fog and haze, and so on. (397 pages, 6½ by 9½ inches, illustrated.)—$5.10 postpaid.—*A. P. P.*

WHY WORK?

By Roger Payne, A.B., L.L.B.

AN analysis, and a sane one, of our wasteful economic system which renders it (apparently) necessary for us to work six days a week when, with possible organization and helped by our machines, we would get the necessary work done in one day and have the other six in which to live. The author, a graduate of Cambridge University, became a hobo, a sort of modern Diogenes, to prove that 50 days' work per year will support a man if he is willing to reduce his wants to somewhere near his needs. He also discusses ways of becoming independent of daily slavery by different kinds of specialized farming such as flower and nut growing. Wastes in human affairs occupies a large part of this book. (404 pages, 5¼ by 8 inches, one illustration.)—$2.60 postpaid.—*A. G. I.*

ALL SEASONS AFIELD WITH ROD AND GUN

By Raymond R. Camp

THE author has drawn from the experiences of a busy life spent in the woods, the fields, the streams, and on salt water, seeking and finding fishing and hunting, to produce a volume which should be the delight of every sportsman. His many years as "Rod and Gun" editor of *The New York Times* have given him the literary background and the technique to present the answers to the ever-present question of when, where, and how to hunt and fish, what equipment is actually needed and how to select it, how and where to find activity in these sports throughout the year. For novice or expert this book will be a welcome addition to the library. (352 pages, 5¾ by 9 inches, 20 half-tones, 75 line drawings.)—$3.60 postpaid.—*A.D.R., IV.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

TESTED blueprints — give us tested blueprints else we perish — was the burden of several frantic letters recently received by this department from a single individual. Amateur telescope makers, these letters urged, should do their work from tested blueprints. Yet tested blueprints didn't seem to be available, so something's wrong.

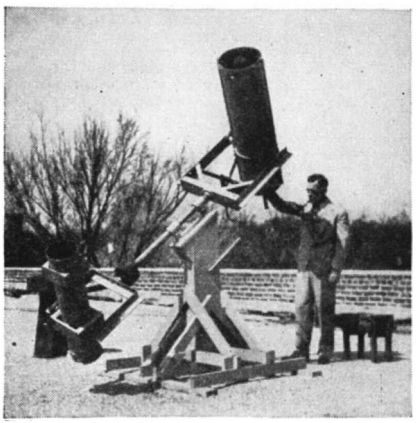

Figure 1: Simpson's double-ender

If amateur telescope makers were the kind who craved tested blueprints and wanted to copy some standard model, even if it might be a bit better, something really would be wrong. Instead, they mainly prefer to learn the working principles of a telescope and then cook up their own concrete expression of them. The result has been an almost infinite and endlessly interesting variety of telescopes, no two alike. This freedom to deviate from a set standard irks some types of men.

Below are a few more of the infinite variety of telescopes, each one of which gave its maker some fun, not alone in making but in planning; and after all, isn't fun the chief commodity sought when a man decides to make a telescope?

CHIEF feature of the instrument shown in Figure 1 is the combination on one axis of an 8″ *f*/4.5 Newtonian RFT, the lower telescope, for star fields, and a 12½″ Cassegrainian, the upper one, for lunar and planetary observation; that is, one telescope for broad, general views and the other for restricted, particular views. Incidentally, this arrangement on one axis brings both eyepieces to about the right height for comfort. The maker is J. F. Simpson, a medical and X-ray technician, Garrison General Hospital, Gastonia, N.C. He states that, in place of the two forks, he believes a perhaps better mounting would be a long, heavy double yoke, with the two tubes mounted in tandem within this same simple yoke. He also plans to substitute a 12½″ *f*/5 RFT for the present 8″ RFT, and to add a motor drive, so that objects will not move out of the field when the user steps away to permit a visitor to look—one of the annoyances of showing the stars to the totally inexperienced.

