PROBING ATOMS

—With Man-Made Eyes

SCIENTIFIC AMERICAN

Including:
A DIGEST OF
SCIENCE & INDUSTRY
.. also ..
Amateur
Photography
By Jacob Deschin

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SEPTEMBER
1939
•
35c
a Copy

For MEN

who want to become independent in the NEXT TEN YEARS

IN the Spring of 1949 two business men will be sitting in a mid-town restaurant. "I wonder what's going to happen next year," one of them will say. "My business is fine now—but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh.

"That's just what they said back in 1939," he will answer. "Remember? People were looking ahead apprehensively—and see what happened! Since then there has been the greatest growth in our history—more business done, more fortunes made, than ever before. They've certainly been good years for *me*."

He will lean back in his chair with the easy confidence and poise that are the hallmark of real prosperity.

The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say.

● Today the interview quoted above is purely imaginary. But be assured of this—it will come true. Right now, at this very hour, the business men of America are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say:

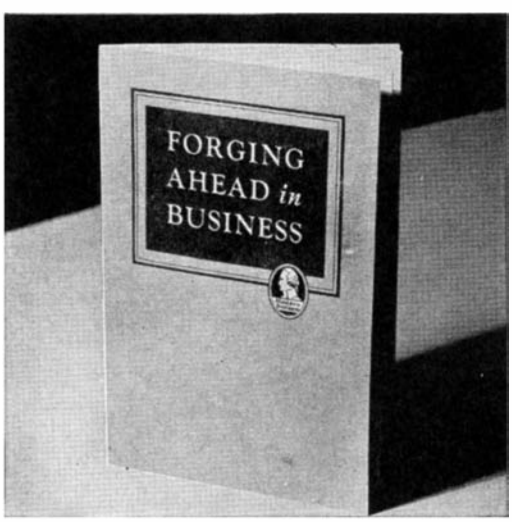
"I've got what I wanted."

And the other will answer:

"I wish I had those years back."

In which class are you putting yourself? The real difference between the two classes is this—one class of men hope vaguely to be independent *sometime;* the other class have convinced themselves that they can do it within the next few years. Do you believe this? Do you care enough about independence to give us a chance to prove it? Will you invest one single evening in reading a booklet that has put 400,000 men on the road to more rapid progress?

This booklet costs you nothing—and for a good reason. It is worth only what you make it worth. It explains how for more than thirty years it has been the privilege of the Alexander Hamilton Institute to help men shorten the path to success; to increase their earning power; to make them masters of the larger opportunities in business.



"FORGING AHEAD IN BUSINESS" is an interesting, helpful booklet. It is yours for the asking. Send for it. Measure yourself by it. Look clearly, for a few moments, into *your* next few years. Whether or not you will follow the path it points is a matter that you alone must decide.

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The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

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NINETY-FIFTH YEAR • ORSON D. MUNN, Editor

CONTENTS • SEPTEMBER • 1939

REQUIREMENTS of heavy-duty service and quiet operation in electric locomotives call for a high degree of accuracy in gear cutting. Hence the inspection device, illustrated on our front cover, wherein three mechanical fingers rapidly check tooth space and tooth contour. The illustration reproduced was made at the Works of the Gearing Division of the Westinghouse Electric & Manufacturing Company at Pittsburgh, Pennsylvania.

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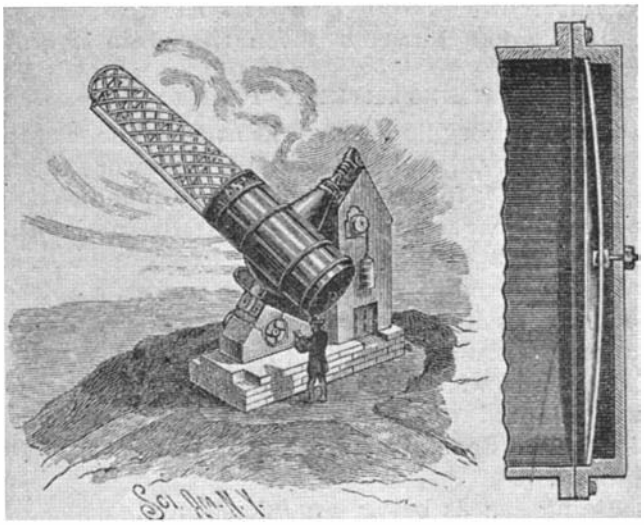
50 Years Ago in . . .

Scientific American

(Condensed From Issues of September, 1889)

TELESCOPE MIRROR—"A means whereby concave mirrors of long focus may be readily produced from plane-faced mirrors is illustrated herewith. To make such a mirror a pan is employed, preferably made of cast metal to be extremely rigid, and with flanged edges by which it may be bolted by three equidistant bolts to the flanged end of the tube. This pan is formed with a seat or shoulder, as shown in the sectional view, upon which there is placed a plane mirror, through the axis of which there is drilled



a small hole adapted to receive a tube, with threaded ends to engage an upper and a lower disk, fitting on the upper and lower faces of the mirror. The bottom of the pan has a central aperture through which is passed a headed and threaded tube engaging the other tube, and the tube passing through the bottom is turned by means of a suitable wrench, to draw the center of the mirror down against its own rigidity, bending it into concave shape."

TUNNEL—"The Hudson River tunnel, designed to give passage for railway trains under the wide body of water that separates New York from Jersey City, is again in process of construction. Vertical shafts were sunk near the shores of the river. The one on the west shore is sixty-five feet deep, circular in section, and thirty feet in internal diameter. The walls lining it are four feet in thickness. From these as starting points two tunnels commence, diverging slightly and coming later into parallelism with each other. Each tunnel is lined with a shell of steel, built up of plates secured at the joints by angle irons projecting inward. The steel is three-sixteenths thick as at present used. Within this shell a brick lining is placed, of the best brick, laid in hydraulic cement mortar. The brick lining is two and one-half feet thick."

MORTAR—"A new idea in Germany is the wholesale manufacture of mortar of the best quality, to be sold to small builders and private individuals. Some 2,000,000 bbl. were thus sold last year in Berlin. This obviates the necessity of making the mortar on the ground under unfavorable circumstances and at unnecessary expense."

TUBING—"Considerable interest was shown at the Brussels exposition in a flexible metallic tubing exhibited . . . formed by wrapping strips of metal spirally around a mandrel. The metal strips were bent over at both sides and a thin, narrow rubber band was inserted to prevent leakage. The tubes could be sent in any direction, were perfectly tight, and were claimed to possess great resistance to both internal and external pressures, and to be easily handled and repaired."

ALUMINUM—"The Pittsburgh *Commercial Gazette* says: Few persons are aware that an aluminum-making plant is now in full operation in this city. . . . About fifty pounds of aluminum metal are produced daily. It is worth about $4 per pound, and this is a very large single output when compared with the product of the factories in other parts of the world. The material is used for various purposes. It has taken the place of silver leaf in sign painting, and in that particular has proved a great success."

TALKIES—"At a recent meeting of the French Academy M. Lippman presented a note by M. G. Gueroult, in which it is suggested that by the combined use of a phonograph and an apparatus for instantaneous photography and reproduction of the pictures obtained, it would be possible to reproduce at any future time not only the speech of a person, but also bring before the audience a vivid picture of the person's gestures and facial expression."

PAST GLORY—"In 1880, the total tonnage of the English merchant marine was 18,000,000 tons, and that of the United States 9,000,000—a tonnage four times as large as that of France. American ships monopolize nearly 20 percent of the total receipts of the commercial maritime carriage of the world. France and Germany figure in this commercial contest only for 5 percent each."

LAMP—"A new type of semi-incandescent lamp . . . consists of two horizontal rods of copper, set in line with each other, but separated by a space of about 3/16 of an inch. A thin fluted carbon rod is set vertically, and rests upon the ends of the copper rod, forming a bridge across. The current passes through the copper rods and through the point of the carbon rod, which is thereby rendered brilliantly incandescent."

GUN—"The great 12.06 inch De Bange gun excites much attention at the Paris exhibition. It was tested on the trial ground at Calais on May 7, 8, and 9 last. . . . The greatest range was a trifle short of twelve miles. A war ship capable of carrying and discharging these weapons might lie three miles out in the ocean off shore at Coney Island, and throw projectiles into the cities of New York and Brooklyn. Our war department should begin to think about obtaining some of these arms."

ELECTRICITY—"According to reliable reports, there are at present 3351 isolated electric lighting plants and central stations in the United States alone, operating 192,500 arc and 1,925,000 incandescent lights each night."

AND NOW FOR THE FUTURE

¶Insanity at the Wheel—What Psychologists are Doing for Highway Safety, by Andrew R. Boone.

¶Fungus Threatens Poor Man's Food-Fruit—the Banana, by Charles Morrow Wilson.

¶Manganese from Cuba—Hope of Our Steel Industry, by Richard B. Clarkson.

¶The Real Low-Down on High Blood Pressure, by T. Swann Harding.

¶Biggest Explosion in Atomic History—Two Elements for One, by Jean Harrington.

OUR POINT OF VIEW

Oily Outlook

PETROLEUM, black gold of the oil fields, source material which in more ways than one has made possible our highly developed automotive age, holds forth promises of even greater marvels in years to come. Given a quantity of petroleum, the modern research chemist produces an awe-inspiring variety of materials which, in one way or another, can influence, even change the mode of, our daily lives. And this he does with what, in the future, will be considered to be a meager knowledge of his subject.

Meager though present-day knowledge may be, developments in the field of petroleum research make it possible for the technologist with a flair for prophesy to give us a well-founded glimpse of what the future holds in store. Thus, Dr. A. E. Dunstan, British petroleum technologist, did not stretch facts beyond possibilities when he visualized the petroleum home of the future where even the food served will, in part at least, be derived from petroleum. Briefly described, Dr. Dunstan's dream home will have a roof of petroleum-base tile and walls of synthetic glass or hollow brick, while doors, partitions, windows, and even furniture will be fashioned of some form or another of petroleum-extracted plastics. Decorative effects will be obtained with similar plastics, aided by brilliant or subtle colorings skilfully obtained from through the use of petroleum dyes.

The people who live in these petroleum-created homes will even wear clothes whose origin will lie in petroleum. Fibers made from a petroleum base will be woven into fabrics that, in turn, will be colored with dyes from the same source.

Synthetic food from petroleum will constitute at least a part of man's diet, Dr. Dunstan believes, and backs up this thought with a reference to the fatty acids that can now be extracted from petroleum. These substances could very likely be combined with other petroleum derivatives to form foods that would equal in nutritive value the animal and vegetable fats of today.

Whence will come the vast supplies of petroleum necessary to carry forth this program? Alarmists would have it that our petroleum reserves will be exhausted shortly. But improved methods of reclaiming oil from Mother Earth, new fields being explored, more efficient utilization of petroleum, are all pushing further and further into the future the time when the point of exhaustion will be reached. In the meantime, it is pleasant and inspiring to let the mind wander through new fields to a region where today's home will be yesterday's potential crankcase filling.—*A. P. P.*

Hypergeometry and Hyperperplexity

SOME months ago—as long ago as March, in fact—this journal published an article entitled "Visualizing Hyperspace," in which was discussed a fourth dimension of space and a method of visualizing exactly what this kind of space would look like if there were such a thing. From time to time since then the editors have received inquiries from puzzled readers who appear to be confused about a variety of questions suggested by this article. Is not time the fourth dimension? How do the mathematicians know that there are more than the three common dimensions with which we are all daily familiar? How many more dimensions are there and, anyway, aren't a good many of the mathematicians just a bit "teched"?

First, regarding time as the fourth dimension: True, time does figure in the so-called "space-time continuum," but not as an extra dimension of *space*.

Next, how do they know there are extra dimensions of space? They don't! They play with them, however, just as if they did exist. All the mathematician does is to take the algebraic formulas of analytic geometry which he has applied to three-dimensional space and go on developing them in the same way for added dimensions. It is a game but the matter ends there—that is, so far as they know, for it is of course dogmatic to assert positively that there are no extra space dimensions. All we can assert is that, if there are, man has never run across any real ones.

The mathematician is a whimsical fellow who thoroughly enjoys deliberately creating a make-believe and then proceeding to show what would be the case if it were true. He does this simply because it is such fun. His brain is active and can't help playing these little games. And, at that, there is no crime in extending his logical processes out into the fog, provided they remain consistent throughout—that is all science asks.

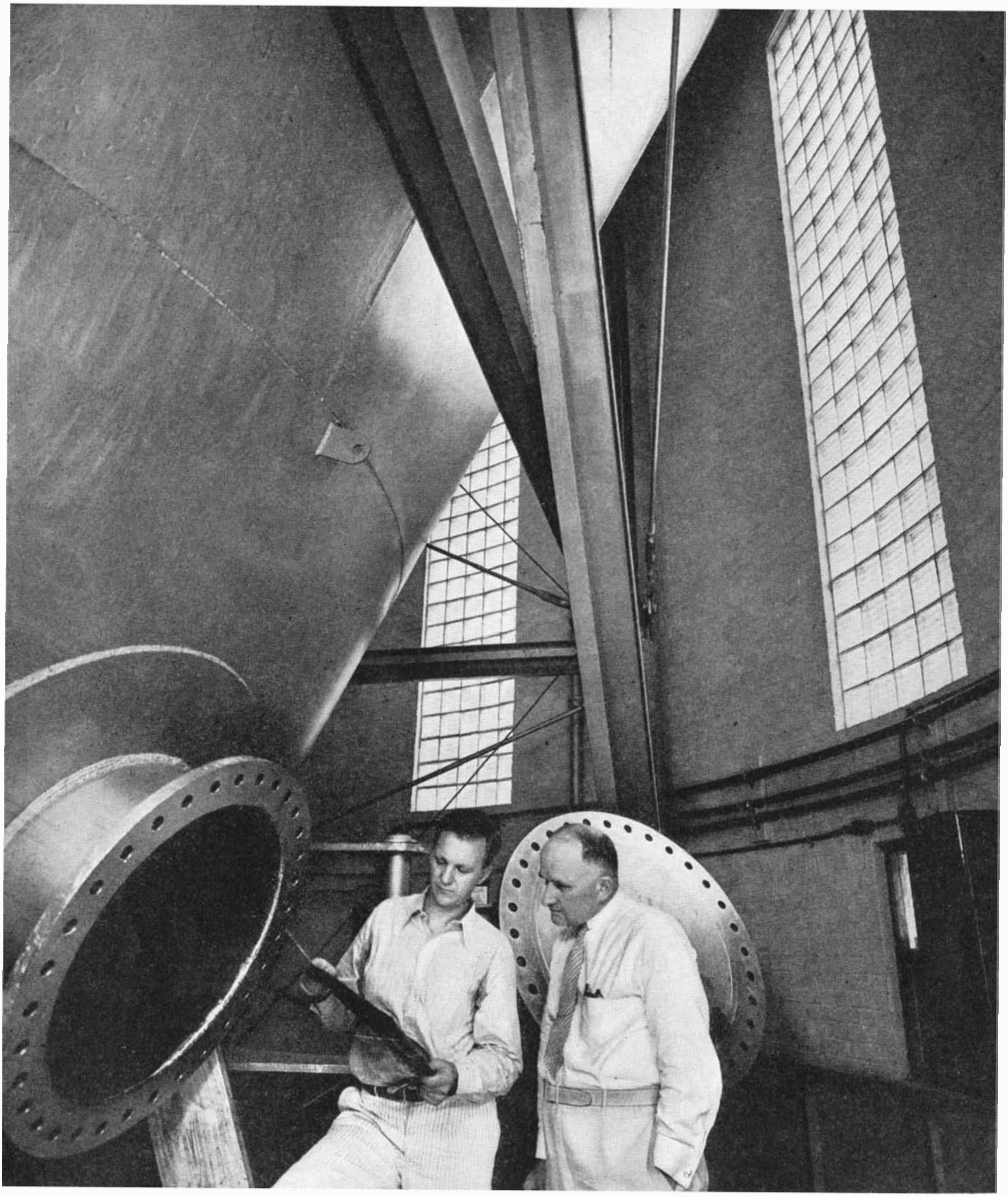
What probably confuses the puzzled non-mathematician is the fact that the mathematician uses for his excursions into the imaginary the same word he uses in connection with something he and all the rest of us knows to exist; that is, "dimensions." If he would call them something else the confusion would promptly end for most of us.—*A. G. I.*

Trees

TO say that all the lumber cut in the United States during the past 135 years would make a solid cube a mile on each dimension would not impress many people. We just don't visualize the enormity of such a cube. In terms of board-feet, however, the quantity shows up clearer and we begin to realize the inroads we have made on our timber resources. A cubic mile of lumber would total considerably more than 1700 billion board-feet. Yet this is only a fraction of the drain on our forests, for the vastly increased demands for pulpwood—for paper, rayon, and related products—has denuded many thousands of once heavily forested acres. And the continual process of cutting firewood and of clearing wooded areas for farming, as old farm soil wears out and is abandoned, is taking its toll.

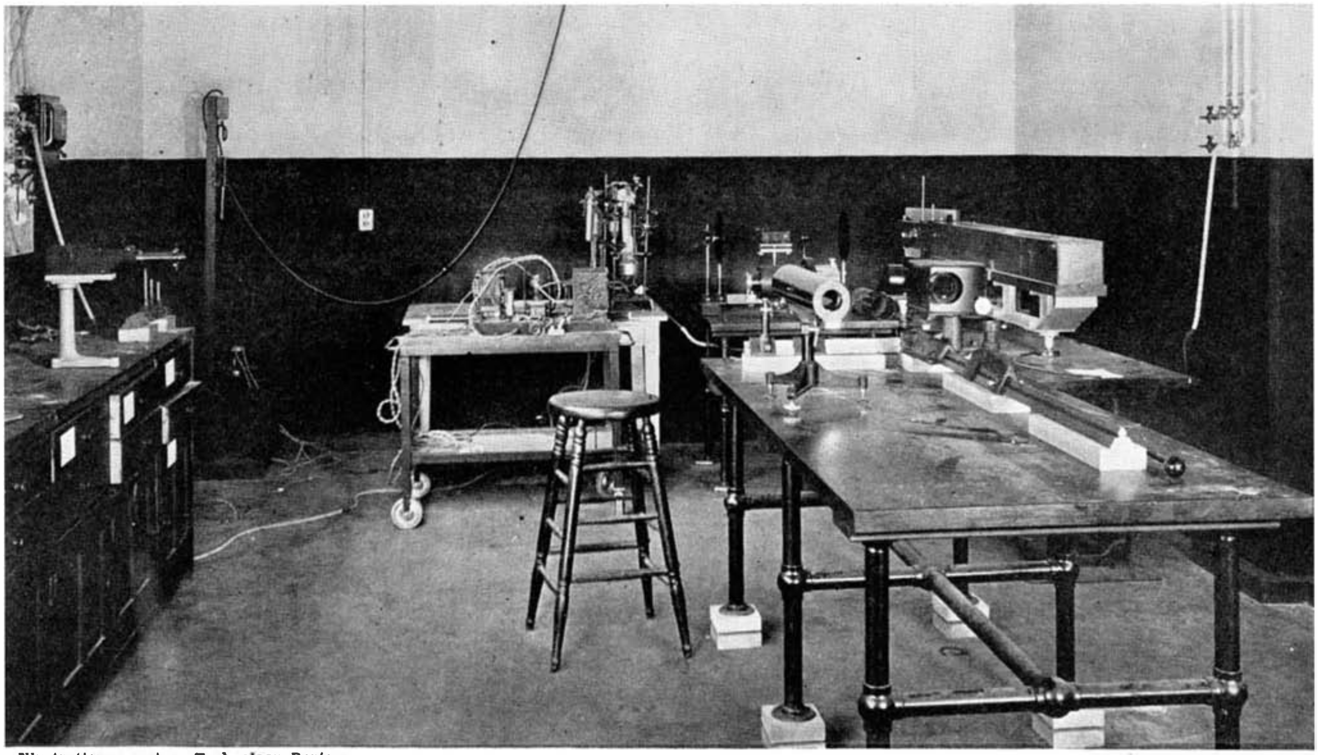
Conservationists are now, therefore, cheered by the news that farmers have more than doubled their tree-planting since 1935. The Forest Service of the Department of Agriculture reports distribution in 1938 of over 55 million tree seedlings and transplants as compared with a distribution of only a little over 26 million in 1935. The law providing for such distribution by the Federal Government in co-operation with state governments—the Clarke-McNary Law—is not so new that it would provide explanation for this spurt in planting. It dates from 1924. The indication is that some other factor is involved, and we'd like to feel that it is a nascent consciousness of our sins of the past and of the great value of trees in our national economy—trees standing alone or in woods, forests, or wind-breaks.

The timber companies and the paper mills have that consciousness and are doing their share by reforesting as fast as they cut. New farm planting, if the idea continues to grow, will round out the cycle and assure maintenance of a continuing supply of wood for all purposes. New growth will be slow in maturing, of course, but we certainly must have reached the point where patience should rule—after our years of impatience to grab, before someone else did, the golden profits from Nature's bounty of trees.—*F. D. M.*



WITHIN THE HOUSING OF A GIANT ATOM SMASHER

TO "smash" atoms they must be bombarded with high-speed particles. One way to give particles high speed is with the cyclotron, while another is by means of an electrostatic machine. Better results are had if this machine is operated in an atmosphere of compressed gas, and this has led to the installation of atom smashing equipment inside very large steel tanks to permit control of this factor. The photograph shows the exterior of the huge container of the Van de Graff generator now under construction at the Carnegie Institution of Washington, inside its Insulex glass block housing.



Illustrations courtesy *Technology Review*
A spectrograph of the kind used in measuring small amounts of impurities in metals, as in manufacturers' laboratories

EYES THAT SEE THROUGH ATOMS*

The Spectroscope, Long a Master Key in Science, is Proving to be of Major Practical Importance in a Wide Variety of Arts and Industries

By GEORGE RUSSELL HARRISON, Ph.D.
Professor of Experimental Physics and Director of the Research Laboratory of Physics at the Massachusetts Institute of Technology

(In Two Parts—Part One)

THERE exist a few scientific instruments which, though they have contributed directly to the establishment of no vast new factories, and are never sold over the counter, are of incalculable value to mankind. One of the most powerful and useful of these instruments is the spectroscope; indeed, Henry Norris Russell has called the spectroscope the Master Key of Science. It appears to be true that with this talented instrument scientists have succeeded in unlocking more secrets of nature than with any other single device. Though comparatively simple in its structure and operation, the spectroscope gives answers to an incredibly wide variety of questions merely by dissecting a beam of light and separating this into its component colors.

Is life possible on Mars? Ask the spectroscope. Is a certain painter's illness caused by lead poisoning? The spectroscope can tell. How much does the core of a helium atom weigh, and how much that distant star? Does this greenhouse contain the correct amount of carbon dioxide to support plant life? Of what is the tail of a comet made? How many electrons are there in an iron atom? Is this the sweater of the burglar who crawled through that broken window? How hot is the Sun? Thousands of such questions are being asked from time to time, and are being answered correctly with the aid of the spectroscope.

ANY atom or molecule will emit light if it be struck a hard atomic blow, and all light originates from atoms which have thus been stimulated by heat or electricity. Since any material object—a star, a drop of blood, a speck of putty—is composed of atoms, any material object can be induced to emit light by heating it until it becomes an incandescent vapor. The light which is thus emitted carries inevitably in itself many secrets concerning the atoms from which it originated. It is the function of the spectroscope to analyze this light, and thus lay bare these secrets for the eye of science to read.

The chemist finds that a tiny pinch of salt needs more than a bathtub full of water in which to hide from the ferreting eye of the spectroscope, and he uses this instrument regularly to detect and measure minute traces of impurities in the materials with which he works. So bright is the light which the atoms in a small speck of metal can emit, that a piece of brass the size of a pinhead will serve for a complete determination of the presence or absence of 70 of the chemical elements, and none will be overlooked which is present in an amount as great as one millionth part of the whole. In fact, at least ten of the chemical elements were originally discovered with the spectroscope.