LIKE the telescopes themselves, housings for them afford an infinite opportunity for the maker's desire for variety. Figure 2 is a housing of the dome type made by Edison T. Schaefer, Schulenburg, Tex. The concrete pier on which the telescope rests is visible in the photograph, within the wooden fabrication which supports the floor, walls, and dome. The latter has a 30″ slot.

The telescope within (Figure 3) is a 10″, *f*/7.6 of the Springfield type and Schaefer describes it as follows:

"It is controlled by means of three electric motors; note the switchboard (Figure 3). The declination motor is turned on by one switch and reversed by another. It turns at 5000 r.p.m. and is geared down to 230, also two slower speeds, by means of a 500-ohm resistor and two push-button switches. The R.A. motor is the same as the declination motor and is hooked up to drive forward or backward at three different speeds. Maximum speed, 180° in two minutes. For sidereal time a third identical motor is used with rheostat control. This gives sufficient accuracy for photographing the Moon."

Figure 2: Schaefer's observatory

IN transmitting the photograph shown in Figure 4, Raul J. Fajardo, Aguilera alta 27, Santiago de Cuba, Cuba, states that he wanted an ordinary astronomical telescope plus equipment for measuring position angles of celestial objects, determining geographical coordinates, and so on. On the eyepiece end of the tube, which rotates, is a circle divided down to 5° spaces and opposite on the fixed tube is a vernier. Inside is a reticle in the eyepiece, made of threads. The whole is fairly simple and, while it splits no small hairs, it does what it was built to do.

"To illuminate the reticle a flash-lamp bulb in front of a diaphragm near the middle of the tube throws light forward, some of which is reflected back from the back face of the objective lens, resulting in a perfectly even, yellow illumination of the field of view and of the micrometer, against which the stars stand clearly (The accuracy of this telescope is not so great as to make one consider the lamp's heating effect).

"I have many times found the latitude of my town by the zenith method, also the longitude by means of the Greenwich time transmitted by radio from London. In determining the latitude by the zenith method I used *B* Cassiopeia and *B* Cetus which have zenith distances about the same in my latitude. For the latitude of Santiago de Cuba I found 20° 1′ 15″ ± 30″ which is in close agreement with the latitude found years ago by a commission from U. S. A. I have found that my telescope can work every time within an error limit of ± 30″ in latitude and ± 12s. in longitude. With this instrument, which costs not over $15 in all, I have been able to practice many problems of astronomy and navigation."

MORE about the Gaviola test: Recently your scribe, in corresponding with Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alta., Canada, said he wished someone would describe the new Gaviola test, alluded to in our last two numbers, in about eleven words of one syllable or less, and here is what Wates wrote in reply, with an interlarded comment by N. J. Schell, 1019 Third Ave., Beaver Falls, Pa., and another by your scribe.

"In the Gaviola test, an optical surface is regarded as being built up of a large number of small surfaces, each having about 1/25 (for example) the diameter of the whole mirror. A series of these small surfaces, each of which is regarded as sensibly spherical, is isolated by suitable masks (Figure 5, I), and the exact position of the center of curvature of each element is determined by a new and very accurate method.

"In the case of a truly spherical mirror, the center of curvature of all elements is situated at one and the same point — the C of C of the whole mirror (Figure 5, II), but in the case of a paraboloid (or any