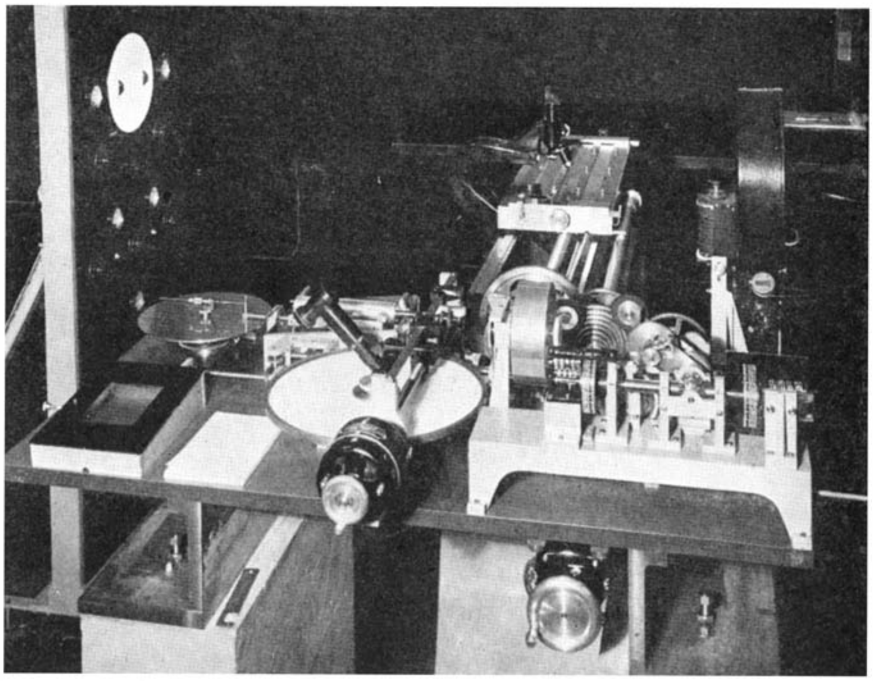
Atoms which are to be studied with a spectroscope need not be anywhere near it, for the light which they emit can travel a billion miles across space and still deliver up its secrets when captured and analyzed. The astronomer is thus enabled to analyze the materials of distant stars, and has learned that even the farthest visible nebula is composed of the same atoms that we know on earth—dust similar to dust across the vast stretches of the cosmos. More than three fourths of the discoveries of modern astronomy have been made with the spectroscope, and no large telescope is considered complete without one to sort out the light it gathers. Nor is the spectroscope merely an analytical tool, for with it stars and nebulae can be weighed, their temperatures taken, their speeds through space measured, and the courses charted of their lives and deaths.

To the biologist and physician also the spectroscope is invaluable, for with it such complicated molecules as those of vitamins and hormones can be studied, and metallic poisons can be detected in the blood long before they accumulate in amounts sufficient to be harmful. If the human body is analyzed down to its constituent elements, almost every kind of atom is found, but many are present in extremely small amounts. Which are essential to life and which are merely incidental? For example, little copper is found; too much copper is poisonous; yet some copper must be present if life is to continue. How much copper is too much, the spectroscope is helping the physician to determine. The same question must be answered for numerous other kinds of atoms.

Drugs also can be studied with the spectroscope. In cases where cocaine poisoning is suspected, a few drops of fluid taken from the spine of the patient can be diluted and the cocaine content can immediately be determined from its light absorption. To draw enough fluid to analyze chemically might harm the patient.

ENGINEERS find the spectroscope useful also. With it they can look inside the cylinder of an engine while this is in operation, and study the burning and explosion of gases and the propagation of pressure in the cylinder. A plug of metal is cut from the top of the engine and a thick window of clear fused quartz is inserted in its place. Through this window comes enough light to enable the spectroscope to establish the temperature of the flame at any instant, and to give analyses of the composition and rate of burning of the fuel.

Even in crime detection the spectroscope is useful, and it has had its day in court in a number of lawsuits. In one case, gasoline which exploded in a sewer was traced to one of a dozen filling stations in the neighborhood from which it might have leaked, by using the spectroscope to show that the gasoline found remaining in the sewer absorbed light identically with the brand sold by the station. The G-men in their government laboratories use the spectroscope regularly, as do workers in the various state criminological laboratories.



A newly devised automatic machine for measuring the wavelengths of the light producing spectrum lines, directly from the positions of the lines on a spectrogram. The spectrogram is clamped on the carriage in rear, the projection microscope above it throwing the spectrum on a screen in the center of which is a slit which admits the light to an electron multiplier. The carriage is moved by the lead-screws shown, and the dial geared to this reads in angstroms

The spectroscope is thus at once a powerful tool for analyzing matter; a super-telescope, and a super-microscope; a super-speedometer, thermometer, tape-measure, and clock. In each rôle it exceeds in range and power the more common forms of these devices. This it can do because it attacks fundamentals; it studies the world and the heavens in terms of the very atoms of which they are made, and these atoms in terms of the energy which is their very life.

The foundations of spectroscopy were laid by a 24-year-old boy. One day in 1666 a young student, later to win fame as Sir Isaac Newton, threw the first purposefully produced indoor "rainbow" on the wall of his bedroom. Newton thrust a prism into a beam of light which was shining through a round hole in his landlady's windowshade, and saw that the prism split the white light up into a bright spectrum of colors. By so doing he came breathtakingly close to inventing a spectroscope. If the sunlight had entered through a crack in the shade instead of through a hole, and if Newton had turned his prism so that its base was parallel to this crack, and had inserted a pair of lenses into the beam, he might have noticed dark streaks or lines running across some of the colors on the wall. More than a century elapsed, however, before Joseph von Fraunhofer designed a spectroscope which would separate light into its ultimate purity of color, and observed these dark lines in the spectrum.

Despite its tremendous analytical powers, a spectroscope is really a simple instrument, and it has no moving parts to wear out. Light to be analyzed is sent into it through a narrow slit, and then passes through a prism or similar device which separates the different waves of light in accordance with their lengths. Waves of each particular length are sent in a particular direction, where they can be observed with a small telescope. The lenses in this telescope serve to heap similar waves neatly together in one pile, where they appear as a line of colored light, an image of the spectroscope slit in light of utmost purity.

THE great power of the spectroscope arises from the fact that under sufficient provocation all atoms and molecules emit light, and each of the kinds of atoms which make up our earth—iron and hydrogen and sodium and more than fourscore others—emits light of certain wavelengths and those only. Since light waves are identical with ultra-short radio waves, under proper stimulation every atom becomes in fact a tiny short-wave radio transmitting station. When a radio set is tuned to a certain wavelength a peak of sound intensity is heard if some station is broadcasting on that wavelength; a spectrum line is the peak of light seen at a certain wavelength because an atom is broadcasting on that wavelength. The millions of atoms in a flame or electric arc broadcast on hundreds of frequencies at the same time, but the spectroscope can be tuned to all these wavelengths simultaneously, sorting them out so that all can be observed together without mutual interference.

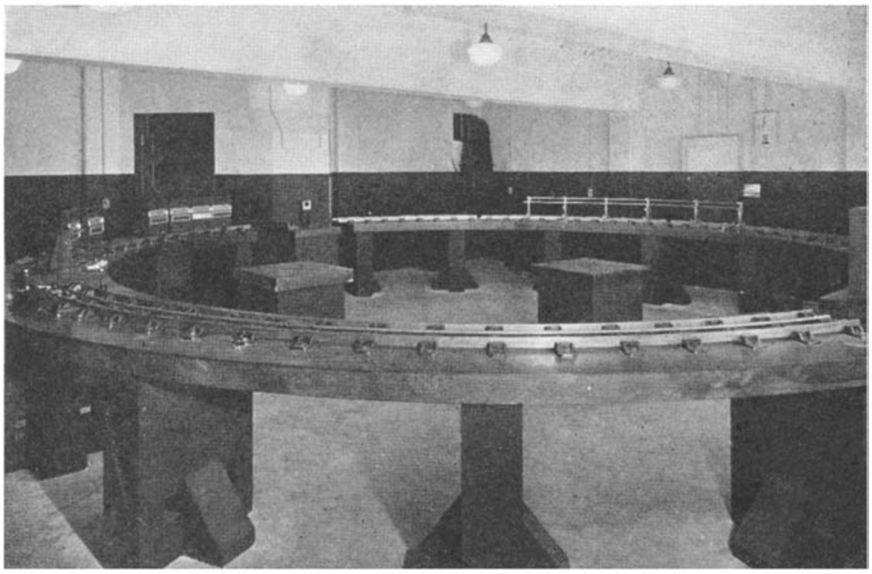
Though the waves which the atoms emit bring no purposeful message, they tell much, and by literally reading between the lines (to seven figures, in fact) the physicist has been able to deduce many facts about the atomic world from the broadcasts which originate there. Most important is the identification of sending atoms merely by noting the wavelengths on which broadcasting is being done. Just as an experienced radio listener knows that he is hearing station WZZZ when he turns the radio dial to 422 meters and hears any sort of noise, merely because WZZZ is the only station which broadcasts on that wavelength which his set will pick up, so a spectroscopist knows that he is looking at light from sodium atoms when he sees the familiar yellow light of the sodium flame, because sodium atoms broadcast on the yellow wavelength 0.5893 micro-meters. (This is usually written by the spectroscopist 5893 angstroms. Ten billion angstroms is one meter.)

The spectroscopist can be even surer of his station identification than the radio listener can, for each atom broadcasts not on one wavelength alone, but on a whole group of wavelengths. Iron atoms, for example, when made sufficiently hot are found to produce more than 20,000 spectrum lines. More than 1,000,000 separate spectrum lines have been distinguished all told, and most of these have been identified as caused by light which comes from one or another of the various kinds of atoms and molecules of which matter is composed. Since one or two carefully measured lines will serve to identify the atom which emitted them, it thus becomes almost impossible for an atom to mask its identity if its light can be sent through a spectroscope.

The patterning of lines in a spectrum is a language which the spectroscopist has gradually learned to read clearly. As the series of irregular black marks on this page conveys certain ideas to a reader, so the unevenly spaced lines in a spectrum convey to the scientist flashes of information—here is iron, here arsenic, here are lines of copper and lead. Some of the lines are brighter than others, so the light can even be made to tell how many atoms of each kind are broadcasting—here is a great deal of iron, here a little arsenic, here too much copper in this lead.

Since the spectroscope arranges the spectrum lines in order of wave-length it is not necessary that they be seen in color, and they can therefore be photographed and later identified from their positions on the resulting spectogram. This method of observing spectra is now commonly used, both because the records thus produced can be studied at leisure, and because many spectrum lines are found in the ultra-violet and infra-red regions where they cannot be seen but can be photographed with ease. When a camera is thus used in combination with a spectroscope the resulting instrument is called a spectrograph.

Most small spectrographs contain a prism to split the light which passes them into its constituent wavelengths, but large instruments use a more powerful device, a scientific light-sieve called a diffraction grating. This is usually a highly polished mirror on which as many as 200,000 sharp, parallel scratches have been accurately ruled with the point of a diamond. These narrow scratches, when evenly spaced 20 or 30 thousand to the inch and accurately placed to within a thousandth of the thickness of a hair, sort the light waves into spectrum lines without the use of auxiliary lenses. Prisms must be made of transparent material; glass serves for visible light, but quartz is needed for ultra-violet and rock salt or some similar material for infra-red light. A diffraction grating ruled on a mirror has the advantage that it can be used with waves of any length, within reason.



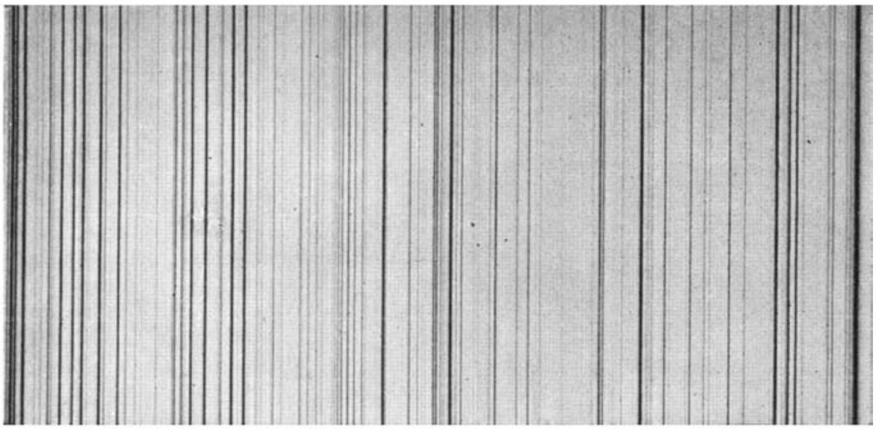
A large diffraction-grating spectrograph. Light which comes through a slit at the far side of the circular track, just to the left of the center, is spread by a diffraction grating in the black box at the right around the circle as a spectrum. Photographic plates are placed in proper positions to record the lines

A LARGE diffraction-grating spectrograph requires a vast, vibration-free room to house it, and can throw light into a spectrum stretching a hundred feet around a huge circle. Such instruments are giants compared with the most common spectroscopes, small brass tubes on tripods familiar in elementary science laboratories. The positions of spectrum lines can be determined to within 1/25,000 of an inch, and when such precision is attained the length of the light waves is determined to one part in 3,000,000. Since the light waves are themselves only about 1/50,000 of an inch long, their lengths can thus be found to within a few trillionths of an inch—a billionth of the thickness of a hair.

When a spectrograph is used to determine which kinds of atoms are present in a given sample of material, the sample is vaporized and a discharge of electric current is sent through it. The simplest method of accomplishing this is to strike an electric arc between two pieces of very pure graphite, and insert into this arc the speck of metal or clot of blood which is to be analyzed, so that it is burned to nothingness. This burning tears the molecules of the material apart, separates them into their constituent atoms, and pounds each atom so hard with a deluge of electrons and other atoms that it emits the light which reveals its identity.

Suppose that a manufacturer of watches finds that a competitor is using a new hairspring of remarkable quality. This spring must be duplicated or improved on at any cost, but what can it contain that confers on its steel the new temper and elasticity which are so desirable? If a chemist is to analyze the spring by ordinary means he must buy several dozen watches, extract their tiny springs, and then guess which substances are most likely to be involved, so as to select the proper chemical reactions to carry out. He must dissolve and mix and scrape and weigh his materials with the greatest of care, for one single atom of a new alloying material to every 100,000 atoms of the watch-spring material may be responsible for conferring the high quality, and these are easily lost in a tiny sample.

How much more directly can the problem be attacked with a spectrograph! Now the chemist need merely strike an electric arc between two pieces of graphite, insert a small section of the spring into the flame, and let the flash of light which results enter his instrument and be recorded. When the plate is developed it shows hundreds of spectrum lines, and from these can be selected those which are known to arise from each kind of atom. It is but the work of a few moments to identify lines of iron, copper, chromium, nickel—all common in springs of one sort or another. But here are some lines which belong to hafnium—there must be hafnium in the spring! That no metallurgist or chemist would have guessed that hafnium would improve a hairspring is of no consequence, for the hafnium is there, it is the only new element present, and the springs are strong and supple.



A typical section of a spectrogram taken by means of a large diffraction grating. This example shows the characteristic spectrum lines as emitted by iron

ALMOST any material can be burned in the blistering 9000 degrees, Fahrenheit, of an electric arc, and if a material can be burned its metallic constituents can be determined with the spectrograph, whether it be a sample of blood from a patient suffering from lead poisoning, a drop of condensed milk thought to contain more than one part of copper in 3,000,000 parts of milk, or paint from an automobile suspected of having collided with a lamp post. Since it is not necessary to know in advance what kinds of atoms are being looked for, 70 kinds of atoms can be tested for in one separation.

No metal has ever been made so pure that the spectroscope could not find impurities in it. Even the superfine, extra-pure, 1000-proof gold which is the basis of the currencies of many countries is found to contain much atomic dirt under this revealing eye which sees through atoms, and if the average is like the samples which have thus far been measured, dross of various kinds totalling more than $1,000,000 in supposed value exists in the gold of the world.

An entire freight train filled with pig-iron can be tested in a few hours by a spectroscopist dragging electric wires behind him as he proceeds from car to car, and carrying a small spectroscope in his hand. Opening a car door he clips a wire to a sample pig, strikes an electric arc between this and a bar of pure iron he carries, and observes the light in the spectroscope. If certain impurity lines are brighter than a standard which his instrument shows, that pig contains too much impure metal, and he passes to another. By properly selecting samples at random the whole trainload of iron can be tested without bothering to unload it.

Amounts of metal so small as to be difficult to detect chemically are often of great biological importance. Why, for example, do the livers of scallops concentrate cadmium?

A little copper is good for the digestion, but too much is not. In areas where many cranberries are grown, sprays have for years been used to kill pests, and the government at one time feared that the soil might have become so saturated with copper from these sprays that the cranberries might be absorbing more copper than would be good for the consumers. So cranberries, cranberry jelly, cranberry juice, dirt from cranberry bogs, and cranberry stems and leaves were all separately consumed in electric arcs and forced to reveal their copper content to the discerning spectrograph. Fortunately the instrument announced that all was well.

Very small amounts of lead or arsenic can do great damage to the human body, and lead poisoning is one of the greatest hazards of industry. Lead fumes are found in some mines, and in storage battery and paint factories. Unless some care is taken to protect workers in these industries the amount of lead in their bodies may slowly rise past the danger point, and once this point is passed the resulting diseases are very difficult to cure. It is therefore important to keep a constant check on the lead content of the blood of such workers. By placing a few drops of blood from a worker in a tiny carbon cup and striking an electric arc to this cup, the blood can be vaporized almost instantly, and any lead atoms present will emit their characteristic light, which can be identified with a spectrograph. This light being recorded on the photographic plate, a series of samples of blood containing no lead, but with varying known amounts of lead added to each sample, is burned and has its spectra recorded. The spectroscopist matches the intensities of the lead lines in the worker's blood with those in some of the samples whose lead content is known, and thus can measure amounts as little as one atom of lead to 1,000,000 molecules of blood. If a person be allowed to sleep for one night in a freshly painted room a definite, though harmless, increase in the lead content of his blood can often be observed with the spectrograph. Nor is this sensitivity confined only to lead, for any one of the nearly 70 other sensitive chemical elements can be determined as readily.

THAT two or three parts of aluminum or lead can be detected readily in 10,000,000 parts of lobster or condensed milk may seem unimportant, since such concentrations are below the toxic limits considered dangerous to health. Yet, obviously, tests on the rapidity with which the internal coating of a can dissolves in foods stored within it can be made easily and quickly when such sensitive methods of detection are available.

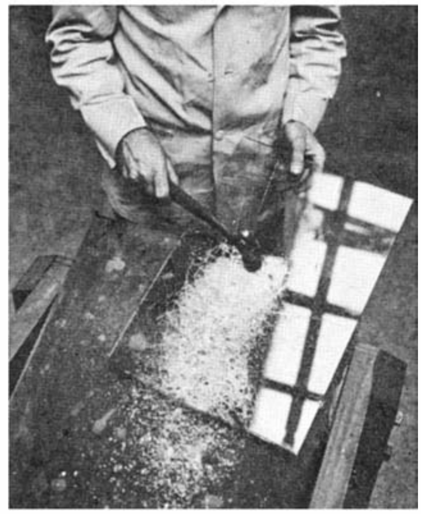
Chocolate and chewing gum manufacturers use spectroscopic analysis to insure that the lead content of their products is below the limit set by pure food laws. Have the arsenic and lead been properly removed from sprayed foods before canning? Is beer kept in cans dissolving anything more from the container than it would if kept in bottles? The spectroscope gives an easy, sure, and quick means of deciding.

So we find paper manufacturers who want to discover the source of tiny black specks in their spotless white product, producers of bakery equipment who wonder if their new coating compound for pans will contaminate the dough, spark-plug manufacturers who wish to study the effect of minute amounts of alkali metals in improving sparking, all finding the spectroscope helpful.

(To be concluded)

Five Companies Present: Safety

Superior Safety Glass . . . Four Times Safety Factor, Five Times Elasticity of Old Product . . . No Fogging . . . No Break-away . . . No Splinters



Repeated hammering on the new glass merely powders the surface

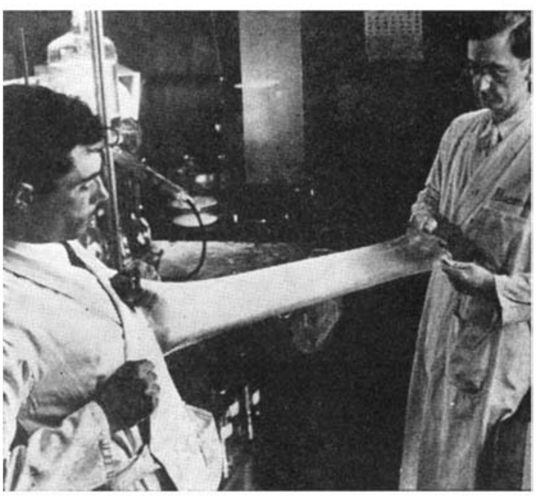
AMERICA'S 25,000,000 comfort-conscious motorists have grown safety-minded to such a degree that they are quick to acclaim the development by science and industry of some noteworthy contribution that makes the automobile a safer mode of transportation.

Such a contribution is the new, lustrous, high-test safety plate glass which graces many of the sleek 1939 model automobiles, adding greater safety and visibility. The glass has four times the safety factor and five times the elasticity of the old product. It was developed during six years of intensive laboratory experiments by five large industrial firms at an aggregate expenditure of more than $6,000,000.

Sharing in the development of the product, which has been made available at no increased cost, are E. I. du Pont de Nemours & Co., Inc., Libbey - Owens - Ford Glass Co., Monsanto Chemical Co., Pittsburgh Plate Glass Co., and the Carbide and Carbon Chemicals Corporation.

In perfecting the new glass, the laboratory technicians made a product that defies deterioration and discoloration, either from seepage of moisture and air into the "sandwich" plastic filler between the two sheets of plate glass, or from the actinic rays of the sun. This enables the glass to retain its high visibility. Resilience of the glass is unaffected by extreme ranges of temperature, making it equally safe in summer and winter. It is easy to cut, facilitating replacements for damaged areas.

Statistics show that more than half of the injuries resulting from automobile accidents in the past have been attributed to flying glass. This danger is further lessened by the new glass, because if it is broken by the impact of an object, the pieces adhere firmly to the plastic "sandwich" filler and do not fly about the car.



At left: Two research men stretch a piece of the glass "sandwich" filler to show its resilience. *Above:* Girl workers make the "sandwiches" by inserting a sheet of the polyvinyl acetal resin between sheets of polished plate glass

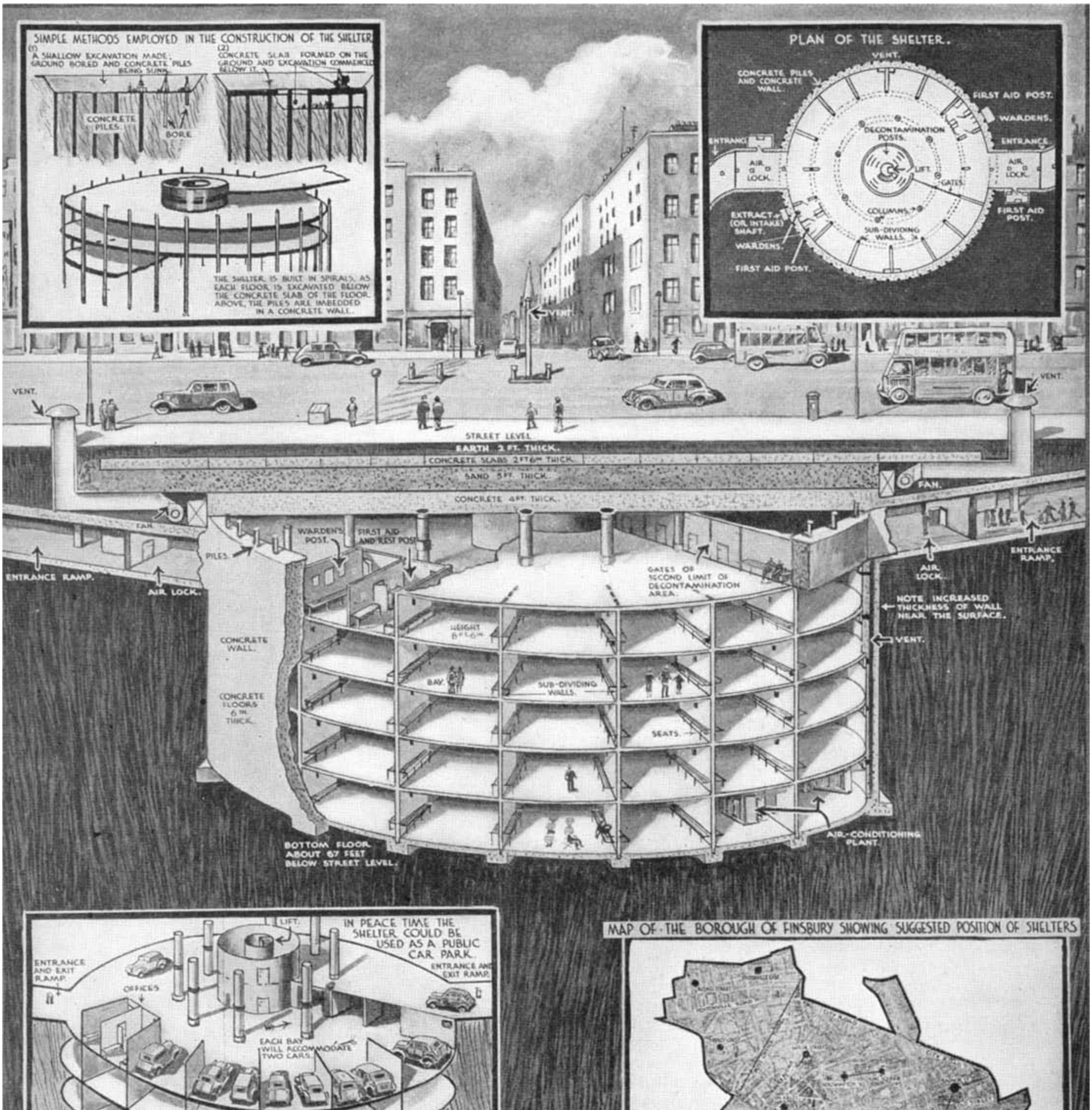
Because of its resiliency, the new glass supplies a cushioning effect when a body or head is thrown violently against it. There is greatly lessened danger of a fracture of head or limb as the glass gives readily and absorbs part of the shock. To test this feature, one of the research laboratories employed a professional stunt man to batter his bald head against a plate of the safety glass. In repeated demonstrations, charging into the glass like a football player making a tackle, the man cracked the glass with his head but received no injury.