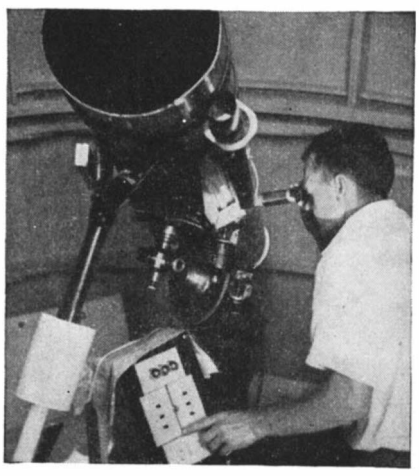

Figure 3: Schaefer and telescope

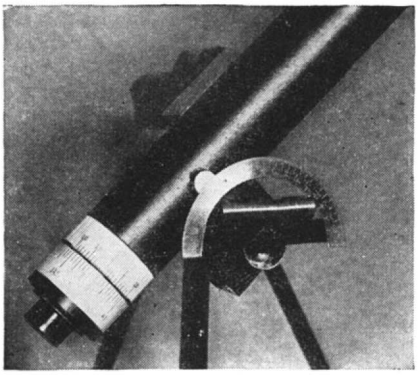

Figure 4: Fajardo's instrument

other shaped surface), the centers of curvature of the elements do not coincide. Instead, they form a more or less irregular conic surface in space. A cross-section of this spatial surface is a curved line on either side of the axis, which Gaviola calls a caustic." [The envelope, or general shape, traced out by combining or linking up parts of the several reflected rays shown in the lower part of the drawing on page 283 of "A.T.M." is a caustic. It looks like a big C, rather small at the top. It is true, this particular caustic happens to be made by the envelope of parallel rays reflected by a sphere but if, instead, one were to use rays from a pinhole — that is, diverging rays —

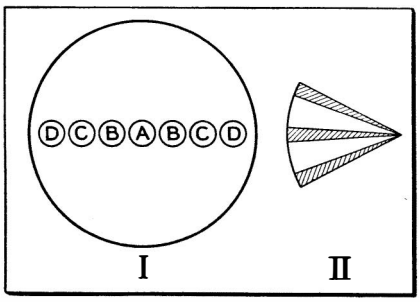

Figure 5: In re Gaviola test

and reflect them from the parabola in the upper part of the same drawing, one would get a caustic instead of the focus shown. The heart of Gaviola's test is that it is done along the caustic, and is therefore more nearly exact. Exactness in practice is a relative matter. Strictly speaking, our everyday assumption that our reflected rays come to foci along a straight line is not quite correct — though most of us will have to exhaust the full degree of exactness and skill contained by the old test before we venture into this more exalted realm of precision. Even if we never get there at all we shall, however, be curious to know what the test is all about, hence this little discussion.—*Ed.*]

"By the application of suitable formulas, this caustic may be reduced to a graph of the actual surface of the mirror, either with reference to a true sphere, or with reference to any one of a family of paraboloids, just as we do with the Foucault test, by placing the knife-edge at various positions, inside or outside of the mean center of curvature.

"In Figure 5, I, is the surface of a mirror with a series of small isolated elements. In the Foucault test these elements or zones are measured directly on the axis in pairs, *A, BB, CC, DD,* and so on. In the Gaviola test they are measured individually, but along the caustic, and their relative displacement is thus determined.

"In the Foucault test, with any non-

THE BEGINNER'S CORNER

NOT alone some beginners but some others also appear to think that the best seeing, through the telescope, will be had when the stars look brightest and sharpest to the naked eye. It could be, but generally isn't. Some recorded oral comment by the widely known advanced amateur observer, Dr. W. H. Steavenson of England, reprinted from the ever-interesting *Journal of the British Astronomical Association,* is instructive.

"The word 'seeing' should be taken as referring merely to the quality of the telescopic image. Many beginners have the impression that bad seeing means everything that was described by the late T. W. Webb as 'an impediment to distinct vision.'

"I will deal first with the question of transparency, which is really quite distinct from the question of seeing. Transparency is, of course, primarily of importance to those who work on faint objects in towns, on account of scattered light. The inexperienced is apt to get a misleading impression of the effect of a slight increase in transparency, since an extension of 0.3 magnitude in the limit of visibility nearly doubles the number of stars to be seen.

"I will now deal with the question of seeing proper, which means the definition of the telescopic image. It is often best under conditions of bad transparency. There are two possible sources of disturbance, the true atmospheric conditions, due to air currents at great heights, and local disturbances low down, often in the tube of the telescope. These latter are the ones which can often be avoided. The best way to find out where the trouble lies is to put a bright star out of focus, racking the eyepiece out and using a high power. The out-of-focus image may often be seen crossed by parallel lines or streams moving with great speed. These are due to air currents at great altitude, often as high as 50,000 feet. They are generally most evident just before changes of weather begin, but they are consistent with quite calm conditions at sea-level.

"At other times the focused image may be quite sharp, but it goes slowly in and out of focus. All *slow* changes mean disturbances inside the telescope. There are two forms of these disturbances, mirror currents, which usually are only serious with large mirrors of twelve inches or over, and tube currents. Mirror currents, which consist of air currents in close contact with the surface of the mirror, show themselves in the out-of-focus image as wavy lines slowly creeping across the image in a direction at right angles to their length. Tube currents are much more common, and give rise to a series of vortices in the out-of-focus image. It should be noticed that any disturbance far outside the tube is generally rapid and is seen in the form of straight lines in the image. It is well to remember that refractors may also show tube currents, and the fact that they are not commonly recognized is due to the fact that large instruments of this type are not generally used under the same exposed conditions as reflectors of similar aperture."

Beginners who want to go a bit deeper into these matters will find that a chapter entitled "Atmosphere, Telescope and Observer," in "Amateur Telescope Making — Advanced," companion volume to "Amateur Telescope Making," is instructive.

TELESCOPTICS

(*Continued from preceding page*)

spherical mirror, it is assumed that the C of C of any given pair of elements or zones occupies a position somewhere on the optical axis of the mirror, but this is not absolutely true, as may be seen in Figure 6, at III.

"In the Foucault test, the knife-edge is made to cut the portion of the two cones of rays, common to both (shown blacked out), and the operator tries to make the shadows reach the centers of the two zones simultaneously. This is made more difficult by the fact that the shadows move at different speeds.

"In the Gaviola test, the knife-edge is placed at *A* and *B*, these being the points at which each separate element, *a* and *b*, appears spherical, that is, darkens evenly all over. By means of very accurate micrometers, the distances $2x$ and y are measured. The fact that this must be done with an accuracy of about 1/20,000 of an inch makes the test unsuitable for most amateur workers. But I have no doubt that someone will overcome this difficulty." [The test consists of measuring a lateral displacement smaller than the usual longitudinal displacement, but provides means for doing this with an accuracy 25 or more times better than was possible with the older method. Its usefulness over the older method applies particularly to mirrors of focal ratio shorter than *f*/6. Very careful construction of tester, and very rigid supports, are required. Gaviola recommends masonry supports. As an indication of the values to be measured, with stationary light source, the y figure is approximately three times the familiar r^2/R, and the $2x$ figure is approximately r^2/R divided by the focal ratio. Both of these are, of course, to be taken from the mean of each zone under test.—*N. J. Schell.*]

"Although the test as described can be done with the conventional knife-edge, Gaviola prefers to use a double knife-edge in the form of a thin wire. In his article in the November *Journal of the Optical Society of America,* he describes three methods of observing the image of this wire, with and without an eyepiece, and comments that any of these methods is more sensitive than the accuracy of any micrometer screw.

"Having measured x and y for all zones, these measurements are then applied to the formulas, and a graph drawn of the surface of the mirror, which may be done within less than 1/100 of a wavelength.

"The surfaces of the zonal elements may (and do) vary in two ways. They may change their curvature, and they may tilt. These two changes cause corresponding movements in the C of C — longitudinal and transverse, as shown by the arrows in Figure 5, at IV. The Gaviola test provides for accurate determination of both of these variations — the Foucault test does not.