DESPITE its greater resistance to breakage from sudden impact, the "bendability" of the new glass enables a passenger, trapped in a car equipped with it, to push the glass out of its frame as a means of escape. When the glass is broken up by hammering it can be rolled up like a rug without the particles of shattered glass pulling away from the plastic filler.

The plastic, or "sandwich" filler, is the principal factor in the success of the new glass. Although it is made under several trade names, the plastic has one chemical common denominator—polyvinyl acetal resin.

In the ten years that followed the first general use of laminated safety glass, laboratory technicians have bent every effort to produce the features which are dominant in the new high-test glass. Vinyl plastic is resistant to moisture, which makes it unnecessary to seal the edges. It will not separate from the glass under impact or when the glass is cracked or broken. Replacement areas are cut by scoring and cracking, drawing the glass away from the plastic, and cutting it with a razor blade.

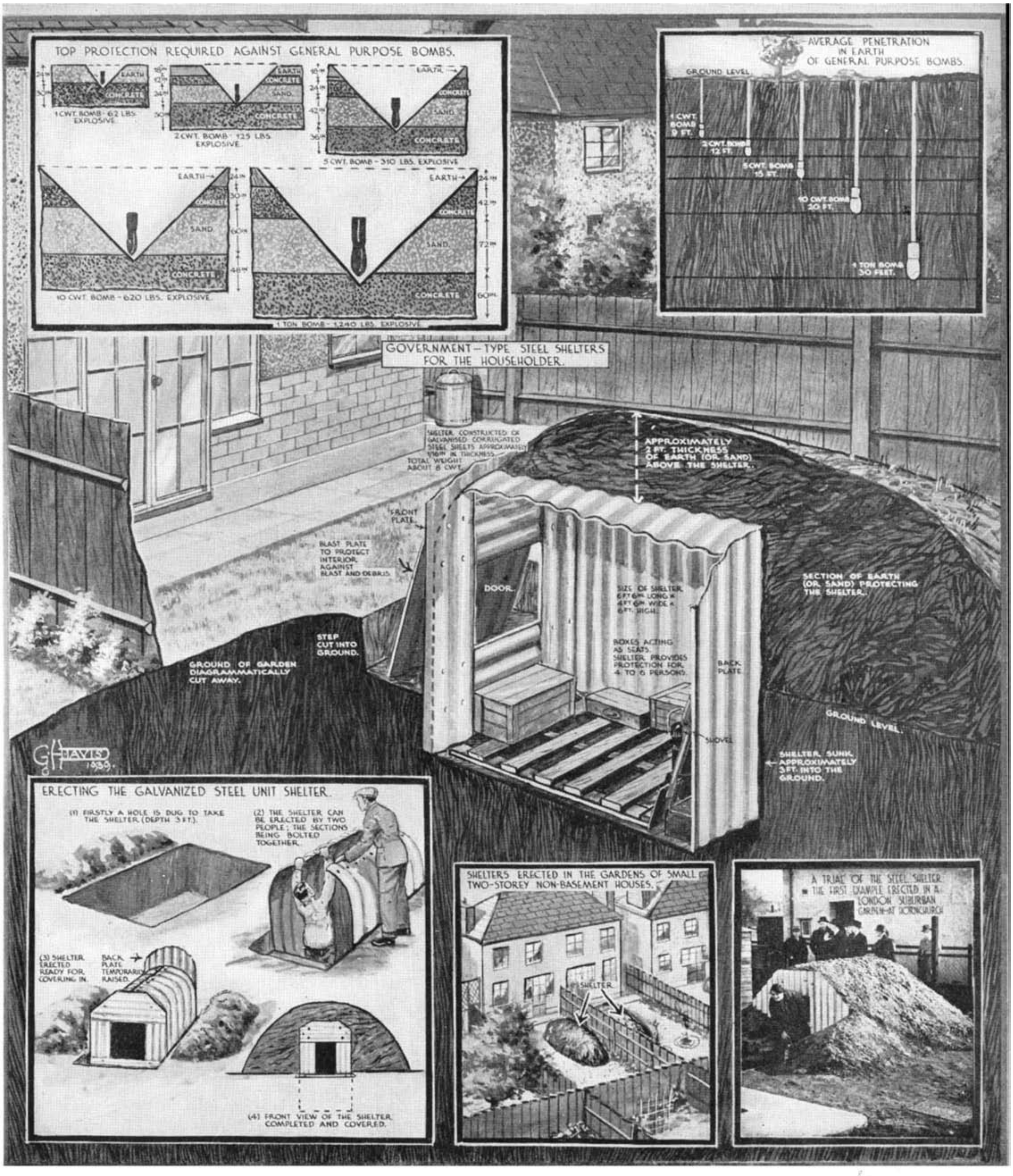
The new plastic may be produced either by calendering or extruding. The first method involves rolling and pressing out sheets of plastic, and the second forces the plastic at a doughy consistency through a narrow orifice. The resulting sheeting is quickly cooled.



Bombing Raids Will Find London Prepared

NOT long ago a writer facetiously pointed out the irony of a certain "back to earth" movement that is taking place in large sections of the world. Primitive man (he reminded us) lived in caves or holes in the ground, but as he achieved civilization he came out into the air and sunshine. Down through the ages he progressed, built great cities, mastered the secrets of the world about him. He rose to new and greater triumphs until he finally left the dirt and took to the air, gloriously happy in his god-like genius. And then the cycle suddenly begins again. One of man's latest and most spectacular achievements turned, like Frankenstein's monster, upon its maker and sent him scuttling back to holes in the ground—modern, civilized troglodytes.

The analogy was interesting, the irony real, but the aforesaid writer intended only to provide a bit of humor to offset the seriousness of air bombing dangers. They are serious, indeed, as many millions of Englishmen will testify. London knows something of what may happen when and if enemy bombers fly over the city. Shanghai and Nanking, Madrid and Barcelona—current and recent brutalities—have provided the object lessons. But they are not enough, and London surmises many things more, takes no chances, provides against



many contingencies. Now London stands determined, methodically preparing against the day which the world hopes will not come. Intensively, the city and the surrounding country make their plans for lessening the danger and destruction of an air raid, having made up their collective mind to go back to earth, literally, should bombing planes arrive.

A bombing raid over London would be no half-hearted affair. There is no doubt that the enemies of Britain would stage a monster raid—or series of raids—in the hope of gaining a smashing victory. However this might affect the population, psychologically, and how great the destruction of property might be are beside the point at the moment; whether any great number of civilians might be killed would depend upon how well bomb-proof shelters are distributed throughout the areas involved. Plans have been made, considered, and discarded and other plans made up for large underground shelters that will house the multitudes during raids. On the opposite page is one suggested design of a structure which would be very effective, and it has the added merit of being useful during peacetime as a public car-parking space. Conceivably some of the large shelters may be built to this design or some modification of it. On this page are shown several views of one of the back yard shelters for residences. There are a number of variations of this type, protecting only against concussion and flying debris, being installed all over the threatened area. The inserts on the two pages show various details. This drawing is published through the courtesy of *The Illustrated London News.*

River Models Outwit Nature

Miniatures of Rivers, Harbors, Dam Projects Solve Flood and Flow Problems . . . Considerable Design Ingenuity Involved in Model Making

By PAUL W. THOMPSON
First Lieutenant, C. E., and Director,
The U. S. Waterways Experiment Station

NATURE poses no challenge more baffling to man than the one offered by flowing water. The enigma of flowing water is made the more challenging because it is presented before man's very eyes. Man can observe water in motion; he can photograph it and record certain of its physical dimensions; but he cannot explain what he sees and records. The road to geometry is indeed a royal boulevard compared to the byways which must be traversed by the hydraulic engineer.

The sad fact of man's inability to rationalize the phenomena of flowing water has not obviated the equally sad fact that often he must do something about those phenomena. Lands must be made safe from flood, rivers must be made navigable, erosion must be checked, and so on. There are problems to be solved, whether or not the means for rational solution are at hand. Furthermore, the hydraulic engineer has not the advantage of being able to bury his mistakes. If the levee is built too low, the flood comes with redoubled fury; if the dike is built in the wrong place, the river steamer and its cargo end up on a sandbar. Having made it difficult to win, Nature nevertheless has not neglected to make it costly to lose.

When rational solution fails, man resorts to solution-by-trial. He calculates things to the best of his ability, tempers his calculations with judgment, adds a liberal factor of safety-ignorance, builds his structures, and hopes for the best. If calculations, judgment, and luck are good, the structures stand and serve their purpose; if luck or other factors are bad, there is a flood or an unnavigable channel or a dangerous erosion. Good or bad, the process of solution-by-trial obviously is expensive—expensive in the way of a disaster at worst, and expensive in the way of over-design at best.

Since the solution of hydraulic problems must, in the main, be by the method of trial (and error), it is idle to think of such problems in terms of absolute economy; rather, the hydraulic engineer thinks in terms of relative economy. And it must early have occurred to him to wonder whether the trial-and-error process might not be more economically accomplished if applied not directly to the waterway in question, but rather to a small-scale replica thereof. When that thought occurred to some early hydraulic engineer (could it have been during the conception of the Roman aqueducts?) the now-flourishing science of analyses of hydraulic problems by means of small-scale models was born.

A model of the river through Johnstown, Pennsylvania, by means of which a very serious flood problem was solved

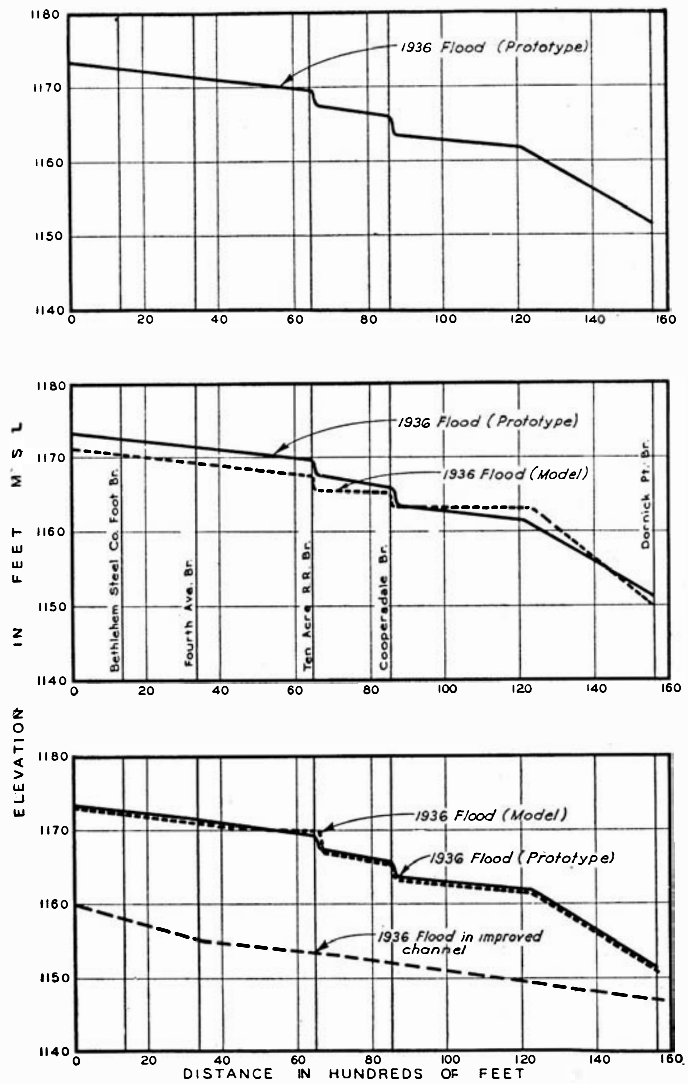
Today, few important projects involving the flow of water are undertaken without benefit of model-analyses. That statement is a paraphrase of the comments with which the English scientist, Sir Osborne Reynolds, concluded the account of his pioneer model study of conditions in the River Mersey in 1885. Sir Osborne's observations had convinced him that it would be "madness" not to take advantage of the small-scale model in designing any important project. The hydraulic world by no means flocked to get aboard the Reynolds bandwagon; but now, 50 years later, that world has practically accepted the Reynolds point of view. By the turn of the century, the German hydraulic engineers were model-minded; whereas, in America, the U. S. Waterways Experiment Station—now the largest of the world's hydraulic laboratories — has been in active operation for more than nine years.

What, then, is the small-scale model—this tool which, while not eliminating the necessity for solution of hydraulic problems by the method of trial, nevertheless enables the hydraulic engineer to do his trying and erring at relatively little expense? Briefly, the small-scale model, as utilized in hydraulic engineering, is a replica which *acts* like its prototype. The verb deserves the emphasis, for the essence of model-analysis is action. There is a technical expression covering the thought: dynamical similitude.

THE purusit of dynamical similitude permits of no side diversions. It demands compromises and apparent contradictions. Thus, in getting a model to *act* like its prototype, it frequently is necessary to take steps which preclude the model *looking* like that prototype. For example, a model of a railroad train looks like the real thing, and, furthermore, it looks as though it is acting like the real thing. However, the details of its actions are quite different from those of its prototype. On the other hand, the model of the Ohio River at the Experiment Station looks like nothing in particular, but it acts like the Ohio River.

This distortion in the model's physical dimensions and appearance is a necessary evil, forced on the experimenter by such hard facts as limitations of available materials; conflict of various forces; necessity for depths not less than certain minima; necessity for economy; and other considerations. The model, in fact, represents a series of compromises, an assembly of components in which one distortion compensates for another. The fact that the experimenter must distort, say, his model bed material (by using some material, such as crushed coal, which is available but is too heavy) makes it necessary for him to distort his velocities (by making them higher than they should be); and the fact that he distorts his velocities makes it necessary for him to distort his model roughness. The thought may be conveniently expressed by stating that the model-as-it-should-be is quite a different article from the model-as-it-is.

Consider again the model of the Ohio River, mentioned before. Rational analysis does not even suffice to make that model act like the Ohio River. (In fact, were rational analysis equal to that task, probably it also would be equal to the task of solving the prototype problem and thereby the model study would be unnecessary.) How, then, is it established that the model *does* act like the Ohio River? The simplest way to answer that pertinent question is to let it answer itself by means of an example.



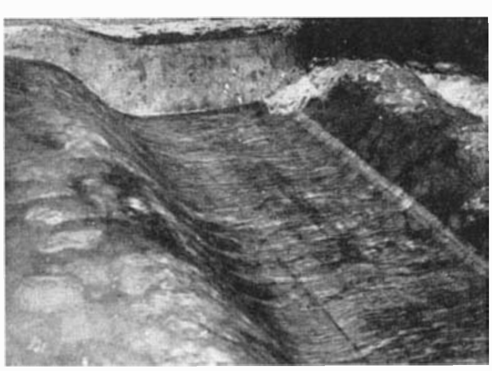
The three graphs referred to in the text, showing how the model reproduced the 1936 Johnstown flood and the height which the same flood would reach in an improved channel

One of America's critical flood problems has existed along the Conemaugh River and its tributaries at Johnstown, Pennsylvania. The great flood of March, 1936, was followed by a project aiming to increase very materially the capacity of the Johnstown channels. The project involves deepening the present channels, widening them, and, to some extent, realigning them. Details have been resolved by means of the small-scale model shown in an accompanying photograph. All horizontal dimensions on this model are 1/200 and all vertical dimensions are 1/80 of the corresponding prototype dimensions. Thus, the model-river is relatively deep and steep. Meanwhile, the areas enclosed by tin walls represent city blocks. Certainly, the model doesn't *look* much like its prototype. How, then, is it established that the model *acts* like its prototype?

Consider the accompanying graphs. The solid-line curve in each graph represents a known event: the highest elevations reached by the water during the 1936 Johnstown flood. No conjecture or calculation enters that curve; it is compiled from gage heights actually observed and recorded. The dashed-line curves also represent data actually observed—but on the model, not the prototype. In each case, there was being discharged through the model quantities of water corresponding accurately to the quantities which deluged Johnstown in 1936. The experimenter reasons that, were his model *acting* correctly, the dashed and solid lines should coincide. He takes steps to obtain the desired coincidence, these steps consisting chiefly of roughening and smoothing operations. His progress may be followed through the middle and lower graphs. The latter he accepts as satisfactory, and, secure in the belief that his model is acting correctly, he proceeds to the testing of the proposed plans. Incidentally, having successfully adjusted (or "verified") his model, the experimenter's worries are largely over. Figuratively speaking, the testing of plans involves only the turning of a crank on a machine which it has taken months to build, calibrate, and adjust.

(As a matter of interest, not strictly pertinent to the discussion of verification, there is plotted on the lower graph data indicating the effectiveness of the improvement plans. This curve represents the crest of a flood identical to the one of 1936 but occurring in a channel like the one proposed.)

IT will be observed that the small-scale model is a very practical instrument. That is, it is designed and adjusted so as to aid in solving a specific problem—such as the flood situation at Johnstown. It contributes only in relatively minor degree to the advancement of abstract science. It is, in fact, only a semi-scientific instrument. That being the case, it is found not in institutions devoted to the development of funda-



Model analysis of a spillway problem. The object of the engineers was to reduce water velocities and eliminate dangerous erosion below the dam. At the left, velocity was high and scour so bad as to cause much erosion. The model was then modified to produce lower velocity (*right*). Result was negligible erosion

mental truths, but rather in agencies charged with the prompt accomplishment of real projects. Thus, the Bureau of Reclamation maintains a model-analysis laboratory at Denver, and the TVA maintains one at Norris. The Corps of Engineers of the Army, charged as it is with the improvement and control of most American rivers and harbors, conducts model analyses in various laboratories, the largest of which is the U. S. Waterways Experiment Station, at Vicksburg, Mississippi. The photographs and figures accompanying this discussion relate to the latter laboratory. A further glance at its current operations will afford examples of most types of problems to which model-analyses are applicable.

Man constructs dams across rivers with various purposes in view: to regulate the stream flow in the interests of navigation or flood control; to concentrate head in the interests of power development; to conserve water in the interests of irrigation. Conduits and spillways frequently present perplexing problems, among which are the precautions to be taken to prevent dangerous erosion. The danger of erosion arises from the discharge at high velocities of water through conduits or over spillways. The problem is to reduce these velocities before the water reaches the soft materials of the river valley. In such case, the model-method of analysis is easily and directly applicable. To describe by illustration, consider two of the photographs on page 141 that have to do with a model of the spillway for the Great Salt Plains Dam, about to be constructed on a tributary of the Arkansas River. One of the photographs shows the high-velocity discharge onto the erodible material; the other shows the results of provisions for the "stilling" of the high velocities. Relatively speaking, the erosion has been made negligible.

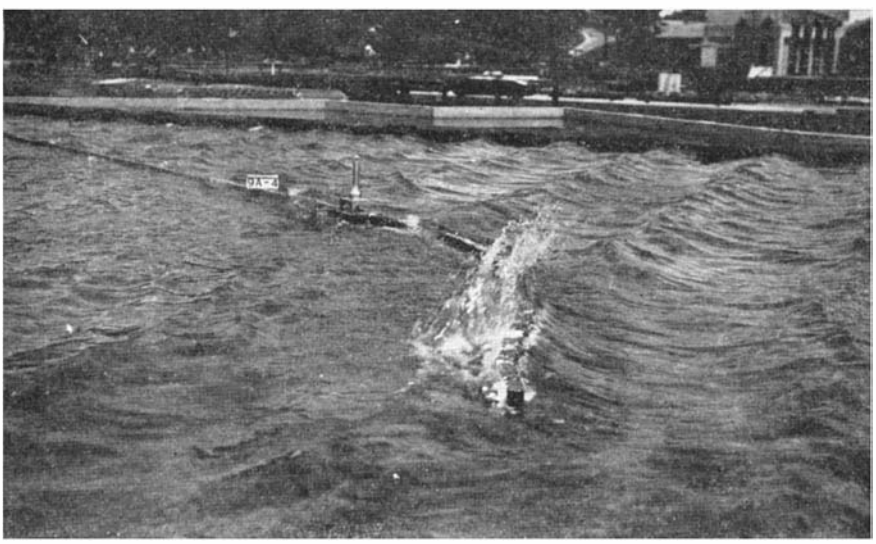
IN their natural states, few rivers are susceptible of economic navigation. Most of them must be "improved"; that is, made deeper. There are several methods of improving rivers for navigation: by canalization, as on the Ohio and the upper Mississippi; by increasing the critical or low-water flow, as on the Missouri; by "open-river" works, as on the Mississippi below St. Louis.

Description of the open-river method of improvement involves consideration of the elements of an alluvial river. Such a stream consists of long, relatively deep pools, these extending along the concave sides of the river bends. Between successive pools are short, relatively high, "crossing" bars. In effect, the river is a series of flat, deep reservoirs, or pools, the water from one reservoir spilling into its downstream neighbor over the steep, shallow, crossing bar. Thus, the situation facing the navigator is this: through perhaps 95 percent of his course he is in a channel having several times the depth his vessel requires; *but*, through the remaining 5 percent of the course he is crossing over bars where the depths very likely are less than he desires. The object of open-river regulation is to provide such training works as will cause the river to erode deeper channels over its crossing bars. In such a case the method of model-analyses fills an especially great need.

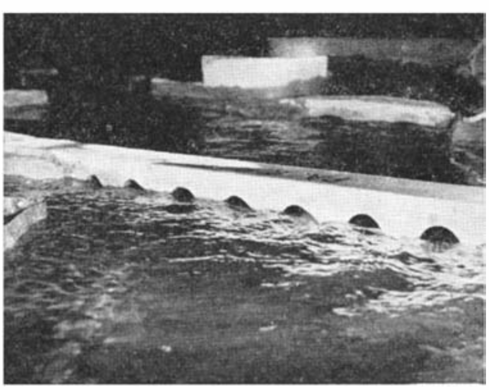
Man attacks his flood problems in various ways: by impounding the excess waters and releasing them only when they will do little or no damage; by increasing the capacity of the river channels; by constructing levees which exclude the water from restricted areas. The small-scale model is a valuable tool, both in enabling the engineer to select the method of protection best adapted to the situation at hand, and in aiding him to develop details of design after the method has been selected. Two more of the photographs show the model reproduction of a bridge at Johnstown, one illustrating flood conditions at 12:30 A.M., March 18, 1936, while the other presents the improved channel taking all the flood water. Business in town goes on as usual.

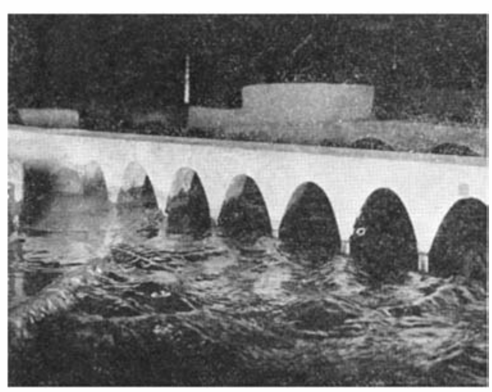
The unfavorable deal which Nature provides in connection with its rivers is repeated in connection with its harbors. The tides, the ocean currents, the waves, and the bed materials blend together to form a phenomenon which man perceives clearly only in its resultant form. In the face of such complexity, the small-scale model is of only limited reliability; but so difficult are the problems that the aid provided by a model, even of limited reliability, frequently is valuable.

Thus, in the manner indicated by the examples cited, the profession of hydraulic engineering marches on, its progress over many of its most difficult obstacles being lighted by data from small-scale model experiments. One can say the same thing in another way: the baffling complexity with which Nature endows flowing water has found —to some extent, at least—its compensation in the development of the small-scale model.