"The beauty of the Gaviola test lies in the fact that individual judgment of shadows passes out of the picture. One is testing a series of spheres, and the sphere is the easiest surface of all to measure. Whether

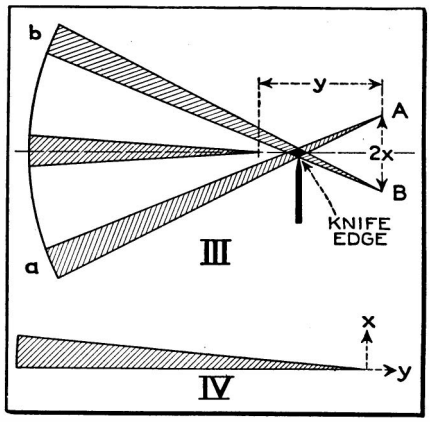

Figure 6: Concerning Gaviola test

some T.N. will develop a modification of the test suitable for amateurs who do not possess expensive micrometer apparatus, remains to be seen. In measuring a 6-inch mirror ($f/3$), the maximum value of x is less than one tenth of an inch, which means pretty delicate technique! One of my brainwaves is the suggestion to try two plates as a condenser, in an oscillating circuit, in place of a micrometer, to measure x."

JOINING two sheets of HCF is a necessity in cases where the desired lap is wider than the standard widths (8" and 10⅛") of HCF will afford, and in "ATM," p. 367,

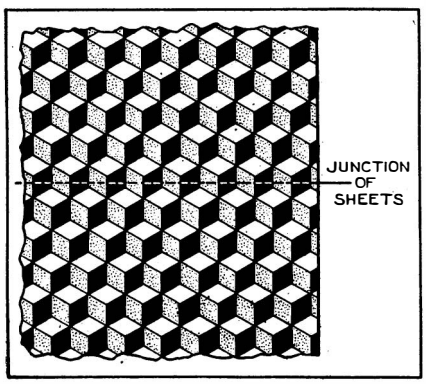

Figure 7: Marrying HCF and HCF

a method of welding these sheets edge to edge is described. An alternative method which requires less of the art of legerdemain has been communicated by Horace H. Selby. First, he trims the two sheets back from the edge a little way, in order to get into uniform material, so that a careful crosswise match between the cells is possible. Then he slides one of the pieces along the other till he has a precise lengthwise match between cells. The sheets are now ready for permanent joining. This he does with an ice pick, very hot, which he touches very lightly and quickly to the cell slopes at their respective junctions, skipping alternate slopes (the down slopes) and filling these in later by turning the sheets around and repeating the process (Figure 7). He says it takes only ten minutes to join pieces of HCF for a 15" lap.

PITTSBURGH is to be the mecca for all amateur astronomers and telescope nuts on Friday, Saturday, and Sunday, July 5-7, and there will be plenty to do and see while there. This is in addition to the annual Stellafane get-together, to be announced here later.

CURRENT BULLETIN BRIEFS

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

STEEL SERVES THE FARMER is a lavishly illustrated bulletin that traces the development of farm equipment from early beginnings down to the present day when steel has become a highly important metal in farm implements. *American Iron and Steel Institute, 350 Fifth Avenue, New York, New York. — Gratis.*

A BIBLIOGRAPHY OF BIRDS is a two-volume, 937-page reference work to scientific articles on the anatomy, physiology, ecology, behavior, and related aspects of ornithology, listed alphabetically by authors. It is intended mainly for the investigator and it omits uncritical literature. *Field Museum of Natural History, Chicago, Illinois. — $6.00.*

FLEXIBLE METAL HOSE is a 38-page catalog that describes and illustrates a wide variety of flexible metal hoses and their uses in industry. Included are hoses for handling saturated steam, super-heated steam, liquids of all kinds, many types of corrosive chemicals, and so on. A number of tabulations present essential data. *Chicago Metal Hose Corporation, Maywood, Illinois. — Gratis.*

HOW TO USE THE G-E EXPOSURE METER FOR PRINTING AND ENLARGING is an illustrated circular that will enable the dark-room worker to put his exposure meter to uses other than that of determining exposure when making the original negative. *General Electric Company, Schenectady, New York. — Gratis.*

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION. The title connotes something exceedingly dull but the actuality is quite the reverse, because the bulk of the report is a so-called "appendix" containing 32 of the best scientific papers of the year — 470 pages of them. Many persons having scientific leaning buy these books annually, never miss one of them. *Superintendent of Documents, Washington, D. C. — $1.50.*

THE SENTINEL ELECTRIC EYE DOOR ATTENDANT is a circular that illustrates and describes a photo-electric set-up which can be used for a wide variety of purposes, from announcing store customers to acting as a burglar alarm in home or shop. Prices are included. *Photobell Corporation, 123 Liberty Street, New York, New York. — Gratis.*

MT-SCOPE is a 16-page illustrated brochure which describes equipment to be used for underground exploration for buried masses of metals. *Fisher Research Laboratories, 745 Emerson Street, Palo Alto, California.—Gratis.*

PLACER DREDGES is almost a reference manual on the subject of placer dredging. It not only describes mechanical and structural details of a complete line of dredges but it also contains instructions for computing sizes and outputs of dredges. Two full pages of formulas and computations will be found useful in placer mining work. A four-page insert is of historical significance, telling the story of the beginnings of placer gold dredging in the United States. Bulletin No. PD-4. *Bucyrus-Erie Company, South Milwaukee, Wisconsin. — Gratis.*

SPEED FLASH MANUAL is a 34-page pocket-size booklet that describes Photoflash synchronizers and tells how to use them with various cameras and under varying operating conditions. Thoroughly illustrated with drawings and photographs. *The Kalart Company Incorporated, 919 Broadway, New York, New York. — Gratis.*

CATALOG AND DATA BOOK is a 104-page illustrated pamphlet that gives answers to everyday finishing problems, reports new developments in spray painting equipment, gives prices, provides engineering and performance data. Request Catalog No. 75. *Binks Manufacturing Company, 3114-40 Carroll Avenue, Chicago, Illinois.—Gratis.*

MANUAL OF RADIO SERVICING gives in compact form, for the radio service man, facts about service problems as encountered in modern radio sets. It presents a series of ideas that will assist in trouble-shooting. *Supreme Publications, 3727 West 13th Street, Chicago, Illinois. — 10 cents.*

AHRIMAN, A STUDY IN AIR BOMBARDMENT, by Brig. Gen. Oliver L. Spaulding, U. S. Army, is a 144-page paper-covered book that presents a brief, non-technical synthesis of the general subject of aerial bombardment of cities. It deals lucidly with such controversial subjects as the cost of air raids and what the air raid can accomplish. Best of all, it presents plans for possible preventive action. *World Peace Foundation, 40 Mount Vernon Street, Boston, Massachusetts. — 50 cents.*

RAILROADS CAN DO THE JOB is a folded leaflet that demonstrates graphically and in text that railroads can meet present and prospective needs for transportation and can do a better job than any competing form of transportation. *Association of American Railroads, Transportation Building, Washington, D. C. — Gratis.*

THE SPERRY GYRO-HORIZON AND THE DIRECTIONAL GYRO is a 24-page booklet that describes in some detail these two instruments which are of tremendous assitance to the airplane pilot. *Sperry Gyroscope Company, Incorporated, Manhattan Bridge Plaza, Brooklyn, New York. — Limited Free Distribution.*

COLOR PHOTOGRAPHY is an illustrated pamphlet that describes the operation of the Lerochrome One-Shot Camera. Several drawings illustrate the principle of color photography as well as the operation of this particular camera. Prices are given. *National Photocolor Corporation, 480 Lexington Avenue, New York, New York. — Gratis.*

ANNUAL BULLETIN OF THE TEXAS ARCHEOLOGICAL AND PALEONTOLOGICAL SOCIETY, for 1939, is a 271-page book with 55 plates, containing nine articles on archeological finds, mainly in the Texas region. *Dr. Otto O. Watts, Hardin-Simmons University, Abilene, Texas. — $3.00.*

LEGAL HIGH-LIGHTS

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

By ORSON D. MUNN, Litt.B., L.L.B., Sc.D.