Above: **Waves impinging on a model of a breakwater. Such waves as these must not enter the harbor**





In the Johnstown model: a bridge past which flows the equivalent of the 1936 flood. At the left is the condition as it was and at right is shown the lower stage heights of the great flood with the improved channel

No More Blown Patterns

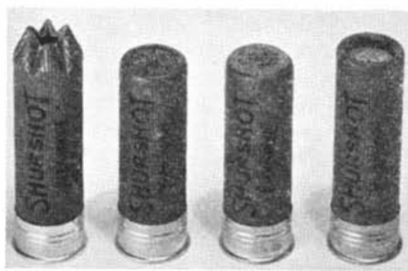
Top Wad in Shot-Gun Shell is the Villain That Causes Them . . . Elimination of Wad by a New Crimped Shell End . . . Unimpeded Shot Charge

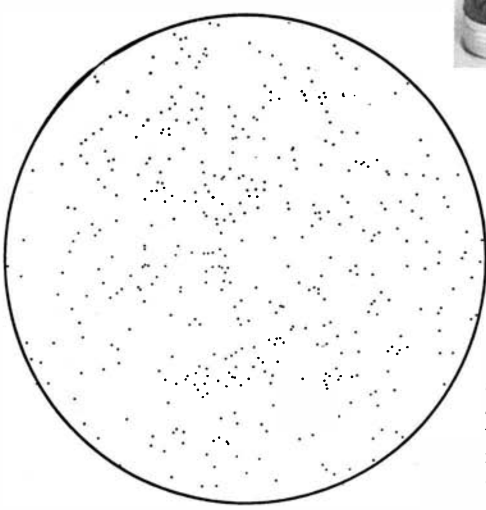
A SHOT-GUN shell recently announced, which will eliminate blown patterns, means much to trap and skeet shooters. Blown patterns—shotgun patterns with "holes" in them—have been a flaw in the art of ammunition making known to all manufacturers; and no amount of painstaking work on the part of the most skilled gunsmiths can eliminate the five to ten patterns out of every 100, made with conventional shells, which unaccountably are much more widely scattered or "blown" than the others.

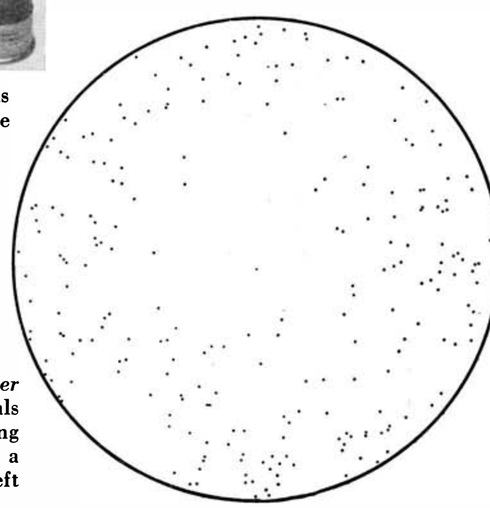
In the ordinary trap load, for example, 90 shells out of every 100 would put 60 to 80 percent of their pellets into a 30-inch circle at 40 yards. But the remaining 10 shells would all be below 60 percent. And three or four of these would scatter their pellets so widely that barely more than 30 percent of the shot charge would get into a 30-inch circle at 40 yards. Even with the best of gun pointing, it is obviously sheer luck whether, with such a pattern, the clay target is struck by some of the pellets or whether it flies blithely through one of the numerous holes.

Thousands of patterns have proved that the top wad is the villain in this story. With the top wad ahead of it, the shot charge rushes from the muzzle at about 1200 feet per second. The terrific resistance of the air on the flat surface of the top wad at this velocity checks its speed and causes it to get in the way of the shot. Most of the time it slides along the outside of the shot charge or is flipped entirely out of the way and does little damage. But, about ten times out of every one hundred, the top wad obstructs the column of shot, and a blown pattern results.

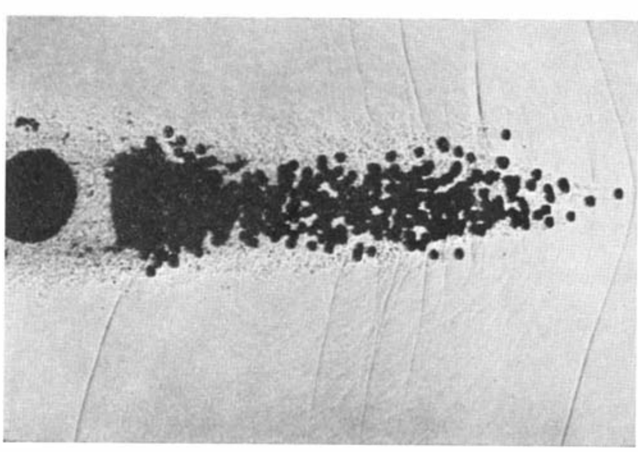
Shells with the new Remington Crimp avoid this effect, because they contain no top wad to get in the way of the shot column. They have exactly the same contents as are used in ordinary-crimp loads at present. To provide means of load identification and to waterproof the shell, a waxed paper disk only three one-thousandths of an inch thick is pasted to the crimp closure. On firing, the shot charge pushes the top open and breaks the disk into six pieces. These remain affixed to the shell body. Hence, from the very beginning, the shot charge is completely unobstructed in its flight toward the target, and produces a blow-proof pattern.

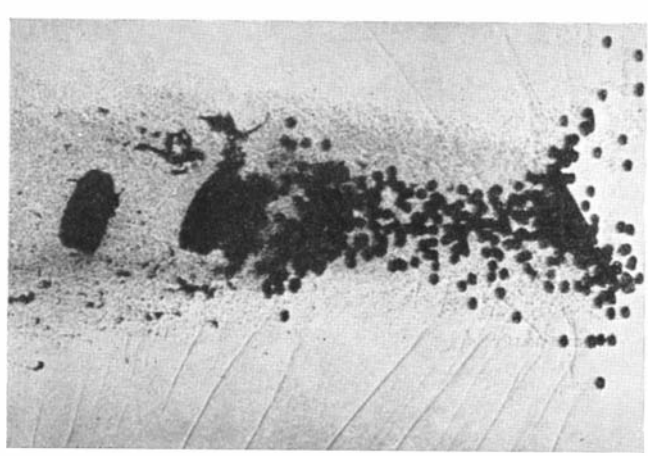


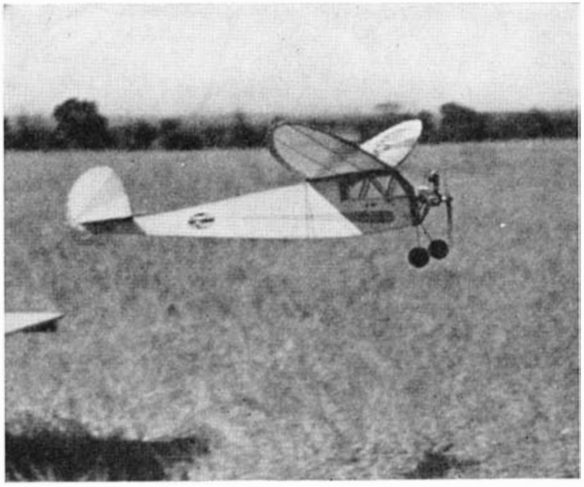




Above: Shot-gun shell at right is of conventional type in which the top wad causes occasional blown patterns. Other three shells show steps in folding and sealing the crimp of the new shell described. _Lower right:_ The spark photograph shows how the top wad breaks up the shot charge, resulting in a blown pattern such as shown at the right. _Lower left:_ Another spark picture reveals the continuous shot charge coming from the new type shell. Such a charge produced pattern at left







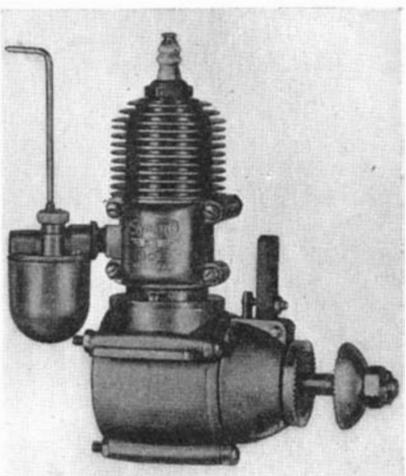
Photograph by Jacob Deschin

The illustration above, taken at a recent meet, shows one of the competing planes an instant after leaving the starting table. It has started from a standstill under its own power. *Below:* A Syncro Ace Special, less than five inches high

Up in the Air for a Hobby

Half a Pound of Power . . . Avocation Makes Big Business . . . Inexpensive Midget Motors by Mass Production

By L. B. POPE



TINY gasoline engines with an average weight of only six ounces, a height of four inches, and a horsepower rating of one sixth are furnishing the motive power for proportionately small airplanes which have made remarkable endurance, distance, and altitude flights. The engines form the basis of a hobby which is daily attracting new recruits of all ages to the ranks of the gas-powered model-plane enthusiasts. It has been estimated that there are more than a thousand clubs in the United States in which membership is exclusively confined to those model-plane flyers whose ships are gasoline powered. Doctors, lawyers, business men; all professions and crafts are represented in the ranks. They have taken the small plane from the classification of a boy's plaything and made it the foundation of a serious pursuit which helps to pay weekly wages in hundreds of retail hobby stores, in the factories where motors are manufactured, and in shops where plane equipment and materials are produced.

The hobby offers triple fun. First is the pleasure of building the planes and second the thrill of seeing them fly. The flights give a sense of adventure, and many an altitude record or transoceanic hop has been made vicariously. More important, though, is the very real joy of competition; flying the plane in one of the frequent inter-club or intraclub meets. Each "aviator" keeps foremost in his mind the hope that his plane will someday establish an official record which will serve as a goal for the thousands of other model-plane enthusiasts throughout the country.

The reason for the recent increase in interest in gasoline-powered model airplanes is not hard to find. The story is the familiar one of mass production making available a quantity of some product at a price within the means of all interested. The gasoline motors on the earliest model airplanes represented hours of careful planning and work. They were beyond the average model fan who had neither the equipment, skill, time, nor money necessary for their construction. But modern shop practice has changed the whole picture in favor of those who would fly gasoline-powered planes, but who for one reason or another cannot design and construct a suitable engine.

THE modern little power plants that are constantly setting new model records are carefully engineered working miniatures of those two-cycle gasoline engines commonly used for outboard motors, small water pumps, power lawn mowers, and so on. There are many manufacturers who offer a variety of designs and hence there is a wide price range from which to select. Partially assembled engine kits, requiring only a screw-driver for complete assembly, at about $5 is the minimum. Complete motors with batteries, coil, tank, and accessories are priced up to $22. The motors are rated at from 1/7 to 1/2 horsepower although they are only three or four inches high and weigh but a fraction of a pound when installed.

To arrive at a clearer idea of what a model-plane motor really is, 16 typical examples were selected and their characteristics averaged. The results give a hypothetical motor weighing six ounces, slightly less than four inches high, with a horsepower rating of 1/6 at 8000 revolutions per minute. The bore and stroke are each 3/4 inch. (Of the motors used to obtain these average figures, only five had equal stroke and bore dimensions.) It would cost $13.64 to buy this imaginary composite motor, an average figure which represents the cost of the model power plant, ready to be put into a plane and run.

Since this composite and average motor is only four inches high, the component parts are tiny indeed, yet standard machine shop practice is followed in the manufacture of all the various small parts. Most of the crankcases are die cast. Cylinders and pistons are usually machined from the solid, then hardened, ground, and lapped to fit. The pistons are smooth wall or with one or two piston rings. Connecting rods may be die cast or steel drop forgings, with hardened and lapped bearing surfaces. The crankshaft, drop forged or machined, has usually only one solid bearing area. (Some manufacturers advertise ball bearings at slight additional cost.) At one end of the crankshaft is the connecting rod and the counter-balanced crank; the propellor is on the hub at the other end. Between the two is the bearing, an inch or two long, of bronze or steel. A balanced flywheel, grooved for rope starting, is sometimes used on the 1/5- and 1/4-horsepower motors.

A glance through the advertising literature of model engines will reveal such phrases as chrome-molybdenum crankshaft; tool-steel crankshaft; cadmium-plated head; aluminum piston; micrometer needle valve; bronze bearings; transparent gas tank; or perhaps the maker will stress the fact that his particular model may be run either upright or inverted, a fact which might influence the model builder who has ideas for motor cowling. Thus does competition in this field, as in many other fields, work for the benefit of the consumer. In order to attract the public, each manufacturer constantly strives to improve his product.

The fuel system of these model-plane motors includes a gas tank, a needle valve, and an intake manifold. The tank may be of metal or some transparent material and is supported in back of or under the cylinder. It holds only a few ounces, as very little gas is required for the motors. The fuel is usually a mixture of gasoline and motor oil (S. A. E. No. 70) in the proportion of four parts to one. The fuel passes by suction through the needle valve and into the crankcase, where the oil lubricates the main bearing and other moving parts, and then into the combustion chamber where it is burned.

The electrical circuit of the motor includes batteries, coil, condenser, contact points, and a spark plug. Small flashlight dry cells are used to supply the necessary three volts. The coil and condenser together weigh only two or three ounces and furnish the hot spark which ignites the gas. The contact points are on the driveshaft directly behind the propeller and make contact once every revolution. Spark advance or retard, as may be necessary for proper operation of the motor, is accomplished by moving a lever located behind the hub. The lever shifts the ignition points forward or backward to make earlier or later contact. The spark plugs are made by several manufacturers, but are of standard sizes about one inch high and with 3/8-24 or 1/4-32 threads.

The planes which carry and are powered by these small engines usually are the results of hours of labor on the part of the owner. They may be bought complete or in construction kits, but frequently they are the embodiment of the hobbyist's own ideas and the result of much personal experience.

With many different sizes and shapes of gasoline-powered model planes, some sort of regulations must exist in order to run competitions on a fair basis. Thus the National Aeronautic Association, Model Division, has established contest classifications, and rules governing them, for all model planes including gas-powered types.

The models are classified according to the area of their supporting surfaces; most gas-powered models are in "E" class with an area of more than 300 square inches. All regulations are kept in mind while the plane is building, otherwise it will not be licensed and qualified for officially sanctioned meets. There are regulations governing minimum and maximum weight, cross-sectional area of fuselages, and wheel size. The landing gear must be demonstrated to be strong enough to support the plane when gliding to a landing from a height of four feet, without damage and without nosing over.

Photograph by Jacob Deschin

Details of plane construction. The large dry cells shown on the ground serve merely as an engine starting aid and are detached before flight

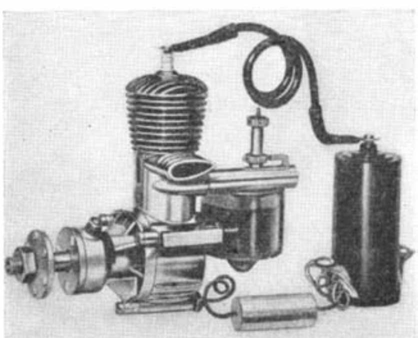
THE serious and adult nature of the hobby is shown by the official classification of contestants. No one under 16 years of age may compete without special permission and supervision.

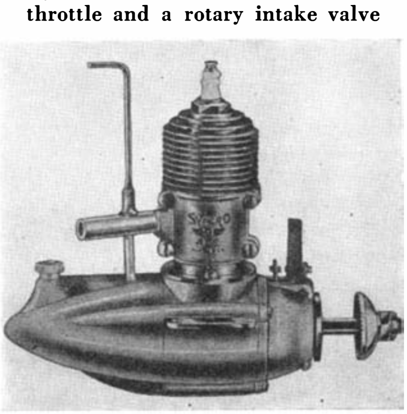
Records made by model planes are not official until they have been accepted by the Contest Board of the National Aeronautic Association. Official recognition is given to duration records only. All official records must be made in sanctioned meets or under specific direction of the Contest Board of the N. A. A. New records must exceed the old ones by 2 percent in order to qualify for recognition.

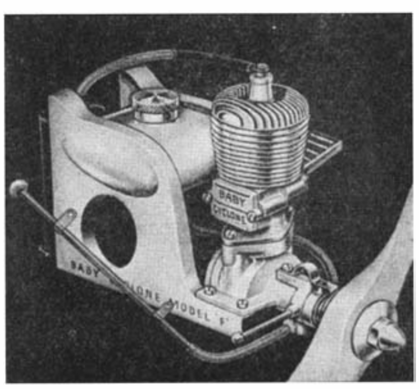
Official contest flights are made by allowing an engine run of 20 seconds, the time being limited by either a mechanical flight timer or by fuel measurements. In that time the plane must take off from a standstill and climb as far as possible. After the motor stops, the plane glides to the ground. The flight duration is timed from the instant the wheels leave the ground or starting table until they hit the ground. An indication of what these little planes can do is the winning time of a recent meet. First place was won by a flight lasting 20 minutes and 20 seconds. This means that the plane was so nicely trimmed that it soared in the air without any power for exactly twenty minutes. Other non-competitive and non-official flights without the 20-second motor run limitation have been made which lasted more than two and a half hours. A well-designed gas-powered model plane may cover 50 airline miles and soar to a height of more than 10,000 feet.

The surest way to antagonize any devotee of this universal hobby is to refer to his ship as a "toy plane," for they cannot truthfully be called toys in any sense of the word. The gas-powered model plane enthusiasts are a hard working and serious lot.

At the right, an Ohlsson motor showing how the coil and condenser are connected. *Below:* A Syncro motor with the gas tank as part of the streamlined crankcase assembly. *Below, right:* The baby Cyclone motor has a remote control throttle and a rotary intake valve







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For those readers who want to obtain more specific information on this interesting hobby, and further details of planes, motors, and equipment, a list of manufacturers and dealers will be sent on request. Please enclose a stamped envelope.—The Editor.

A REMARKABLE TRIPLE STAR

How the Spectroscope, Working on a Star Whose Secrets the Telescope Does not Reveal, Affords a Striking Abundance of Detailed Facts

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

EVERYONE knows that hundreds of double stars have been detected by the spectroscope. As the stars move in their orbits, they sometimes approach us, and again recede, and the positions of their spectral lines shift accordingly. By following these changes, we can find the period of revolution in the orbit; but to work out its size is not so easy. If the orbit is turned edgewise toward us, the motion at certain points will be directed straight toward the Earth or away from it, and the spectroscopic observations will reveal the true speed. But if the orbit is tilted at some other angle, there will be no point on it at which the motion is in our direct line. Even at best, a large part of it will be sidewise, and only a fraction (in technical phrase, a component) of the velocity will be in the right direction to shift the spectral lines. In the extreme case when the orbit-plane was squarely at right angles to our line of view, there would be no change in the distance, and no Doppler effect, however rapid the actual motion.

It follows that spectroscopic observations can give us only minimum values for the real speed, and the real size of the orbit. But this is not all; the two stars of the pair, as Newton showed long ago, will move around their center of gravity, keeping on opposite sides of it, in orbits of the same shape, but different sizes. The more massive star will have the smaller orbit, and move slower.

With two stars of about the same brightness, both spectra will be visible on the plates—one shifted to the red when the other is displaced to the violet—so that the dark lines appear double, and considerably "washed out" by the superposition of the continuous spectrum of the other star. In such a case we can find the distance of each star from the center of gravity and their distance from one another — still subject to an unknown correction for the orbital inclination.

It is only when the two stars eclipse one another that all uncertainty can be removed. In this case the inclination can be found, the true distance of the stars, and also their actual diameters and their masses. There are about 30 systems for which this full information is available. Almost all these stars are larger and brighter than the Sun—for the fairly obvious reason that bright stars can be seen at great distances, and have an enormously better chance of getting into our observing lists than those which shine feebly.

They are mostly hot white stars too—and again the reason is intelligible. A white star gives out a great deal of light per square mile. If it has a fainter companion of different color and temperature, this will be redder, and have a lower surface brightness, so that, though fainter, it may be as large in diameter, or even larger than its primary. This obviously sets the stage for a conspicuous eclipse, if only the inclination of the orbit is favorable. But if a bright red star has a fainter white companion, the latter will be of very much smaller diameter. If it comes in front of its big associate, it will obscure so small a part of its light that the change is most unlikely to be detected; and when it goes behind, only its own light—a small percentage of the total for the pair—is cut off. Hence, even if eclipses occur, they are likely to escape observation, unless conditions are unusually favorable. The remarkable system Zeta Aurigae, in which the big red star is more than 20 times the diameter of its white companion, is one of these exceptional cases.

BUT if there is a pair of stars of nearly equal size and brightness, the chance that they will eclipse one another depends only on the orbit's being nearly edgewise to us, and it should make no difference whether the stars are white or red. We actually find many such pairs of white stars, and plenty of yellow and reddish ones too—but the latter are all dwarf stars of about the size and brightness of the Sun, or smaller.

But eclipsing pairs in which both components are giant stars of low density are very rare. This suggests that it must be decidedly unusual to find a double star composed of two red or yellow giants, and among the far wider pairs, which are resolvable with the telescope, this is the case. Occasionally we find a pair, such as Gamma Leonis, in which the two are of about the same brightness and color. But the great majority of doubles among the giant stars have companions much fainter than themselves, and usually "earlier" in spectral type and whiter in color.

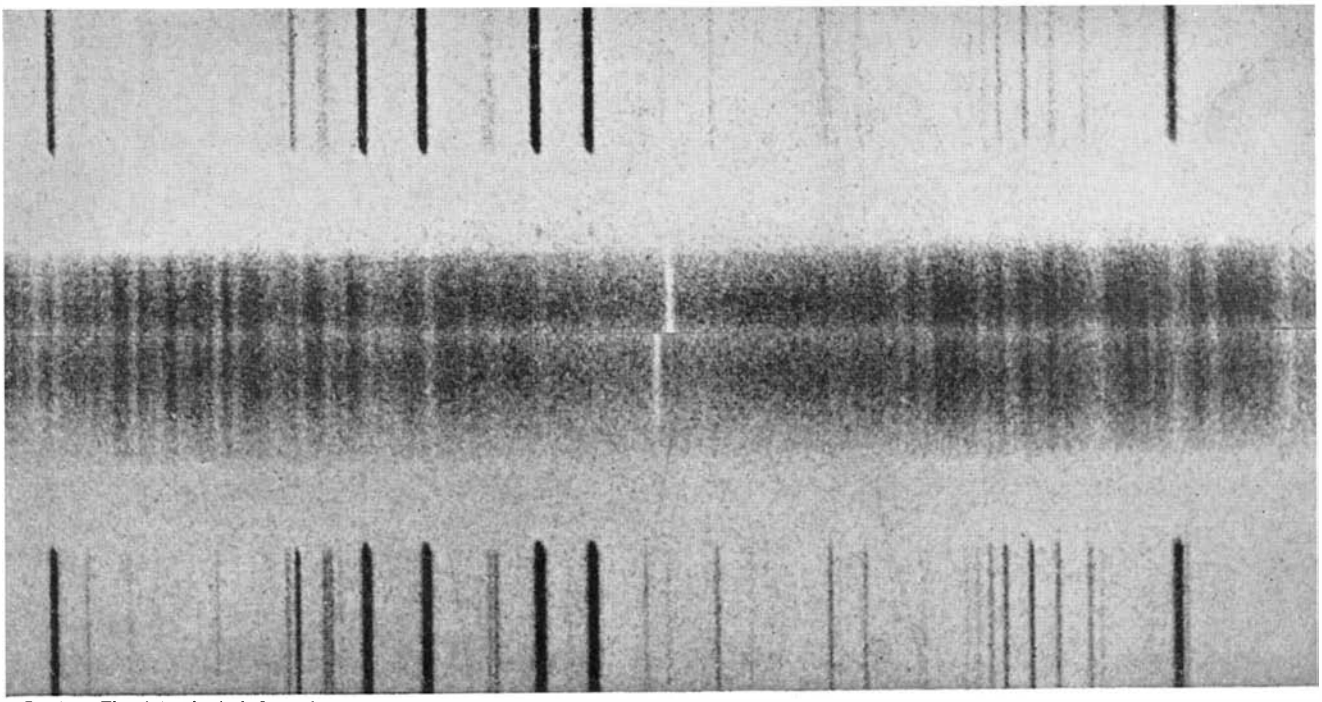
The same thing is found among spectroscopic binaries. There are very few giant stars which show double lines, and have companions similar to themselves. Capella is a conspicuous exception, but a rare one. Usually only one spectrum can be seen and we are left with no way of estimating the real size of the orbit or the masses of the stars. Once in a while, luck favors us.

For example, the third-magnitude star Beta Capricorni—which has a spectrum of Class G, like Capella—was found by Campbell in 1899 to show changes in radial velocity, which later proved to have a period of 1375 days, or 3¾ years. Only one spectrum was visible. An orbit was calculated, showing that the distance of the bright star from the center of gravity of the system was 2½ times the Earth's distance from the Sun (plus the allowance for the unknown inclination) and the star was tacitly placed on the list of those about which we had found out all we could.

But, in 1935, three new spectra were taken by Sanford at Mt. Wilson on successive nights. These extended farther to the violet than the earlier plates, and showed the great H and K lines of calcium.

Luyten, to whom the plates had been sent, noticed a remarkable thing. The H and K lines in a G-type star are normally very wide and diffuse and very strong. In this star they were weak and shallow, with narrow, fairly sharp lines in the middle. What is more, the sharp H and K lines showed a conspicuous displacement in two days, compared with the numerous lines of the main spectrum.

Sanford then began to observe the star steadily and soon found that these calcium lines shifted periodically in a period of between eight and nine days. It was now evident that this is a triple system. The new lines belong to the fainter component of the system of four years' period, which is itself double, with a period of 8.678 days. It is so much



Courtesy The Astrophysical Journal

Two spectrograms of Beta Capricorni (the two-part central area of the illustration) taken two days apart and adjusted for coincidence of line detail of star *A*. Strong K lines of calcium seen at the center of the half-tone belong to star *B* and are definitely out of step. The present semi-popular account is based on the paper by Sanford, published in *The Astrophysical Journal*, Volume 89, No. 3. In that journal the American professional astronomer publishes the official accounts of his researches but, since these are written for the scientist, they often are abstruse and Professor Russell explains them here

fainter than the principal star that its lines would be completely masked by the stronger spectrum of the latter, were it not that these two lines fall in the middle of great wide dark lines in the other spectrum, which afford a "window" through which they can be observed. Three silicon lines belonging to the fainter star (*B*) and showing corresponding changes in velocity have also been detected in a "window" formed by the strong cyanogen band in the G-type spectrum of star *A*.

The strength of these lines of ionized silicon, and the narrowness of the calcium lines, show that star *B* must be much hotter than the first—of Class B8—like Algol. A spectrum extending to λ 3200 in the ultra-violet shows that, in this region, the light of star *B* is considerably stronger, in comparison with that of star *A*. This is as might be expected.

No lines belonging to the third body *C* have been detected. It must be considerably fainter than the second.

If this interpretation is correct, the velocity of the center of gravity of the close pair, *BC*, should show changes in the four-year period, always opposite in direction to those of star *A*, so that when plotted they should show a curve of the same shape, but upside down. Sanford's observations have now been continued over almost a whole period and they show conclusively that this is the case. The proof that we have here a triple system is thus completed.

The observations of the wide pair now cover 40 years, and make it possible to find an accurate period, 1374 days. The orbit has a considerable eccentricity (0.42). The minimum value for the distance of star *A* from the center of gravity (on the assumption that we see the orbit edgewise) is 395,000,000 kilometers or 2.65 times the Earth's distance from the Sun. The pair $B + C$ is on the other side, at a distance of 360,000,000 kilometers (2.41 astronomical units). The size of the relative orbit comes out therefore nearly that of Jupiter's orbit about the Sun. As the period is only one third of Jupiter's, the masses must be much greater than the Sun's. They come out 4.35 times the Sun for star *A*, and 4.77 for *B* and *C* combined.

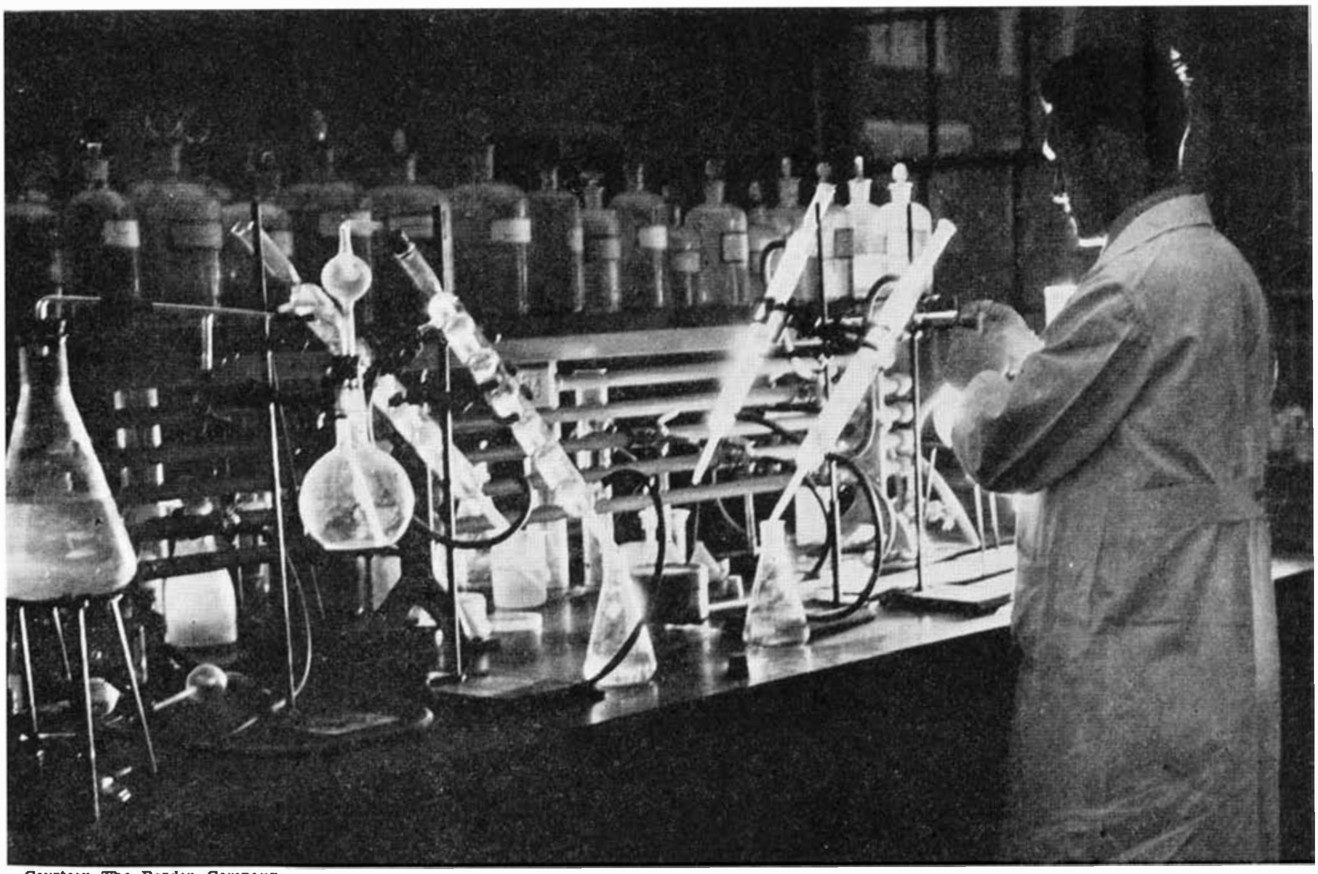
(If the inclination of the orbit plane is *i*, the distance given above must be multiplied by cosec *i* and the masses by $\text{cosec}^3\, i$. For example, if $i = 60°$, the distance of the star comes out 6.0 astronomical units and the masses 6.7 and 7.3 times the Sun's.)

The orbit of *B* about the center of the pair *BC* is moderately eccentric ($e = 0.36$ but is small, with a radius of 4,200,000 km. if it is seen edgewise.) It can be shown from this that star *C* is, in all probability, of small mass.

Working, as an illustration, on the assumption that the inclination of the larger orbit is 90°, we have the combined mass of *BC* 4.77 times the Sun's. For this mass, and a period of 8.68 days, the distance of the components can be calculated and comes out 21,200,000 km. If the inclination in the small orbit is taken to be 90°, *C* is found to be 17,000,000 km. from the center of gravity—4.05 times as far away as *B*, so that the mass of *B* is 4.05 times that of *C*, which makes the masses 3.93 and 0.95 times the Sun's. With different assumptions regarding the inclinations, different results would be reached; but, unless we assume that the orbit of the wide pair is seen almost edgewise, and that of the close pair at a small angle, the mass of *C* always comes out small compared with *B*.

THIS accounts for the failure of its spectrum to appear, for by the well known relation the luminosity of a star varies about as the cube of its mass. (Recent work indicates that the 3.3 power is a better approximation.) On this basis, if *B* is four times as massive as *C*, it should be a hundred times as bright.

Comparing *A* and *B*, on the assumption already made, we find that the latter has a mass 90 percent as great and should give 70 percent as much light. It appears to be considerably fainter than this; but a moderate and wholly permissible alternative in our assumption about the inclinations of the two orbits would lead to complete accordance. The only hope of clearing up this uncertainty lies in the possibility that one or other orbit is so nearly edgewise that eclipses occur. For *AB* this would demand an inclination so very near to 90° as to be highly improbable; for *BC* the chances are rather better, but the light of *A* would drown out the variation so that very precise observations would be needed.—*Princeton University Observatory, June 14, 1939.*



Courtesy The Borden Company

Equipment for chlorophyll and vitamin research in a biochemical laboratory

SECRETS OF LIFE'S COLORS

Chlorophyll, Key Substance of Life, Mysteriously Concentrates and Stores the Sun's Energy . . . Gives Promise of Vast Resources to Industry

By BARCLAY MOON NEWMAN

COLORS are clues to life's most fascinating mysteries. Green, red, and yellow — the most meaningful life-colors — are guiding scientists through regions in which Nature, by the changing beauty of light waves, signals the locations of treasure caches.

Many of these treasures are turning out to have immediate cash value. Many are discoveries which promise other stores of knowledge that will stimulate civilized progress and some day will alter the modes of man's existence.

Plant green, the pigment chlorophyll, seems to be leading man toward great manufacturing secrets and the ultimate production of both fuels and raw materials as well as foods in almost unlimited quantities. Experiments are beginning to teach man the mechanisms of energy use and fuel production in green plants. Many of the details are already known. When many more are known, then foods, raw materials, and fuels will be almost as cheap as air and water and sunlight. Even now, chlorophyll has practical value. In this country each year thousands of pounds, extracted from leaves, are used to color foods, soaps, and candles. To medical science, chlorophyll is of inestimable, immediate significance. The architecture of its big molecules is amazingly similar to the architecture of the molecule that runs red in blood.

Green, the prime pigment of the plant world, is most intimately related to red, the prime pigment of the world of animals and men. Study of the one is instructive in the study of the other. In 1931, Hans Fischer, great student of chlorophyll, received a Nobel award for his brilliant synthesis of hematin, the red of animal blood corpuscles. And today the physician is richer in understanding and saves more lives because investigations of green have promoted successful investigations of red—and of diseases wherein the phenomena of animal red are abnormal and puzzling.

Yellow is as widespread and as important as green, though masked by the chlorophyll of vegetation. A light filter which absorbs most of the green rays from chlorophyll but permits the passage of other light has been devised by the Eastman Kodak Company. A green field or a green forest observed through this filter is a fiery yellow admixed with orange and some slight red. For in every green plant cell there are yellows and yellow tinged with orange and red. When aviators, intent on dropping bombs, observe the landscape through this special light filter, the green of vegetation looks fiery yellow—but the green paint of camouflage still is green, and there is no yellow. Because of this difference between greens—a subtle difference made evident by the filter—and because of the presence of hidden yellow in the one case and not in the other, the bombers know where to loose their destruction. This application of pure science is practical—and of immediate value—if you call war practical and bombing valuable.

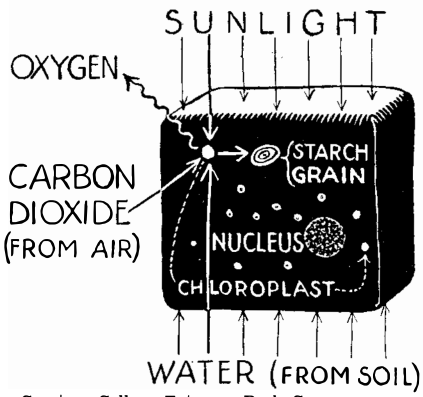
Definitely practical and definitely of inestimably great immediate value are science's new facts concerning these yellow pigments. For, chief among plant yellows are the carotenoids—source of the millions of dollars annually spent to obtain vitamin A, the essential nutrient derived from carotenoids. And who can put a price on the vitality and health that medical science has brought us through its increasing understanding of carotenoids and vitamin A? Certain internationally famed experts, besides, are convinced that vitamin A is one factor in the problem of lengthening the span of human life.

The value of carotenoids to the plant is still unknown, but their occurrence is related to rapid growth and high activity, as in the green leaf, where photosynthesis is under way. Green chlorophyll is never found unaccompanied by these mysterious compounds. Probably their secrets are bound up with the problem of photosynthesis—where chlorophyll has a role of predominant significance.

Green is spread extensively over the earth. This abundance is a sign that the greenness of the chief plant pigment, chlorophyll, is indispensable to practically every form of life on this planet. Chlorophyll is an indispensable promoter of the transmutation of solar energy into the energy of life activities. Without it, there would be no food, no coal, no oil, and no men. An enlightening and fascinating quiz is to ask a succession of questions tracing back to the origin —the Sun—the energy in the various prominent items of our dietary, fuel, and raw material economies.

PHOTOSYNTHESIS—the synthesis in plants of sugars and other nutrients by the use of sunlight, is almost uniquely interesting as a chemical problem—and almost uniquely complex, too. In this process, the living tissue of the plant absorbs molecules of water from the soil or perhaps a watery habitat. Rays of light energy plunge in from the Sun. The plant uses green chlorophyll to deal with these rays. That is, chlorophyll somehow manages to concentrate their energy and to store it—probably by stimulating the reaction of water molecule with carbon dioxide molecule. The reaction of these molecules results in the formation of sugar and starch, which are energy-rich molecules. Oxygen is a by-product poured out into the air—and later becomes the very breath of every creature. If it were not for photosynthesis, the quantity of oxygen in air would gradually diminish and, so runs the evidence, life would vanish almost entirely.

After photosynthesis, by intricate steps sugar is made to yield a vast list of materials needed by life. Thus, from sugar, by fermentation in the plant cells, alcohol is made, and afterward participates vitally in the chemical reactions whose sum is life. Sugar likewise is the raw material for making glycerine, oils, fats, proteins, vitamins, pigments—green, red, and yellow. All these substances are manufactured with impressive efficiency out of the prime product of photosynthesis: sugar, whose energy came from the Sun and whose atoms once were water and gaseous carbon dioxide. Photosynthesis is the world's most efficient process.



Courtesy College Entrance Book Co.

The green plant cell takes in carbon dioxide and water and, with the aid of chlorophyll (in tiny chloroplast bodies) combines them to make sugar and starch. By-product: oxygen

Investigation shows that there are, in fact, two greens, having very nearly the same architecture of molecule: chlorophyll *a* and chlorophyll *b*. When extracted and crystallized, *a* is blue black; in alcoholic solution it is greenish blue. The solid crystal of *b* is green black; it dissolves in alcohol to a beautiful pure green. Readily *a* is changed into *b* by delicately taking away two atoms of hydrogen and replacing them with an atom of oxygen. The life scientist notes that they are always together in any green plant cell: each is an essential cog in the machinery of photosynthesis.

Each chlorophyll molecule is a web of carbon, hydrogen, oxygen, and nitrogen atoms, with an atom of the metal, magnesium, as a centerpiece and chief feature, when the molecule is taking part in photosynthesis.

The red hematin structure is also a web of carbon, hydrogen, oxygen, and nitrogen atoms, but with an atom of the metal iron as a centerpiece and chief feature, when the molecule is taking part in the transport of oxygen in living things.

To ferry oxygen is the destiny of the hematin architecture. That it makes blood red is a mere happy signal of Nature—not always so eager to help man by arresting signals. The disk-like blood corpuscle is red because its activity is the transport of oxygen, and this activity calls for hemoglobin—a giant globin, or protein, to which four molecules of hematin are hitched.

The pallor of anemia is another signal, this time of warning, that the body needs more iron in its blood, iron in the form of hematin.

Where oxygen is plentiful, as in the lungs, hemoglobin forms a loose combination with it. Where oxygen is low in concentration, as in the tissues deep within the body, the oxygen atoms break away from the hemoglobin and are absorbed into the tiny laboratories of the cells. There the oxygen is used to burn, to react with, the fuels and release their energy for running the mechanisms of life. These fuels were formed originally in the plant, by the aid of green chlorophyll in photosynthesis, and originally their energy was sunlight. All flesh is grass, which labors in the sun.

THE iron atom, central feature of the hematin molecule, is empowered to attract a molecule of oxygen—two atoms —and seize it, holding it in the web until the appropriate time of release. Thus the huge hemoglobin molecule, having four hematin structures attached, can hold four molecules of oxygen at a time. Each red corpuscle, having many hemoglobin giants within its delicate fabric, can carry many oxygen atoms. The transportation of oxygen to the hungry cells far from the lungs is therefore an efficient enterprise.

No scientist thinks that the close likeness of hematin and chlorophyll is an accident. One ancient day, when earth-life was young and low in type, live substance realized the possibility of exchanging an atom of iron for one of magnesium in a web like that of green chlorophyll. Oxygen-ferrying was facilitated. Red blood, and its possessor, the higher animal, could later appear on earth.

New discoveries yield striking evidence favoring this theory. Man cannot exist without minute quantities of copper and manganese in his system. These metallic elements, it has recently been found, promote the formation of hemoglobin in factories located in bone marrow. And lately, too, it has been found that chlorophyll formation does not take place in the leaf in the absence of minute quantities of copper and manganese.

Now color leads us—as it did the investigators of the mystery of life—to one of the major discoveries of science. Throughout all matter that is alive, hematin is found—in the bacterium, in the towering redwood tree, in the aquatic animalcule ameba, in man.

Why, then, is not all living material red? The hematin is present in too low a concentration to cause any color to show up.

Nevertheless, the high sensitivity of the spectroscope sorts that light waves made to pass through live matter and invariably finds those wavelengths which tell that hematin is definitely there, though in proportions almost infinitesimal. Still, distributed however thinly through vital substance, the hematin molecules—we now know—make possible a vastly complex mechanism of energy use. The hematin web is continually busy taking oxygen from this molecule or that, and ferrying the oxygen to other molecules—which then react, usually by uniting with the oxygen, and so are oxidized, burned to release heat or other varieties of energy.

Thus, one great mystery of life is slowly beginning to give up some of its treasures. Oxidation and energy transformations at moderate temperatures constitute a secret not only universal in living things but also thrilling in promise to man. Cold, white light like that of the firefly and deep-sea monster will be the soft illumination in man's buildings when he solves more problems of the most efficient economy in the world—the physico-chemical economy of animate machinery, which with astounding ease stores energy in photosynthesis or releases it in physiological oxidation.

SOMEWHERE in the rise of animals, protoplasm learned to put copper in the place earlier occupied by iron in the hematin web, and thus made a blue from a red. The oxygen ferries—that is, the respiratory pigments—of the blood of the octopus, the oyster, and the lobster are hemocyanins and not hemoglobins. They are blue, not red.

Other lines of animal evolution used the red hematin to make their blood pigments and so were able to go higher in the scale of life. Hemoglobin is four times as efficient a carrier of oxygen as hemocyanin, and is one of the factors in the creation of man out of lower mechanisms. Yet to this day, copper is somehow bound up in the making of hemoglobin.

Yellows outstandingly important to life are perhaps most readily seen in the carrot—from which these pigments were first isolated, and so called carotenoids. They are vital to the plant and to man—and were the sole source of vitamin A until the eminent biochemist Kuhn recently taught chemists how to make this vitamin in the test tube.

In 1831, ruby-red crystals were extracted from carrot root, and named "carotin." This pigment is now recognized as a mixture of at least three closely related chemical structures: alpha-, beta-, and gamma-carotene. In solution, the red changes to the yellow typical of dissolved or suspended molecules of carotene—as in a number of yellow flowers, in the yolk of the egg, in the yellow leaf. But not all plant yellow is carotenoid; not all carotenoids are yellow.

A carotenoid is a special chemical structure: a ring of carbon and hydrogen atoms attached to a chain of carbon and hydrogen and sometimes oxygen atoms. The ring is known as the beta-ionone ring, and holds many a secret. Chemists first knew it as an essential portion of many a fragrant molecule, such as those in oil of violets. They are surprised to find it in pigments, and even more surprised to learn that it is a vital part of the structure of vitamin A.

Science Service photo

President James B. Conant, of Harvard (right), internationally known investigator of chlorophyll. (At the left: Dr. Harvey Cushing, surgeon)

The length of the chain, and the manner in which its atoms are linked, have much to do with the color. Yellow is predominant among these substances, but slight changes in the positions—linkages—of the atoms and an increase in the length of the chain yield orange, red, and then even reddish violet and very rarely dark blue. The red of tomatoes and of watermelons is, for example, a carotenoid—kin of the yellow of yellow tomatoes and of green-masked yellow of all leaves. Vitamin A, however, is colorless—no one knows why.

In the backboned animal, any one of the three carotenes can act as the forerunner of vitamin A. The liver seems to be the site of this transformation, of yellow into a colorless molecule. And the vertebrate can get no parent substance for his vitamin A—no carotenoid —except directly or indirectly from the plant which manufactures yellow. The lack of vitamin A causes lowered resistance to infection, degeneration of skin and mucous membranes, poor vision in dim light, weak dry eyes, and ultimate blindness.

Eggs and milk have vitamin A derived from the animal's ration of plant yellow, or perhaps of cod-liver oil (added to the feed). The cod eats lesser aquatic life, which in turn lives directly or indirectly on sea vegetation which has both green for energy storage and yellow for vitamin A. How intricately woven is the web of life! Bio-science, medicine, chemistry, and eventually even physics (through the study of color's origins) will all amazingly benefit from present and future investigations of yellow, so closely tied up with green and the well-being of men with red blood.

The common yellows of fruits, vegetables, and flowers are carotenoids, but there are other yellows. A yellow scarcely yesterday discovered present in practically all living tissues, plant or animal, is vitamin G, or riboflavin, most readily obtained from milk, a rich source and, in fact, until recently the sole commercial source. What rôle this vitamin plays in extending the life span of man is unknown, but the mouse and the rat definitely live longer when plentifully supplied with the nutrient. Until recently, riboflavin obtained by a laborious process from milk was selling at many dollars per gram—and there are 454 grams to the pound. Thus important did biochemists and medical scientists regard the vitamin. Now, thanks to improved production facilities and commercial synthesis, the price has been much reduced.

THIS yellow takes us back to red. Like hematin, riboflavin is essential to the release and transfer of energy within the vast systems of the life material. It is beginning to appear that in this yellow we have a link between the vitamins and the enzymes, which are the stimulators and accelerators of chemical activities within a living thing. Riboflavin, attached to certain huge protein architectures, endows them with the power to step up the rate of burning and energy- and atom-exchange in many vital chemical reactions. Hence riboflavin, the yellow, is a companion of and co-laborer with hematin, the red, in the control of life's breakdown of fuels.

The world of life is a world of color. And the bio-investigator is finding profound meaning in the play of color. The human eye that looks out over this world is struck by a myriad of clues to Nature's deepest and most significant secrets. And the very eye sees by grace of the pigments that signal so fascinatingly.

Vitamin A, born of yellow, is a part of the mechanism of the human retina, the light-sensitive photographic film, as well as a part of visual purple and other visual pigments known to exist, but still mysteriously, in the eye's photosensitive film. The red which vitalizes the brain and nerves and eye is the offspring of green in the leaf. And throughout the living mechanism of man, yellow and red are speeding the use of the energy which green chlorophyll helped store during spring and summer. Scientists find much profit in such thought.

WHAT SIX YEARS DID

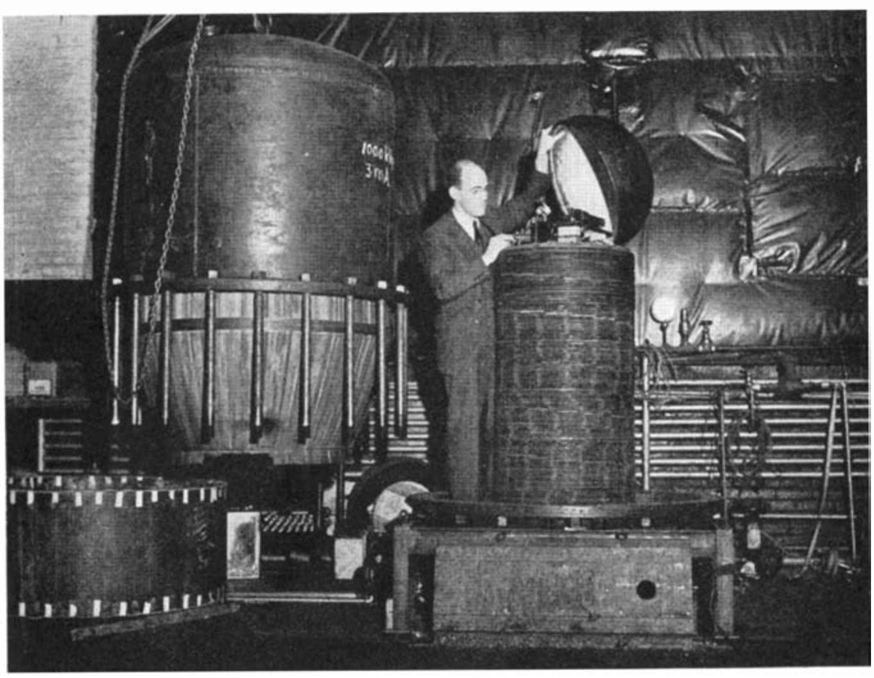
In the Design of Large X-ray Equipment, Progress Has been Extremely Great in the Past Few Years . . . Hospital X-ray equals $90,000,000 Worth of Radium

A MILLION-VOLT X-ray outfit so small that it can be housed in existing hospital buildings, yet so powerful that it gives X radiation equivalent to several thousand grams of radium, has been built by the General Electric Company for the Memorial Hospital in New York, where research in the treatment of cancer is being carried on. It is estimated that the radiation from it, based on present-day radium costs of $25,000 per gram, will be equal to $90,000,000 worth of radium.