New York Bar
Editor, Scientific American

VARICOLORED

THE owners of the trade marks "White Horse" and "Black Horse" for Scotch whisky successfully opposed an attempt by another to register the trade mark "Red Horse" for use on cordials, brandies, rums, cocktails, and similar alcoholic beverages. In the case in question the owners of the trade mark "Red Horse" for alcoholic beverages attempted to register it in the United States Patent Office. The owner of the trade marks "White Horse" and "Black Horse" opposed the registration on the grounds that the trade marks were confusingly similar to each other. The Patent Office decided that the marks were confusingly similar to each other and sustained the opposition. On appeal to the Court of Customs and Patent Appeals, the Court pointed out that if the appellant were permitted to register the trade mark "Red Horse," other producers of alcoholic beverages might attempt to register the trade marks "Brown Horse," "Gray Horse," "Sorrel Horse," and "Bay Horse" and concluded with the following:

"That the use and registration of such marks on alcoholic beverages would destroy the value of appellee's registered marks, is so apparent as to require no discussion."

HAM AND EGGS

A SUIT of more than usual interest involving the so-called "Ham and Egg Pension Plan" was recently filed in the Federal Court in California.

The suit charged copyright infringement and was brought by the proprietor of a copyright for a book against the Secretary of State of California. The copyrighted book described an old age pension system similar to the pension system submitted to the voters of California last November and popularly known as the "Ham and Egg Pension System." The purpose of the suit was to restrain the Secretary of State from distributing to the voters of the state, as required by California law, the proposed constitutional amendment providing for the pension plan. A motion was made on behalf of the Secretary of State to dismiss the suit and during the course of its consideration of the motion, the court pointed out that a copyright for a book did not protect ideas described in the book but merely the language describing the ideas. Since the copyrighted book described a pension system to be operated by the Government, a governmental unit could operate such a system without infringing the copyright. The court then concluded that to operate such a system it was necessary to adopt suitable legislation putting it into effect and the publication of such legislation did not constitute copyright infringement. In this connection the court stated that "a plan or system advanced for government adoption cannot be copyrighted so as to prevent the publication of that plan or system, whatever the medium of expression used, in the form of a proposed law incident to its submission to the vote of the electorate."

As a result of its conclusion the court dismissed the suit.

VITAMIN C

A RECENT attempt to obtain a patent on Vitamin C, the anti-scorbutic factor, met with failure. An application was filed for a patent on hexuronic acid, a white crystalline solid identified as Vitamin C. The application was rejected by the Patent Office on the grounds that hexuronic acid had previously been isolated from the adrenal glands of animals and had been described in a printed publication published some years ago prior to the filing of the patent application. The applicants for the patent conceded that hexuronic acid had been isolated from adrenal glands and had been described in the publication, but pointed out that the previous discoverer did not appreciate that hexuronic acid was the same substance as Vitamin C but merely referred to it as a "reducing factor." The Patent Office, however, rejected the application, pointing out that the substance itself was not new and that a patent could not be obtained for the discovery of a property or characteristic of a substance nor for the discovery of the actual identity of a substance.

Upon appeal to the Court of Customs and Patent Appeals the Court affirmed the rejection of the Patent Office stating: "We have hereinbefore concluded that ordinarily no invention exists in the discovery of a property possessed by an old substance. . . ."

SECRETS

WHERE secret formulas become involved in litigation the court will attempt to preserve the formulas from publication. This is illustrated by a suit involving a secret formula for an alloy used in the manufacture of flat-ware and hollow-ware. The suit involved two manufacturers, each claiming to be the exclusive licensee of the owner of the formula. One of the defenses raised was that the formula was no longer secret but was fully described in a printed publication. If this were true the formula of course would be public property and neither party could restrain the other party from using it.

In order to determine whether the published formula was the same as the secret formula it was necessary to take testimony as to the nature of the secret formula and if the testimony were taken in the usual manner the information as to the nature of the formula would be available to the public and the secret character of the formula would be destroyed. To protect the owner of the formula against this contingency the court ordered that the testimony should be taken in camera and should be then sealed and submitted to the court, stating:

"Having in mind that the taking of evidence upon the question whether the published formula is the true formula, and whether if so its dedication to the public is a dedication of the process, may threaten exposure of both formula and process if they be still secret, evidence may be taken in camera and sealed as was done in A. O. Smith Corp. v. Petroleum Iron Works Co."