The new tool of medical research was built following a long period of study with the objectives of reducing the size and cost of very high voltage X-ray equipment, thus increasing its availability to hospitals. The new apparatus can be produced and installed for far less cost, for example, than the well-known 800,000-volt units of 1933 which required a special building to house them and their vast array of supporting and contributing equipment. The 800,000-volt unit needed a building 62 feet long, 32 feet wide, and 36 feet high, and many tons of lead to protect operators and patients from the cumulative effects of X rays.

The new equipment consists of a transformer of novel and radical design, together with an X-ray tube built of 11 sections. Transformer and tube are contained in a cylindrical steel tank consisting of two sections bolted together. The total weight, including 1000 pounds of lead for X-ray protection, is 4000 pounds.

Revealing the filament end of the tube and part of control mechanism



The outside steel shield (left) that encloses the tube and coils

Lowering the 100-coil transformer over the tall and slender X-ray tube

The transformer operates on three-phase, 60-cycle power, and is designed to produce 1,000,000 volts peak at three milliamperes or more. The tube is mounted vertically within the transformer in the space normally occupied by an iron core. It is three and one half inches in diameter and 56 inches long. The glass portion is completely shielded, electrostatically, for its entire length by the surrounding transformer.

The high tension winding of the transformer consists of more than 100 thin, flat coils of wire, built like huge pancakes with holes in their centers. These are stacked inside the tank. Through the center passes the X-ray tube with the target end at the bottom and grounded, and the hot cathode filament at the top. Completely enclosing the tube and coils is a steel shield which, in effect, becomes the core of the transformer, although it is on the outside of the coils.

ANOTHER unusual feature of the equipment is that gas is employed as an insulating medium instead of the conventional oil. If oil were used in this unit, about 12,000 pounds would be needed, but only 100 pounds of gas (dichlorodifluoromethane) perform the insulating function.

There are no moving parts. The control of the unit is entirely electrical, and the enclosure of the million-volt circuit in a grounded metal tank eliminates the hazard of electrical shock.

Applications outside the medical field include its use in industry, such as for radiographic examination of large steel castings five inches and more in thickness.

Why the Earth's Magnetism?

The New Elsasser Theory . . . Radioactivity Heats Earth's Interior, Heat Sets up Eddies, Currents of Thermoelectricity Flow, Causing Magnetism

By C. W. SHEPPARD

MAN has known that the earth is a huge magnet almost as long as he has known anything about magnets. However, scientists have labored and speculated in vain for over 300 years since that discovery in the attempt to find a reason for its magnetism. Systematic and careful experiments have been made on a scale almost greater than any other scientific project. Special non-magnetic wooden ships have sailed the oceans charting the lines of force. Explorers have carried delicate instruments with them to out-of-the-way places to make careful magnetic measurements. Numerous stations scattered over the earth's surface have watched the hourly, daily, and yearly fluctuations for many years with extraordinary patience and precision.

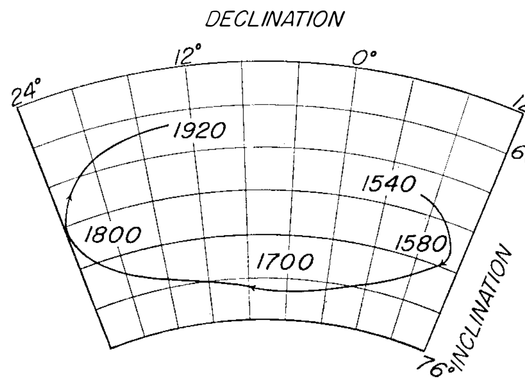


Figure 1: Secular variations of the earth's magnetism, as observed at London since 1540

In the light of this extensive experimental work, a recent paper in the *Physical Review*, official publication of the American Physical Society, will cause great interest among scientists the world over. This paper, entitled, "On the Origin of the Earth's Magnetic Field," by Dr. Walter M. Elsasser of the California Institute of Technology, has cast new light on this old problem and possibly pointed the way toward its ultimate solution.

Early theories of the earth's magnetism were based on the assumption that the earth is a huge, permanently magnetized body. Such theories would no doubt be very successful if it were not for one serious obstacle. The interior of the earth is very hot, being at least several thousand degrees centigrade, and all permanently magnetized bodies lose their magnetism when they become hot. The only alternative, then, is to say that the earth is a huge electromagnet, not a permanent magnet, and that the magnetism is caused by enormous electric currents. These are estimated to be in the neighborhood of a billion amperes. Measurements of the distribution of the lines of force over the earth's surface show that all but a few percent of these currents must flow in the earth's interior. The remainder can be accounted for by a ring of charged particles flowing around the earth somewhere between the stratosphere and the Moon. A fluctuation of the earth's magnetism in step with the 11-year period of the sunspot activity can be traced to this ring, whose charge dies slowly away only to be replenished by particles thrown from the Sun by the violent eruptions on its surface during the sunspot maximum.

Although a description of the fluctuations of the earth's magnetism would fill many pages, its most important variations, from a theoretical standpoint, are the long-term, or secular, variations. Not only does the earth's magnetism change gradually over a few centuries under these variations, but also the north and south magnetic poles move around slowly (Figure 1). Any satisfactory theory of the earth's magnetism must give a proper explanation of this phenomenon. The fact which makes scientists scratch their heads the hardest, however, is that, although the earth's magnetic poles are near the north and south geographic poles, they do not coincide exactly with these geographic poles. What can be the forces at work which make the earth's magnetism tend to be parallel with its axis of rotation and still allow it to deviate a small amount?

ALTHOUGH our information as to the nature of the earth's interior is somewhat meager, there are good reasons to believe that it is metallic. The most important information on the earth's interior is obtained from the behavior of earthquake waves. These waves are of two kinds, longitudinal and transverse. The longitudinal waves vibrate in the same direction as that in which they travel. Sound waves belong to this class. Transverse waves are those which vibrate in a direction at right angles to that in which they move. The waves one obtains on shaking the end of a rope are transverse. It is well known that liquids will not transmit transverse waves. Observations with seismographs at great distances from earthquake centers show that there is a large core in the center of the earth (its

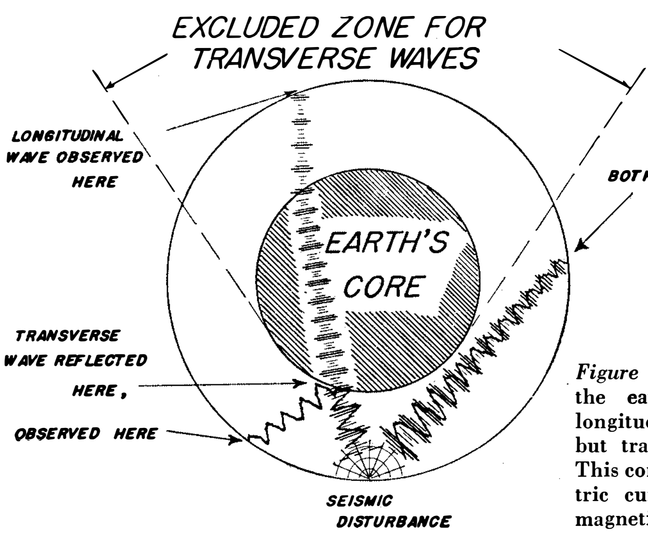


Figure 2: How we know that the earth's core is liquid: longitudinal waves traverse it but transverse waves do not. This core is the seat of the electric currents that give their magnetic field to the earth

boundary about 1950 miles below the surface) that does not transmit these transverse waves (Figure 2). Therefore, one can conceive of the earth as a large ball of molten metal with a thick crust of solid material floating on top just as slag floats on the surface of a melting pot. It is in this easily conducting core that the electrical currents which keep the earth magnetized must flow.

Attempts to explain this current as being due to galvanic effects such as produce the electrical energy in batteries have been unsuccessful, for the currents which could be produced in this way would be much too small. Elsasser's theory finds a much better explanation in thermoelectric currents. Whenever two metals are joined together, there is a tendency for a current to flow from one to the other. This tendency is proportional to the temperature of the junction and depends on two quantities called the thermoelectric constants of the metals. Unfortunately, it is impossible to measure a current without making a closed circuit. Therefore, one must have at least two junctions. Then, however, the tendency for currents to flow at one junction is just balanced by the reverse tendency at the other. But, if the temperatures of the junctions are different the effects no longer neutralize and a current flows (Figure 3, top). This principle is used in thermocouples, which have a wide application in measuring high temperatures and in thermostatic control. Suppose now that, instead of two strips of the two different metals, we take a large number of strips and join them

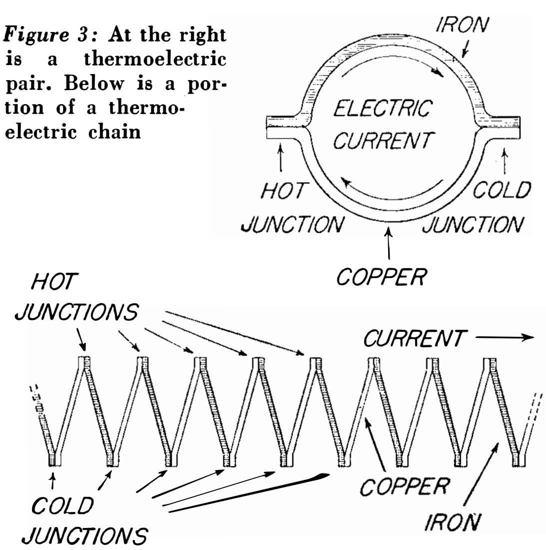


Figure 3: **At the right is a thermoelectric pair. Below is a portion of a thermoelectric chain**

in a closed chain so that the two different kinds of metal with their different thermoelectric constants alternate (Figure 3, bottom). Now, if we keep alternate junctions at two different temperatures throughout the circuit, a current will flow in the same way as before where we had only two strips, but a larger one. If such a situation, or something nearly analogous, could arise within the earth, a large thermoelectric current would flow.

To cause such a systematic alternation of temperatures, the new theory supposes a source of heat at the center of the earth. Given such a source, a turbulent, boiling-up motion would occur. The velocity of the longitudinal waves transmitted by the earth's core, with other information, shows that the interior is very plastic, being somewhat less viscous than ordinary pitch. Thus this boiling motion will be fairly rapid. For the necessary source of heat, small amounts of radioactive material in the earth's interior would be sufficient. This turbulence, or convection as it is called, is the same thing as can be seen in the air above a heater or in a saucepan on the stove. This convection will break up into eddies which rotate about an axis pointing radially outward from the center, and the average motion will be in the direction of this axis. Thus at the centers of these eddies large quantities of hot material will be brought up from the interior and cause temperature variations. If then these temperature variations are coupled with variations in the thermoelectric constants of the surrounding material, a resulting thermoelectric current will be set up.

The question as to how the thermoelectric constants will change is hard to answer. The interior of the earth is at a pressure of at least 10,000,000 pounds per square inch. The highest pressures obtained in the laboratory so far have been only one tenth of this and little hope exists that one can go higher, for the best materials available flow like wax under the stress. However, it is known that high pressure causes changes in the crystalline structure and in the relative composition of various components of alloys, and that these changes occur much more frequently than at low pressures. Since it is quite certain that the interior of the earth is made up of several different metals, a large number of these changes may occur, and thus the thermoelectric constant will vary.

However, as it stands, the thermoelectric currents merely cancel out, as there has thus far been no determining factor as to whether they will go from east to west or vice versa. This is where the earth's rotation enters. Suppose a person sits on a piano stool and holds a weight in either hand at arm's length. If he is now set into motion, he will rotate slowly unless he draws the weights in, in which case, he will speed up. Figure skaters make use of this principle in the pirouette. At the beginning, they rotate slowly and spread out as much as possible. When they wish to speed up for the spectacular finish, they pull themselves inward. The force which causes this speeding up is known as the Coriolis Force. In general, it behaves in a very complicated manner, and cannot be adequately described without mathematics. However, the effect of it on the eddies inside the earth is to cause them to turn over slowly. Thus an eddy whose axis originally was radial gradually turns so that the axis points somewhat eastward. Actually, the description given here is a much simplified picture, and the real motion will be very complex and irregular. Nonetheless, in the random motion, there will always be the above-described tendencies. Meteorologists are very familiar with this force, since it causes the Trade Winds and the Gulf Stream. In this way, then, the Coriolis Force sets up an asymmetric effect (Figure 4) and a resulting thermoelectric current may flow.

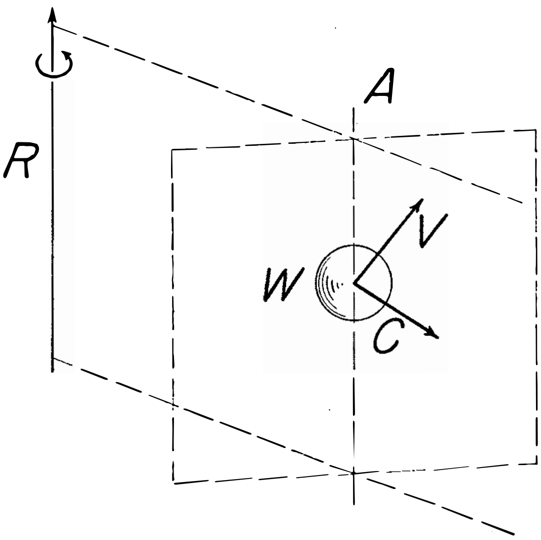


Figure 4: **How the Coriolis force operates. The weight *W* moves in direction *V*. If whole system revolves around the axis *R* in direction shown, *W* will appear to be under influence of a force in direction of *C*. Direction of *C* is perpendicular to plane containing *A* and *V***

Certain difficulties are present in the new theory. The greatest disadvantages lie in the imperfect knowledge now existing as to the nature of the earth's interior and the behavior of materials under the enormous pressures and temperatures known to exist there. All estimates of these things are extensions of knowledge obtained in a much lower range and are not likely to be particularly accurate when applied in this manner. But the new theory does provide a start on an old problem.

The Saluki Everlasting

Carvings Found in Ancient Ruins in the Near East Show That a Breed of Dogs Now Fashionable Among Fanciers was a Favorite there 5000 Years Ago

By W. H. NOBLE, Jr.
The University Museum, Philadelphia

MARCHING down through the ages comes man's love of hunting as a sport, and the pleasure he took in having about him some reminder of the companions of the chase. In a time when much attention is given to the preservation of trophies by taxidermy, the collection of hunting prints, and to bronze models of champions, ancient man is brought much closer to us when we find evidence of his similar devotion to his hunting dogs expressed in one of his earliest and most personal art forms. Such were the engravings of his favorite Salukis hunting hounds on early stone stamp seals.

These stone stamp seals were small, thick buttons or disks, sometimes with knob handles, sometimes without, but almost always pierced so that they could be worn around the neck or attached to the belt by a cord through the piercing. On the flat side was cut some figure or figures which, when pressed into soft clay, left an impression, just as our sealing-wax seals do today. These round, though sometimes square, impressions were men's signatures. Later they appeared on clay tablets. Then the stamp seal developed into the cylinder seal which, when rolled across a soft surface, left in the clay an elaborate group of figures and still later carried even the crudely cut letters of the owner's name.

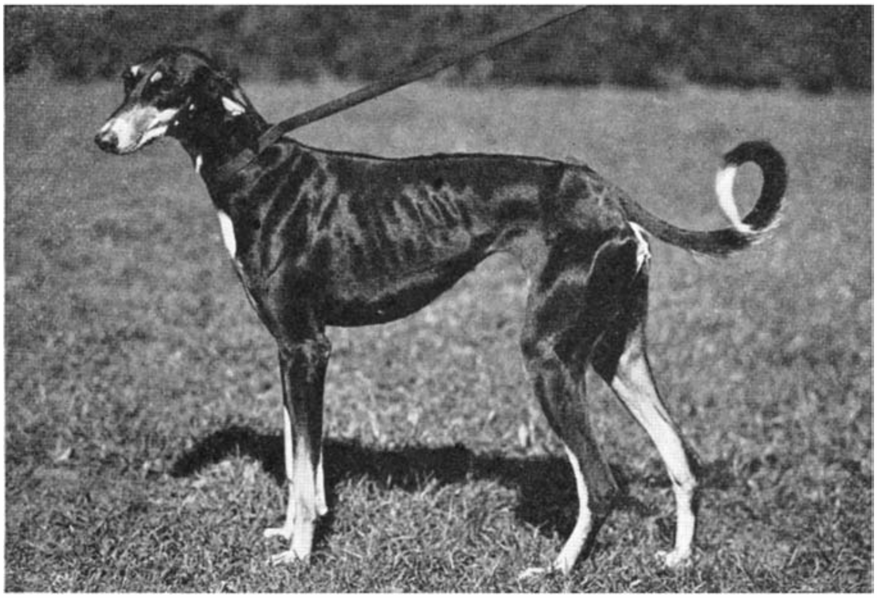
The seals of which impressions are shown at the right are from the joint excavations of the University Museum of Philadelphia and the American Schools of Oriental Research at the great city mound of Tepe Cawra in Northern Iraq near Mosul. [Scientific American, Oct. and Dec., 1935 — *Ed.*] They come from Levels 11 and 11a and were found in house debris which is dated before 3500 B.C. The people who occupied the site at this time are called the Painted Pottery Peoples and they have left the stamp of their development in many parts of the Near East by their fine decorated pottery, and at Tepe Gawra by the advanced state of their architectural progress as well. Among the smaller things to play a part in their lives and which have come down to us, were stone gaming pieces, a pottery holder of an obsidian razor blade (reminiscent of our straight-edged razor), superb obsidian bowls showing a patience and technical attainment of high order in working in this stubborn material and, finally, a number of these small seals of which the impressions of only a few have been shown here.

Modern drawings of some of the ancient seal impressions or personal "signatures" discussed in the text

Crude interpretations of the human figure, geometric designs, fish, and unidentifiable animals appear cut into the stone faces of the seals, but the one subject, and easily the favorite, in which they exhibit an impressive skill in portraiture, is that of hunting dogs. These tall, slim, and uncommonly graceful animals do not present an easy task to the stone cutter, yet they are shown standing, seated, or in a playful attitude and you are definitely conscious that with early civilized man's technical ability went a great interest in and love of his subject. On the face of the seal on the opposite page—one of the best preserved of the round seals—there are as many as three of the dogs and with them are three animals, only one of which is easily identified, an ibex. Of another seal (right, center, in illustration on this page) only a portion of the face is preserved, and there we see the hunting Saluki with a smaller animal in front of him, poorly cut but with the small horns of the gazelle definitely protruding from its head. The rectangular seal face in the same illustration presents a nice study in design, with the three dogs placed one above the other. Just what the objects are in front of them it is difficult to say; perhaps they are the heads of a two-horned animal, though these strange shapes may be merely "fillers," for we know that the purchaser wished to get his money's worth and insisted that the engraver fill up every open space!

THERE is no denying the pride which these sportsmen of over 5000 years ago took in their sleek, graceful hunting dogs, else they wouldn't have placed them so profusely on what must have been one of their fondest possessions—their stamp seals.

Strangely enough, today in the Near East, one of the Arab's greatest treasures is the same type of hunting dog—the Saluki. He does not, however, actually class his Saluki as a dog! If the modern Arab does not hate dogs, he ranks them very low in his estimation. Nor can he be blamed, for the usual type of dog in Irak, Turkey, or in any part of the Near East is likely to be a fierce, ungrateful and often cowardly beast—large, dirty, and untrustworthy. Partly, this is the Arab's own fault, due to his bad treatment and religious attitude toward dogs. The Saluki, on the other hand, is another matter. He is more lithe and graceful than our greyhound, is larger and faster than our whippet and, above all, is very sensitive to human contacts. An American on one of the excavations in Irak wished to photograph a particularly beautiful example of the Saluki. When asked to pose with his dog, the proud Arab master disdainfully refused, denying that it was a dog. His insulted dignity could be soothed only when the American photographer obligingly agreed that this was in truth no dog, but an entirely different class of animal—a fleet and noble Saluki.



Ayesha, the modern Saluki mentioned in the text. She was brought to America by Mr. and Mrs. Charles Bache. Compare with the Salukis on the ancient seals

TODAY the Arab *effendi* saunters through the bazaars with his beautiful Saluki beside him or smokes his water pipe in the coffee house with the lean animal stretched gracefully at his feet. At times he will even bestir himself to hunt the gazelle or the rabit. Then it is that the Saluki shows its greatest virtue, its marvelous speed. With his master riding a horse at a gallop, the Saluki can be seen circling about him in great orbits with unbelievable swiftness, turning in mid-air with a leap when some prey is scented or else spotted with its keen eye.

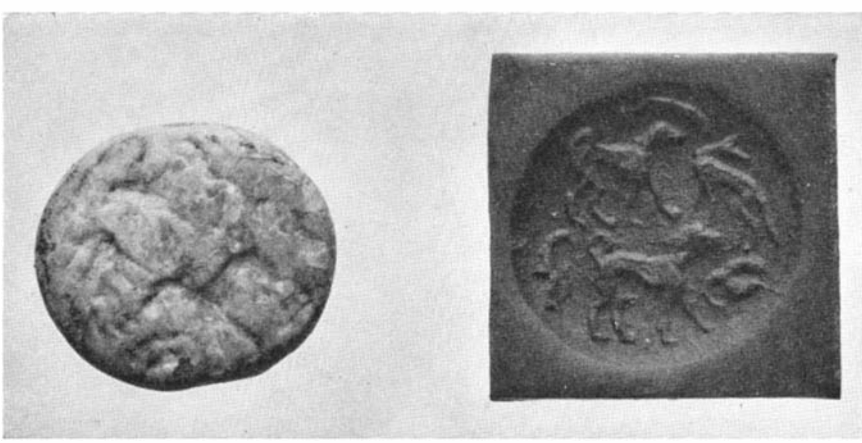
The actual speed of these dogs is difficult to ascertain, though on Iraki roads one has been known to keep abreast of an American car when the speedometer read 42 miles an hour. The driver of the car couldn't "step on it" any more. Probably the Saluki could.

In the last few years American interest in these dogs has quite rightly increased by leaps and bounds. There is now an American Saluki Club, and at many of the leading dog shows on the Atlantic seaboard there are classes of Salukis. While their pedigrees are not so old nor in such good order as some breeds, they have been accepted by the American Kennel Club.

The photograph reproduced above is of the famous Ayesha, brought to this country several years ago by Mr. and Mrs. Charles Bache, of Philadelphia, who excavated many of the seals in Irak. Ayesha stands about 30 inches high and she thought nothing of leaping from the roof to the ground or, for that matter, of plunging through a plate glass door in a Beirut hotel, her knowledge of glass at that time being limited. She was entered with notable success in a number of shows in this country, though her particular kind was rare, being of a Koweit type. This principality is in Southern Irak on the Persian Gulf and breeds a somewhat more powerful animal.

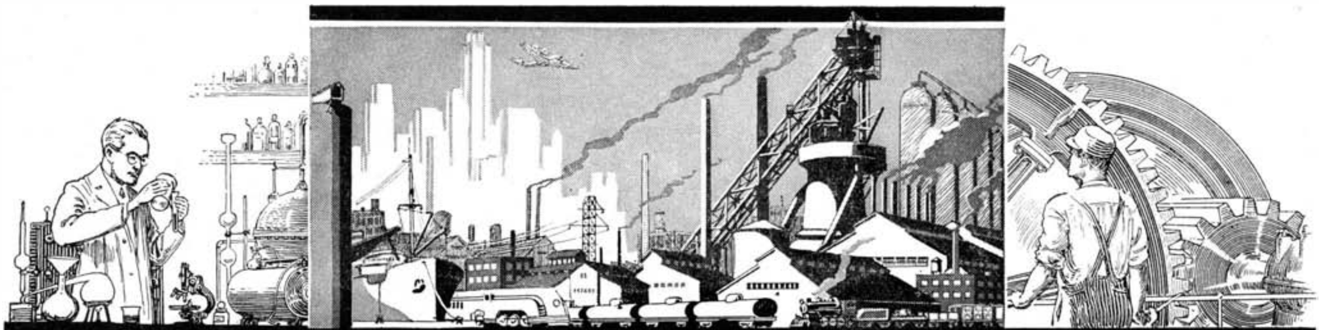
Stamp seals with pierced knobs for convenient suspension from the neck

As we follow the Saluki or his family history down from the Painted Pottery People, interest or evidence of him is fairly slim. In Egypt, on the Old Kingdom reliefs in the Tomb of Tahotep, of the Fifth Dynasty, at Sakkara, we find an animal whose body is that of the Saluki, though the ears are slightly different. Here a group is being held in leash by a servant who awaits their master, while in another register they are shown attacking gazelles during a chase. Persian miniatures show him delicately modeled and cream in color, accompanying his bejewelled and silken master. Morgan Stinemetz, in an excellent dog chart in *Nature* (February, 1939), reports that the Saluki first entered England in 1840 but made little headway until imported from Arabia in 1895. After the Saluki's entrance into Russia in the middle of the 17th Century, "to slake a noble's thirst for fast dogs," he was crossed with a collie-like native to provide the needed fur and so we have the Borzoi. However, this example is a side shoot, not the main line of Saluki descent, and the latter is found in Arabia, not far from the earliest place of record 5000 years old.