MANUFACTURE

THE manufacturing of an infringing article, even though the article is never sold or placed into actual use, constitutes patent infringement. This question was considered in a recent case involving patents for tractors. It was contended by one of the parties that the court did not have jurisdiction over the suit because a tractor charged to infringe one or more of the patents had not been sold or used. The Court pointed out that this contention was without merit because, if the tractor infringed the patents, the mere manufacture of the device constituted patent infringement. In this connection it would be well to note, however, that the failure to use or sell an infringing device would affect the amount of damages. In the absence of sale or use of an infringing device it would be difficult to show that the patentee had suffered any damages or that the infringer had realized any profits.

MERCILESS

AS pointed out in a recent federal court decision, the nature of a patent is such "that joint owners in it are at the mercy of each other." In the suit in question a patent for an electric fan was jointly owned by two persons. One of the joint owners filed suit against a manufacturer of electric fans charging infringement of the patent and the other joint owner refused to join in the suit. To meet this situation the first joint owner joined the other joint owner as a defendant in the suit. The manufacturer of electric fans made a motion to dismiss the suit on the grounds that joint owners of a patent must join in the suit as plaintiffs. The Court first considered the peculiar nature of patent rights, pointing out that where a patent is jointly owned either co-owner may manufacture, use, and sell the patented invention without the consent of the other co-owner and without liability to account for any profits realized from the invention. The Court also pointed out that one joint owner may grant a license to another person without the consent of the other co-owner and may collect for his own use the royalties arising from the license.

The Court concluded that to maintain a suit for patent infringement both co-owners must voluntarily join in the suit and that if either co-owner refuses to do so he can not be joined as a party defendant.

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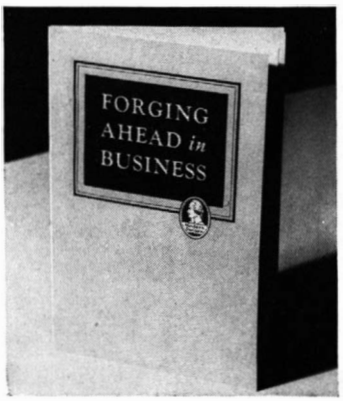

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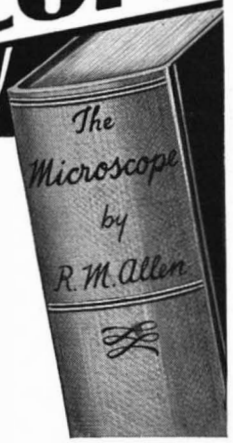

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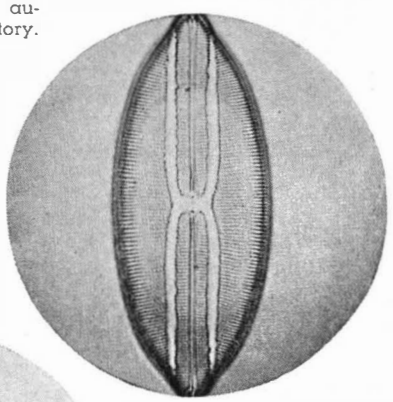

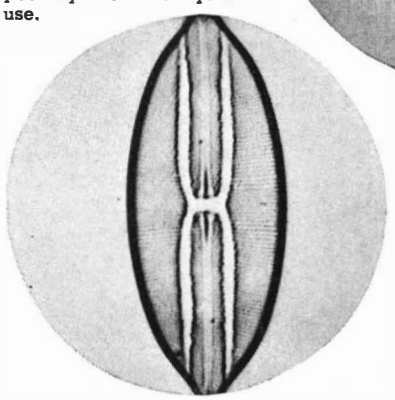

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