The ancient seal at left does not look like anything in particular but its impression, shown at the right, reveals three Salukis and some other objects

BUT it is back we must go to that mound of Tepe Gawra, which flourished in the Land of the Two Rivers as long ago as the 4th and 5th Millenia B. C., to find men who so loved their dogs that they portrayed them in their signatures and on their amulets, and who depicted them so well that there is no doubt about their descendants in the modern Saluki. These graceful animals bound and prance today. What of their masters? That is a more difficult problem to trace.



SCIENCE AND INDUSTRY

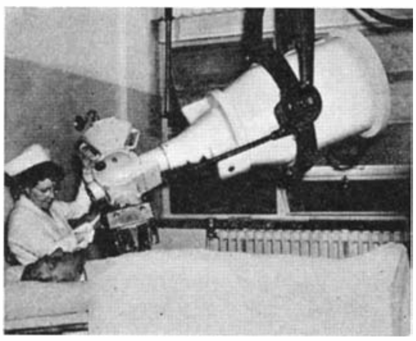
A MONTHLY DIGEST

Conducted by F. D. McHUGH

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

NEW X-RAY UNITS FOR FIGHTING CANCER

HIGH-VOLTAGE X-ray machines of revolutionary design feature the equipment of the Memorial Hospital for the Treatment of Cancer and Allied Diseases, in New York City. Recently dedicated, the hospital uses for radio-therapy a 1,000,000-volt X-ray machine as well as five 250,000-volt units. Notable for their exceeding compactness and maneuverability, all were developed by General Electric through collaboration among research laboratory scientists, Memorial Hospital representatives, and G-E X-Ray Corporation engineers.



Operating one of the easily maneuverable 250,000-volt X-ray machines. These are similar to the 1,000,000-volt unit described in more detail on page 151 of this issue

QUARTZ-LIKE GLASS

AN entirely new method of glass manufacture yielding products which can be heated to cherry red heat and then plunged into ice water without breaking has been developed in the research laboratories of Corning Glass Works, it was announced recently by Amory Houghton, President. The Corning management made clear, however, that while the Research Department had completed its exploration into the unknown and had established its findings beyond doubt, it will be two years or more before the products can be offered to the public.

The weirdest point about the new and revolutionary process is that articles made by it shrink to less than two thirds their original volume yet retain their identity and suffer no distortion of form. This means a linear shrinkage of 13 percent. For instance, if you want to make a nine-inch dish you first make one ten and a half inches in diameter.

The new Corning process consists of a series of contrasting operations and there are several alternative variations at the end which give an amazing variety of results. In simplest terms, what happens in the main process of this: A normal glass object such as a plate or beaker is made by usual melting and molding operations but with a special glass formula. Then, through a series of treatments involving final leaching with dilute nitric acid, part of the structure of the glass is removed—leaving a skeleton, so to speak. Then, under further heat treatment, the glass shrinks down to a volume which is a reduction of 36 percent from its original size. As a matter of fact, during the acid treatment, 36 percent of the body of the glass has been removed; 64 percent remains. The surface feels rough to the touch but does not feel porous. Actually at this stage it is filled with sub-microscopic capillaries or air spaces. On final heat treatment the glass body reaches a transparent, homogeneous state in which it is practically 96 percent pure silica. In this completed state the glass can be heated to a bright cherry red color, and then dipped into a vat of ice water with no injury whatsoever.

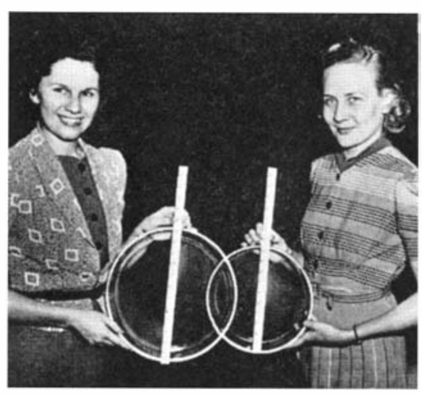
Above: **Molten iron, poured on new glass chilled by ice, has no effect on it.** ***Right:*** **A 12-inch disk shrinks 1½ inches during processing. The glass is 96 percent silica**

The outstanding significance of the new Corning low-expansion glass is that it will offer in an economical price range a material similar to fused quartz. A miniature pilot plant has been operating for several months. To put the process on a full-scale basis would require at least two years, even assuming rapid designing and building, according to the chemists in charge.

PERMANENT GLASS-MARKING INK

CHEMISTS can make an effective and permanent glass-marking ink by mixing equal parts of chromic oxide with powdered lead borate, and stirring this into a mixture of equal parts of water, alcohol, and glycerin, according to *Solvent News.* The amount of liquid used depends on the consistency desired.

After applying the ink with a pen and allowing it to dry, the glass is warmed in the yellow flame of a Bunsen burner, then heated to red heat in a blue flame. The



glass is finally allowed to cool, using the yellow flame to lower the temperature gradually.

The ink is green, and because of the limitations of the process, cannot be used on heavy cast glass equipment such as desiccators, reagent bottles or the like.

TAXES

DURING 1938 gasoline taxes represented an average of 24.83 percent of all state tax burdens in the 48 states.

U. S. S. *Hammann* is an identical sister ship to the U. S. S. *Anderson* shown above

Destroyer "Hammann" Typifies New Steam Power Era

THE ghosts of many a windjammer and the wraiths of out-moded steamships must have looked with envy upon the U.S.S. *Hammann,* newest member of the Navy's fleet of destroyers, as she took a "bone in her teeth" and pranced effortlessly at approximately 38 knots in her builder's trials recently, manned by an expert crew supplied by her builder, the Federal Shipbuilding and Drydock Company, a subsidiary of the United States Steel Corporation.

Sleek and streamlined from her waterline to her bridge, the *Hammann* demonstrated for a group of newspaper and magazine writers the efficiency, economy, and power of high-temperature high-pressure steam that drives her twin sets of main propulsion turbines. She performed as representative of her class of 11 destroyers which were authorized under the 1937-38 Naval Appropriations Act.

The story of the *Hammann* is a story of power, for she is literally a $5,500,000 power house afloat. Compressed inside her needle-like hull is power enough to lift the 300,000-ton George Washington Memorial Bridge more than 160 feet an hour—provided of course that the power of her two turbine units could be harnessed to such a task.

It is the story of the transition of marine power plant designing from empirical engineering with low-pressure, low-temperature steam engines to the scientific development of high-pressure, high-temperature turbines based on some 20 years of research. The result is production of destroyers that are the most economical and fastest fighting ships of their size on the Seven Seas.

If judged by appearances, the *Hammann* is a "little fellow" for a big job; she's only 341 feet long at the waterline, 36 feet in her extreme beam, and she weighs a scant 1500 tons—not much heavier than a gun turret on a modern battleship. But encased in her steel shell the ship carries a compact power plant that approaches in performance the work of many of the largest high-pressure tandem turbines built to operate in big city power stations.

The six main turbines on the *Hammann* weigh altogether only 55 tons, but are capable of producing about 27,500,000 foot pounds of work per second.

Smoothness Indicator

A DEVICE so sensitive that it will indicate the differences in thickness of a fingerprint on a piece of smooth glass, has been developed by J. A. Sams of the General Electric Works Laboratory.

Known as a surface indicator, the instrument is used to determine the smoothness of metal or painted surfaces and indicates minute variations far beyond the range of the human eye. Variations of as little as 1/1,000,000 of an inch are clearly indicated.

By its application, the surfaces of bearings or other moving parts of motors and the like, that are subject to wear, may be tested and their smoothness indicated.

The apparatus appears somewhat like a phonograph with its turntable on which is placed the object to be tested, and its sapphire-pointed stylus or needle that passes over the test material as it revolves.

Small mechanical impulses are created as the hard point rides over surface irregularities. These impulses are then transmitted to an electro-magnetic pickup which converts them into electrical impulses. They are then amplified and transmitted to a recording meter where the surface characteristics are graphically indicated.

The stylus or needle is so sensitive that when it is placed on the revolving metal turntable, the invisible vibrations established by a person whistling are shown on the recording meter.

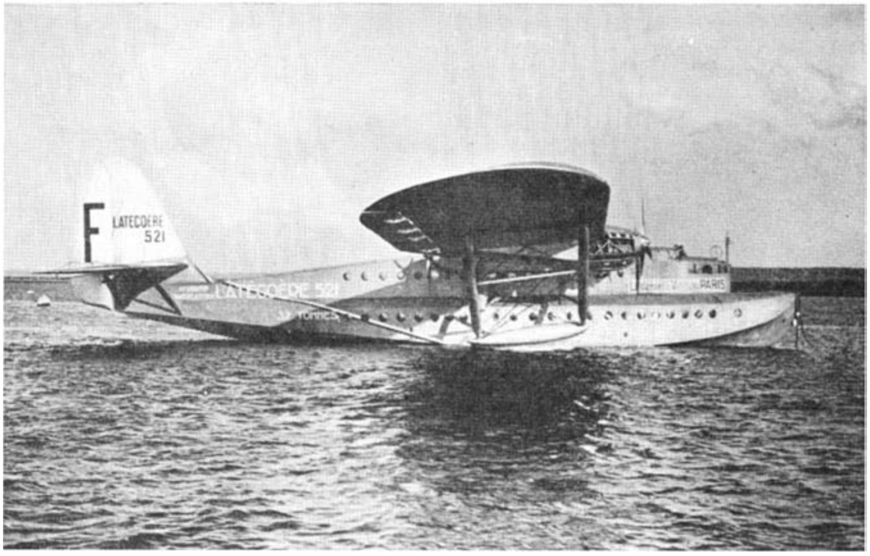
Objects to be tested for surface smoothness are placed on the turntable

Solvent Resistant Gloves

FOR those who work with chemicals, paints, or varnishes, new gloves made by The Surety Rubber Company provide complete protection to the hands. Made of neoprene, they are resistant to the corrosive action of all those products to which neoprene is resistant. They are said to be definitely superior to gloves made of rubber latex or part rubber in their protection against oils, grease, naphtha, turpentine, linseed oil, caustic soda, and many other chemicals and solvents.

The Law of Convenience and Necessity

MEMBERS of the Civil Aeronautics Authority, five in number, have fame and honor thrust upon them. But they also have their troubles. Theirs is the very difficult task of granting certificates of convenience and necessity for proposed air routes. There is no longer a question of inducing a government department to establish mail service and then to grant a contract for that service on a basis of competitive



Eight years old, the *Lieutenant de Vaisseau Paris* is still in service

bidding, solely, without regard to other considerations. Now, as Chairman Robert H. Hinckley points out, much sounder methods are in vogue. He defines the granting of certificates for air routes in the following words: "The law applies the familiar doctrine of convenience and necessity. Under that doctrine, in general, an applicant must show that in the territory to be served there is sufficient potential traffic to justify the service, and that the applicant is fit, willing, and able to perform it. We believe that the law requires proof that a proposed operation can eventually develop mail, passenger, and express revenue to the extent of assuring that the new line will not become a burden either upon the government or the community or the corporation proposing to operate it."

A mass of new applications is even now before the Authority, with a gridiron of proposed new airlines. A tabulation of 48 applications from 24 different air services indicates that should all applications be granted, a total of almost 14,000 route miles would be added to the existing system of approximately 35,000 miles. Nothing gives a better picture of the enormous scope of our transport system. — *A. K.*

Equipment for Safety in Air Transport

When people speak of aeronautical research they generally mean research in aerodynamics, in the light properties and structural strength of the airplane, in greater engine reliability. Certainly such research is of fundamental importance, and it is also the most fascinating branch of aviation research. But, as Paul Johnston, Editor of *Aviation*, pointed out in a recent paper presented at the Aeronautical Session of the National Safety Council, there is another type of research which is conducted by the airline operators, individually or in co-operation, which is not so recondite, not practiced by mathematicians or physicists, but is of equal importance as far as airline safety is concerned.

Thus, in conquering ice formation on the airplane, we find Goodrich continually improving its "over-shoes" or wing de-icers. Non-icing carbureters of the Chandler-Groves type are in service and being continually improved by the airlines. Windshield wipers, with alcohol and other non-freezing mixtures mechanically distributed over the windows, is another subject of investigation. Improved fluids and methods for protecting the propeller against ice are now available.

Radio developments are innumerable, and so well advertised that we need hardly touch upon them here. But there is a long list of other safety devices, some of them of humble character, which may not be as well known to our readers. Thus, upholstery and furniture fabrics in the airplane are being fireproofed. Birds have struck and broken windshields time and again; accordingly, windshields are being reinforced. One transport company is testing bullet-proof glass for use in its windshields. The N.A.C.A. or venturi engine cowls are being built of stainless steel to withstand corrosion and the effects of high temperatures. Cockpits are being improved so that controls can never jam. Hydraulic-pressure bench tests on engine cylinder heads are carried out to warn of possible failure. Metal particle detectors are inserted in engine lubrication lines, where such particles may cause serious damage. Bolts, nuts, and studs on plane or engine may be tightened up too much or too little; instead of relying on the skill of the mechanic, torque control wrenches are being put into service.

The list could be continued. Any new safety idea is welcomed and investigated if it seems reasonable. Designers and inventors still have a fertile field ahead of them in airplane safety equipment. — *A. K.*

Flying Boats Have Longer Lives

We have read so much of the achievements of Pan American Airways, with the new Boeing Clipper, in establishing the first north Atlantic air service, that it is hardly necessary to comment further on this historic subject. Less spectacular but also interesting is the recent flight of the French flying boat, *Lieutenant de Vaisseau Paris*, from Port Washington, Long Island, to Biscarosse, France, in 34 hours and 14 minutes. There are two reasons why this flight is of interest. First, it is part of a series of survey flights being made by Air France. Evidently European companies will not leave the field solely to Americans. Second, the *Vaisseau Paris* is eight years old, and is one of the largest flying boats in the world. We used to think of aircraft as fragile vehicles, short lived due to depreciation or obsolescence. The French boat has seen continuous service in various parts of the world, yet is still going strong. Perhaps the day will come when large flying boats will achieve the longevity of the ocean liner. — *A. K.*

Sodium Lights for Safer Landings

When fog and haze blanket an airport, flight operations may be crippled. Radio may bring the pilot accurately to the airport, and a combination of radio and altimeter may bring him down "blind." Still, the average pilot would rather see in the last stages of his flight than trust to instrumentation alone. Engineers of the Westinghouse Electric and Manufacturing Company have now introduced a new contact lighting system which holds great promise for operations under poor visibility.

In this new lighting system, three green incandescent lights, placed flush with the ground, indicate to the pilot the beginning of the runway. Then, at 100-foot intervals, sodium contact lights of amber color, spaced on each side of the runway, indicate that the plane is over the first 1000 feet or more of the runway. The final 3000 feet of the runway is distinguished by white incandescent contact lights, and at the far end of the boundary there are three more green

Inserting one of the sodium lighting units used as airport markers

lights. Such oppositely placed lights mark out the runway in splendid fashion.

Besides the actual arrangement of the lights in relation to the runway, two advantages are claimed. The use of sodium lights increases visibility under foggy conditions. Field tests at Akron indicate that the sodium lights were visible at 410 feet, when incandescent lights were only visible at 35 feet. Again, all the light emitted from the system is at an angle of from zero to ten degrees above the horizontal, so that all the light is emitted in the direction of the pilot's eyes. — *A. K.*

Exhaust Heat To Prevent Icing

Ice formation in flight still remains a serious problem, in spite of the strides that have been made in preventing it. A technical note of the National Advisory Committee for Aeronautics states that the Goodrich de-icer (which removes ice forcibly and mechanically from the leading edge of the wing) does not function satisfactorily under some conditions. It has been frequently suggested that exhaust heat from the engine might constitute a fine "anti-icer," and now experiments by the Committee indicate that the idea has possibilities.

A model all-metal wing of six foot chord was placed in a refrigerated wind tunnel, in which the temperature was kept at 20 degrees, Fahrenheit, and where a wind velocity of 80 miles per hour was available. Natural precipitation was simulated by admitting water to the air stream through a spray nozzle. Electrically heated air was led through an air duct inside the wing, and a fan was used to circulate the air inside the wing.

The results of the experiment, though preliminary in character, were satisfactory. Ice formation was effectively prevented by maintaining a skin temperature of 200 degrees, Fahrenheit, over the leading 10 percent portion of the wing. The temperature in the duct varied from 360 to 834 degrees, Fahrenheit. Heated air velocities in the duct varied between 45 and 152 feet per second.

Similar conditions could be realized by leading exhaust gases from the engine through the actual wing of an airplane. Let us hope that either the Committee or some venturesome engine constructor will carry out a similar experiment in actual flight.

—*A. K.*

No Order of Less than a Million Dollars

THE airplane industry flourished during the World War, almost perished of inanition after the armistice, had a boom period in 1929 or thereabouts, and then again fell on very bad times. Now all airplane manufacturers, particularly those building military and naval aircraft are flourishing and receiving large orders. It is being said jokingly in the industry that no order under a million dollars will be accepted. For example, Curtiss-Wright in its Buffalo airplane division received recently an order of $12,872,398 for a large number of P-40 pursuit planes, an example of which is shown in one of our illustrations. Some noteworthy items appear in the photograph. The liquid-cooled engine is evidently coming into its own; the familiar radial has disappeared in this ship. Oxygen equipment permits long flights in the sub-stratosphere. Fillets between wings and fuselage are very large. The vertical tail surfaces are disposed below and above the stabilizer, as a precaution against spinning. The Pitot tube for the air-speed indicator is placed toward the tip of the wing and well ahead so as to be free of interference. The cockpit has perfect visibility. All performance figures are withheld, but it is quite clear that our designers are producing excellent military aircraft.

—*A. K.*

$12,872,398 worth of these P-40 pursuit planes have been ordered

PETROLEUM

THE fields of Texas, California, and Oklahoma alone have produced more oil to date than have all the fields in Russia.

Liquid Coal Drives A Car

EXHIBITING the startling possibilities of their newest development, liquid coal, scientists of the Research Foundation of Armour Institute of Technology recently showed how it was possible to operate and drive a 1939 stock model automobile, a Pontiac, on coal. This newest development in research is credited to Dr. Francis W. Godwin, Director of the Coal Research Division of the Foundation.

The most amazing part of the entire demonstration is found in the fact that the test with coal was made on a standard car engine without any changes of any kind in carburetion or in the ignition system of the motor, with the exception of the removal of one fine-screen filter.

According to Dr. Godwin, three different types of colloidal fuel have been used successfully in the tests on the stock model automobile to date. The first of these fuels was a suspension of a specially prepared coal, ground to 300 mesh, in a mixture of gasoline, fuel oil, and lubricating oil. The second test with the "liquid coal" was made with a suspension of the coal in a Diesel oil. The third test was made with a suspension of the coal in a very light oil. The more recent test and demonstration was carried out with a more elaborate preparation of the fuel. A very light oil, or a form of range oil with a light fraction of hydrocarbons, was used as the vehicle, followed by special treatment with the coal, resulting in the suspension of coal of about 500 mesh.

Stoking liquid coal in a motor car

In each case, before the liquid coal was introduced into the auxiliary fuel tank on the automobile, it was chemically stabilized in order to hold the coal in suspension.

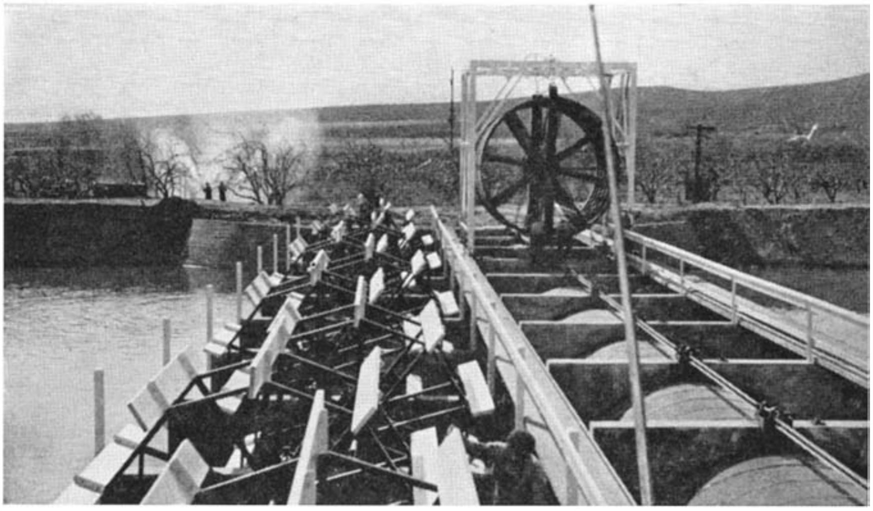
After the liquid coal had been prepared according to the process developed by the scientists, it was introduced into the auxiliary fuel tank. The automobile was then started on gasoline and, after smooth running conditions had been attained and the motor had "come up to driving heat," the fuel system was changed so that the gasoline supply was cut off and the liquid coal introduced in the carbureter. Thereafter the engine ran on liquid coal, and the car ran without undue strain or sluggishness.

Although liquid coal is not a product that is ready for the market or, more specifically, ready for consumer use in automobiles, the possibilities as shown by the demonstration are important. Especially is this fuel desirable for the home owner who has been concerned with the problem of heating. It was pointed out that this fuel has been used in many types of domestic and commercial oil burners during its development, and that the heat value per cubic foot, as proved by these tests, is considerably more than either coal or oil alone. It was pointed out that the new fuel will make use of the tremendous amount of "fines" which are at present a waste product at the mines—a waste product which the coal producers often cannot even give away.

Brilliant Blue

COPPER phthalocyanine, one of a new group of synthetic dyes and pigments which was recently described by M. A. Dahlen, of E. I. du Pont de Nemours and Company, is a blue dye of remarkable brilliance, tinctorial strength, and fastness. It is replacing iron blues and various basic color lakes in printing inks, and ultramarines in paints, lacquers, and enamels. It is also being used in producing coated and printed textiles, coated paper, colored linoleum, and in rubber to produce any shade from deep reddish blue to greenish pastel.

One difficult problem solved by the pigment was the provision of a suitable blue



Above and below: Two views of the rotary fish screens in the Yakima River, described below, in which paddle wheels turn the cylindrical barrier screens

for three-color printing. Another application is in the production of an exterior paint. The new paint does not have the tendency of previous blue-tinted paints to fade quickly when exposed to sunlight.

Rotary Fish Screens Guard Young Salmon

WORK was completed recently on what is declared by Washington State authorities to be the largest battery of rotary fish screens in the world, installed across Wapato ditch at Parker, near Yakima. WPA's participation in the project involved supplying the labor, for which $35,400 in Federal work relief allocations were invested.

These screens were designed to prevent young salmon, en route from headwaters of the Yakima River to the Pacific Ocean, which find their way into the huge ditch, from going into the irrigation laterals to destruction.

A battery of ten cylindrical screens spans the entire width as a barrier in the ditch. Each screen is 12 feet long and 13 feet in diameter. The flow of water in the ditch turns separate paddle wheels directly connected to each cylinder. Continuous turning prevents the screen from being clogged with mud and debris. By-pass channels lead from a bank of the canal, just above the screens, back to the river, to allow the salmon fingerlings to continue their journey to the ocean.

United States Bureau of Fisheries experts and other fish authorities state that the general instinct of the salmon is to return to spawn as an adult to the stream of its origin. The Indians foresee even a more happy fishing ground than in generations past, as a result of the fish screens.

Rub-less Metal Cleaner

A NEW metal cleaner that instantly removes, by chemical action, stains and oxides from chromium, copper, brass, silver, and other metals, has been announced by Rapid Electro-plating Process, Inc., to be sold under the name of "1-Second" Metal Cleaner. It is applied with a brush and immediately wiped off; no rubbing is required.

The new liquid cleans hard-to-reach places, does not soil hands, and has no offensive odor. It is said to contain no caustic; is non-inflammable; will not etch or harm metals; has three to five times the covering power of ordinary polishes; and, since it can be applied with a brush, will clean surfaces inaccessible to hand-rubbing methods.

The cleaner can be supplied either with or without abrasive and is designed not only for use in public buildings, households, and automobiles, but also for industrial operations where it is possible to wipe off excess cleaner after application.

BREATH

THE average human being exhales three pounds of carbon dioxide gas per day. To break down this exhaled gas and return oxygen to the atmosphere three large trees are required.

Nuts

A NUT is an "indehiscent, polycarpellary one-seeded fruit with a woody pericarp, developing from a syncarpous ovary." The acorn, hazelnut, and chestnut are true nuts, as are walnuts, pecans, hickory nuts, butternuts, and beechnuts. But by more popular definition, a nut is any hard-shelled seed that contains a kernel that is easy to nibble and has a pleasant oily flavor, and includes the following *seeds:* coconuts, Brazil nuts, almonds, cashews, pistachio nuts, pili nuts, paradise nuts, pine nuts, pumpkin seeds, water-lily seeds, sunflower seeds, and the versatile peanut.

The pecan nut, produced as a $6,000,000 per year orchard crop in Georgia and from native trees in the Southwest, is being grown in such quantities that new uses are being sought, particularly for imperfect kernels. Recently, Professor T. H. Whitehead, of the University of Georgia reported to the American Chemical Society what is known of this nut, and suggested industrial uses for its component parts. Pecan oil has a bland odor and taste, and, having marked stability against oxidation and even sunlight, has been suggested for use as a salad oil and in cosmetics. Delicious cookies and cakes were made from a base of flour and pecan meal, from which the oil has been expressed, and development of a similar pecan breakfast cereal appears to be under way.

Industrial use of the pecan is predicated on the success of a new flotation method of separating the kernels from the shells of the cracked nuts, by agitating the mass vigorously in a salt brine, after which the kernels float and the shells sink. This may mechanize an industry hitherto peculiarly dependent upon cheap hand labor. Unfortunately, the method recently developed in California for automatically cracking walnuts by miniature explosions cannot be applied to pecans. It will be recalled that in this method a mixture of acetylene and oxygen is fed through a cut into the air space (which the walnut alone provides), after which the mixture is ignited by an open flame. [This was described in Scientific American, April 1939.]

The per capita consumption of peanuts is about eight pounds per year, in the shells, and the farm value of the crop is around $45,000,000. The peanut accounts for fully $200,000,000 worth of business per year in all its aspects. About one fifth of the crop is crushed for oil, and much larger amounts are "hogged off" or otherwise used as stock feed. California produces $4,500,000 worth of almonds and $10,000,000 worth of walnuts annually; and Oregon some $500,000 worth each of walnuts and filberts. Two of the best-flavored of all nuts, the hickory nut and the butternut, are not commercially significant, but are the property of the small boys of the land.

New nuts are added from time to time. Out of exotic Hawaii now come limited quantities of the macadamia nut, a delicacy to tempt the palate of the epicure. Cashew nuts were introduced into America not many years ago by an enterprising and imaginative food chemist, who found them in wide use in India. The cashew is a relative of the poison ivy and Japanese lacquer plants, and parts of the cashew plant, if touched, would poison most people, yet the nut kernel, after being French-fried in hot fat, is a delicious tidbit, notable for its tenderness and sweetness. While at present the cashew nut is being exploited almost entirely as an edible nut (30,000,000 pounds per year of the kernels are consumed), the shell contains a substance which may eventually become more important industrially than the kernel itself. This substance is a resinous liquid which, when chemically treated, forms products which are of marked utility in the plastics industry.

The almond is practically a soft-shelled peach-stone that has a pleasing high-protein kernel. Few other nuts have more than 10 or 15 percent of proteins, but contain from 40 to 75 percent of fat and small amounts of starch and sugar. Pecan meats are the richest in fat of all nut meats, with Brazil nuts, filberts, and walnuts not far behind. Nuts are a highly concentrated food, and an especially good source of the vitamin B complex.

The coconut tree is credited with being by far the most valuable of all the food trees of the world, and is of vital importance in the tropics. The prosperity of the South Sea Islands rises and falls with the demand for copra, or dried coconut meat, which is the source of coconut oil. This oil is used in immense quantities for soap-making and in oleomargarine, and the residue is valuable concentrated cattle food. Because of excise taxes placed on such oil-bearing nuts as the coconut and palm kernel, other nuts with strange names are finding a large North American market. In this group are the babassu nut, the cohune nut, tucum nut, ouricury nut, and the murumuru nut, all South American.—*The Industrial Bulletin* of Arthur D. Little, Inc.

WOOL

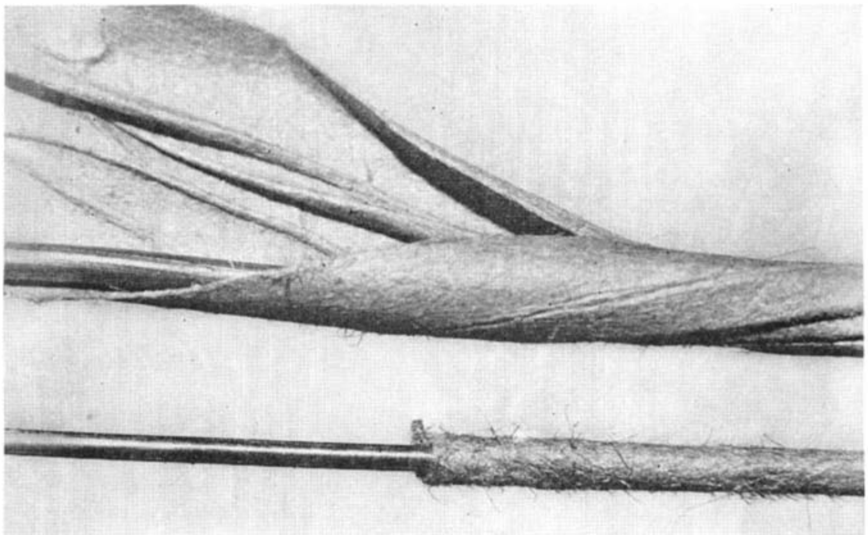
TWENTY-five million pounds of wool, the product of 3,000,000 sheep, are consumed by the automobile industry in an average year.

Digestibility of Straw

STRAW contains large quantities of carbohydrates which can be only partially digested by farm animals. Various attempts have been made to increase the digestibility of straw by some pre-treatment.

In the course of an investigation of the problem, oat- and wheat-straw were treated with caustic-soda solutions of varying strengths and for varying lengths of time.

Best results were obtained with a 1.25 percent solution and an immersion period of 20 to 24 hours without heating. With



Old and New: Spiral paper (top) and new molded pulp wire insulation

the volume of solution used, this represented 10 pounds of caustic soda per 100 pounds of straw. The starch equivalent per 100 pounds of straw was more than doubled by the treatment.

Treated oat-straw fed to fattening bullocks resulted in a daily livestock gain of just under two pounds over a period of 62 days.—*Nature.*

Molded Paper Insulation

USING a new process of producing paper insulation *on* a telephone wire instead of wrapping it around afterward, engineers of the Western Electric Company have just created a cable containing 4242 separately insulated copper wires.

The previous top in wire packing was 3636 wires to a cable 2$\frac{5}{8}$ inches in diameter. The new cable is no larger but contains 606 more wires.

The heart of the new development is a process for forming paper pulp directly on groups of 60 wires passing through a bath of pulp. These strands are twisted two wires to a pair and assembled into the cable which finally is dried out in vacuum ovens.

The saving in insulation thickness per wire is only three one-thousandths of an inch but when repeated 3636 times in a single cable it results in room for 606 more.—*Science Service.*

Asphalt Aluminum Paint

ASPHALT, tung oil, and aluminum paste have been combined in a recently announced paint which is said to be suitable for either inside or outside application. The paint comes ready mixed and may be applied direct from the container.

Industrial Pump Made of Glass

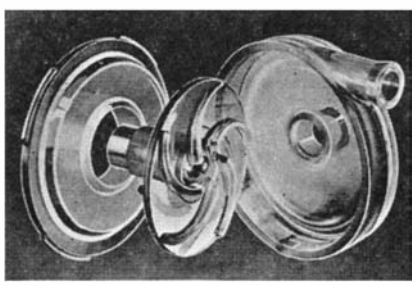
HANDLING of commercial quantities of corrosive acids and chemical fluids has long been one of the most difficult problems of the chemical engineer. Many of these fluids quickly destroy metal pipes and pumps, and thus make some processes costly. Also, minute traces of corrosion impurities may completely change chemical reactions and hence the resulting product.

Pipes of glass have for many years solved the problem of conveying corrosive liquids, and now a pump of glass, perfected by Corning Glass Works, marks a further step in the safe and economical handling of such liquids.

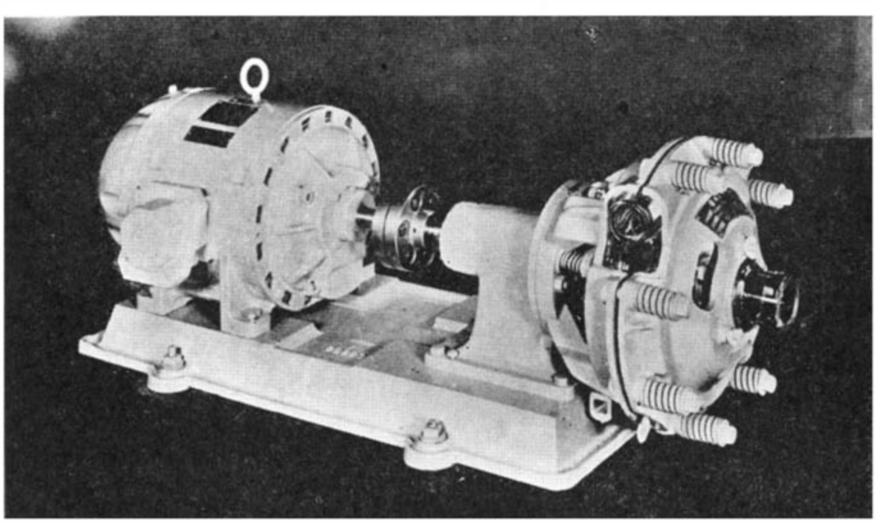
This new pump is of the centrifugal type. Not only the casing, but also the rotating impeller, and all parts in contact with the corrosive liquid are of clear, chemical-resistant glass. The rotor is accurately balanced, and, running at high speed without appreciable vibration, the pump readily handles 6000 gallons of acid or other liquid per hour and will deliver it 70 feet above the suction level.

Neither boiling temperature nor strong acids affect the glass of which this pump is made. The problem of pumping hot hydrochloric acid can thus be solved economically for the first time.

So clear is the glass used that the interior of the pump may be watched while it is in operation. Should cleaning be required, the whole interior of the pump can be laid open in a few minutes. All acid solutions (except hydrofluoric or glacial phosphoric acids) may be used without fear of pitting or injuring the hard chemical Pyrex brand glass surface. Reassembly after cleaning is quickly accomplished and the proper adjustment of parts is practically automatic.



Above: Glass casing, impeller, and back plate of the new industrial pump. *Below:* The pump assembled with direct-coupled driving motor



STOP, LOOK, LISTEN

APPROXIMATELY 35 percent of accidents at highway-railroad grade crossings during 1938 resulted from operators of motor vehicles crashing into the sides of trains.

Clay Film Substitutes for Mica

DEVELOPMENT from common clay of a film which looks like celluloid or Cellophane and which can be stored in water for an indefinite time without deteriorating, was announced recently at the Sixteenth Colloid Symposium of the American Chemical Society, at Stanford University, by Professor Ernst A. Hauser of Massachusetts Institute of Technology and Miss D. S. le Beau of the Dewey and Almy Company.

In sheet form, the new material, Professor Hauser declared, promises to supplant sheet mica, a strategic military material, important in insulation, which the United States has to import from foreign countries in thousands of tons annually.

The water-resistant quality of the new film is the result of research just completed, Professor Hauser said. The first self-supporting, coherent sheets made from pure clay about a year ago swelled and finally disintegrated in water. Called "alsifilm," the material nevertheless had many "amazing" qualities, according to the chemists. Being entirely composed of inorganic matter, it was non-inflammable and would stand extremely high temperature without decomposition. It was resistant to oil and organic solvents in general, as it basically contained aluminum or magnesium silicates. In dry condition, it exhibited very satisfactory electric insulation properties, which, however, dropped rapidly as soon as the film picked up traces of moisture.

The new water-resistant film overcomes this drawback and retains all of the good qualities of the first clay film. Both in regard to its general properties and its actual composition, the material, Professor Hauser pointed out, is comparable with mica.

The alsifilm can be produced in any desired size and thickness and can be made decidedly more flexible than natural mica.

RAILROAD TRUCKS

AMERICAN railroads have 53,000 motor trucks in terminal transfer, inter-city, and store-door delivery service. This number of trucks exceeds the number of locomotives operated by the railroads.

Electric Office Secretary

A MECHANICAL secretary which takes dictation, writes letters that talk, answers the phone, records business deals and conferences, reads the boss to sleep, and acts as watchman, has been produced by a Hollywood manufacturer. With the aid of attachments covered by 52 patents, the machine performs additional duties which have heretofore been in the domain of teachers, salesmen, detectives, reporters, nurses, and others.

The machine, briefly, is a voice recording and reproducing unit as light and compact as a portable typewriter. It records 7800 words (ten average-sized letters) on a collar of Cellophane-like material which costs five cents and is so thin that three of them (containing about 25,000 words) can be folded into an envelope and mailed for a three-cent stamp. A supplementary device makes "carbon copies" or multigraph copies from the original letter when required, by a process similar to that used by phonograph manufacturers in transferring the first or "master records" to the permanent wax copies; that is, by the impression method.

These records last indefinitely and may be folded flat and filed, to be played when needed. Or they may be transcribed onto typewritten pages by a stenographer using either loudspeaker or headphones.

Adapted to 110 volt direct current, the

Records made by the electric secretary are thin, flexible, mailable

Talking Letters can be reproduced through earphones or loudspeaker

device plugs into the regular electric outlet, or may be operated on auto batteries. Thus the salesman or executive may save himself the work of report writing while traveling, and the expense of taking a secretary with him, since the machine, of course, travels free on busses, trains, planes, and boats and will be on hand 24 hours of the day to take down the thoughts of its owner. It is of light, all-metal composition, 8 by 10 by 10 inches.

The voice-recording method used for the new device is an improvement on motion picture processes used for the same purposes. Dispensing with the photoelectric cell and chemical processes, which the studios use, it obtains its results through a simple electric method—a diaphragm which responds to sound waves, an amplifier which boosts these vibrations 477,100 times, and a stylus which impresses them instantly and permanently on the recording surface.

The Cellophane-like collar upon which the sound is recorded is only three one-thousandths of an inch thick, but a strong man could not tear it. It is composed of a wood fiber treated by a gelatin process which renders it as readily foldable as paper while retaining a toughness like that of silk. Without further processing the Talking Letter may be immediately played back, or "read" by the recipient.

Since the machine will record ordinary conversational tones within a radius of 20 feet, it is possible to record a business conference or discussion participated in by a roomful of men.

At newspaper offices, with the personnel busy, the machine may be hooked up to the telephone to take down stories phoned in by reporters, saving the stenographer and obtaining an error-proof record. In hospitals, with the aid of ear-phones, a patient may be read to sleep without disturbing others in the same room. Foreign languages and music may be taught by mail with the same efficiency as personal contact. The actor can hear himself as others hear him. The tourist can save himself tedious scribbling on post cards, by recording voice pictures on the spot of the wonders he is seeing, and mailing the letters forthwith.

Germicide Protects Sporting Equipment

THE problem of sterilizing and deodorizing sporting equipment long has troubled proprietors of skating rinks, gymnasia, and swimming pools. Taking a tip from the WPA., many now are using Wyandotte

Steri-Chlor, an effective germicidal agent that may be applied in powder or liquid form.

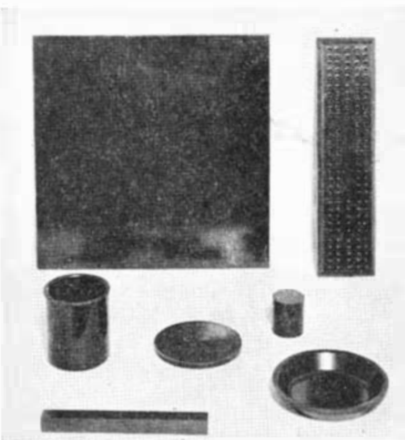
Experience of the federal government has proved that this product is excellent for disinfecting boots that are worn by many workers. A half-teaspoonful, sprinkled inside each shoe, retards the spread of athlete's foot and similar diseases.

The product is stable and will maintain uniform strength. When used in solution, its active ingredients are effective at high or low temperatures, providing the highest degree of sanitation.

Because it harms only germs, it is widely used in sterilizing fountain and dairy equipment. This fact also recommends its use for protecting all types of sporting goods.

Plastic Compound from Sugarcane Bagasse

A PLASTIC compound made from the lignin and cellulose of sugarcane bagasse, one of the country's important agricultural waste products, has been manufactured by chemists of the United States Department of Agriculture at the Agricultural By-Products Laboratory, Ames, Iowa. The chemists estimate that this new compound



Sugarcane bagasse plastic may be molded in a wide variety of forms

can be manufactured for less than half the cost of the cheapest synthetic plastic compound now on the market.

Molding compounds may be made from the bagasse by three methods. The first, and cheapest, is hydrolysis with acid. Counting the cost of bagasse at eight dollars a ton, baled and delivered at the factory, the chemists estimate that a plastic compound can be made by this method, in which the cost of material will be slightly more than two cents a pound. Plastics made from the compound, while not so strong as some synthetic products now in use, are quite moisture resistant and would be suitable for molding bathroom tile for both floors and walls. They apparently have the wearing ability of wood and may be sanded and re-polished through the entire body.

The second method is hydrolysis in the presence of aniline, a coal tar derivative. The material cost of plastics from this process will be more—about 4½ cents a pound—but they are as strong as plastics now in use. In tests it has resisted bending pressures up to 9000 pounds per square inch. They are slightly less water-resistant than plastics made by the first method, but do not warp and may be sawed, drilled, and, with care, nailed. These properties suggest uses as card table tops, desk tops, and building panels.

Treating the bagasse with sodium hydroxide and furfural is the third process. In quality, plastics from this method are about midway between the other two. They flow better and mold at 2500 pounds per square inch compared with 3500 for the second treatment. They may be put to the same uses as the plastic from the second treatment.

Either of the plastics made from the last two processes do not shatter easily. In fact, neither breaks when struck hard enough with a hammer to cause a dent.

It is possible that other farm waste materials, such as cornstalks and straw from small grains, may be used in making plastics by the same processes, the chemists report.

TOLL

DURING 1938 in the United States there was one accidental death every 5½ minutes. Non-fatal injuries suffered in accidents occurred one every 3 seconds.

JUDICIOUS JIGGLES

VIBRATION is like a sirloin steak in that it can be one man's meat or another man's poison. Many engineers are troubled with machines that shake too much; others are spending their best efforts in building mechanisms for the sole purpose of creating vibration, but vibration whose intensity and frequency are under continuous control. There are numerous points in industry, notably in the fields of construction, mining, chemical processing, and conveying, where a little judicious jiggling or even severe shaking is a necessity, declares the *Industrial Bulletin* of Arthur D. Little, Inc.

When these vibrating tools are electrically operated, the source of power is generally a magnet, for it lends itself to mechanisms which are simple in construction, with few oiling points, and with correspondingly few points to wear or cause trouble. The ruggedness of such tools is indicated by the fact that a large outlet for them is in hammers used to break and drill concrete. The electrical method offers savings in weight and freedom from auxiliary equipment.

The conveyor line is a frequent user of magnetically induced vibrations. Not only will relatively tractable materials like sand move smoothly down a properly oscillated trough, but also obdurate objects such as dog biscuits or metallic fasteners which, under ordinary conditions, may not "flow" at all. Although the eye sees only a uniform progression, the goods are actually thrown forward in a series of small, rapid jumps. (The dog biscuits—and articles less inherently humorous—will move as steadily up a slight incline as they will on the level, and vibration conveyors are often so used.)

By means of a rheostat, the rate of feeding can be varied from, say, 10 tons per hour, as in one application in a smelting plant, to a slow dribble. Vibrating conveyor feeders are particularly useful in conjunction with automatic weighing devices, because the close control possible allows an operator to feed rapidly until the scale beam trips, then to stop the flow of material instantly.

In spite of the wide use of magnets in other fields and the accumulation of much empirical data, there are no comprehensive formulas which permit the ready calculation of optimum dimensions for a given condition. Experience during the past decade, therefore, has led to steady improvement in details and to the exertion of progressively greater forces for the same movement of the magnet armature. A more basic improvement has been the application of "power pulses" to energize the magnets. Engineers attempting to avoid vibration, strive for a smooth, steady flow of power through their apparatus; builders of electromagnetic vibrators want, and have obtained, power that comes in spurts. The simplest way to supply the magnets with oversized "quantums" of energy separated by periods of no current flow is to use so-called half-wave rectified alternating current (produced by passing alternating current through some electrical valve that allows current moving only in one direction to pass through it).

A recent and important advance is the use of pulses created by condenser discharges, a method that allows great flexibility in the frequency at which the pulses are supplied. Developments in large capacity electronic tubes permit the original source of power to be either alternating or direct current, and in this manner make control of the condenser discharges commercially feasible.

The icy permanence of print makes the prediction of applications for this increased versatility a dangerous pastime, but magnets are already shaking screens in many process and mining industries. Electrically vibrated screens have been found particularly resistant to "blinding" or wedging of the material between the wires.

Vibration is necessary in making pulp fibers mat into a sheet of paper; it is also being used in the placing of concrete. Satisfactory consolidation can be obtained with lower water-cement ratios than is practicable with hand-placed mixes, and physical properties are correspondingly better. Artificially induced vibration has even proved to be a valuable means of testing laboratory specimens and completed structures such as bridges, buildings, and water tank towers. Oscillators are attached to the structure, and measurements are made of energy input and the degree of dampening. From the readings can be deduced such dynamic properties as endurance limits, periods of resonance, and the existence of structural defects.

In these cases, as in most others where vibrations are deliberately created, no random shakes will do, but it is necessary to provide oscillations which can be adjusted to meet variations in the conditions or to give optimum results.

Copper-bearing Cement

A COPPER-BEARING cement, recently announced, appears to have possibilities of great usefulness in making "composition" floors, stucco, and mortar for tiles and glass brick, reports *Highway Research Abstracts.*

Finely divided copper incorporated with "caustic" magnesia (not the dead-burned MgO) and mixed with a solution of magnesium chloride, produces in the mixture a synthetic mineral that has good resistance to weathering. Thus compounded, the product possesses the advantages of flexibility, resilience, and adhesiveness without the disadvantages of poor weathering, efflorescence, and incompatability with lime.

Strength of the cement is high—several times that of Portland. The two materials do not compete, however; the copper-bearing cement, because of its higher cost and high heat of setting, is not intended for massive work; it supplements Portland cement.

How admirably the cement supplements and complements other building materials is indicated by a statement of some of its properties and uses. It is not damaged by water. It bonds perfectly with a great many substances; for example, its adhesion to sandblasted glass is more than 100 pounds per square inch. It can be troweled, brushed, or sprayed into position. Setting is very rapid. As a masonry paint it allows the material underneath to "breathe." And it will take almost any kind of filler or aggregate: sawdust, marble, asbestos, or what not.

FUEL

THE giant turbines of a luxury liner use almost 32,500 barrels of fuel oil on a transatlantic crossing.

Midget Marine Radio Telephone

FOR the safety and convenience of those thousands of yachtsmen who put out to sea in small boats, the Western Electric Company is introducing a low priced, midget marine radio telephone so simple to operate, so reliable and small, that it may be compared with the familiar telephone ashore.

The little instrument is designed to link those aboard the craft with the telephone system on land, with the Coast Guard, and with other radio-equipped boats.

To make a call with the new instrument, the user merely turns an "on" switch which places the equipment in operation, presses a "talk" button contained in the handle of the handset, and gives the telephone operator the number desired. Calls coming from shore, or from other boats, are signalled by a loudspeaker contained within the instru-

For reliable marine phone service

ment. The loudspeaker may be switched off during the subsequent conversation.

Provision may be made also for "selective calling." A boat so equipped is assigned a number, and its equipment maintains a continuous, silent watch, to receive only calls that may be directed to it. When the shore station operator dials its number, a telephone bell rings exactly as on land.

Built in a single, self-contained unit, and designed to occupy less space than a small overnight bag, the instrument is easy to install. Radio transmitter, receiver, power conversion pack, and built-in loudspeaker are all assembled in a special metal cabinet that is finished to resist corrosion, and only three electrical connections are required for installation: the antenna wire, ground, and power supply.

The device may be operated from a six or twelve volt battery or it may be simply adjusted for use with other voltages. The transmitter operates on any one of four crystal-controlled frequencies. By merely changing the quartz plates, frequencies other than those originally selected for the transmitter may be substituted, within the range of the equipment. No further tuning adjustment is required when making the change. The receiver, too, may be crystal-controlled if desired, which eliminates the inconvenience of "fishing" for incoming calls.

Specially trained personnel is not required to operate the equipment. The regulations of the Federal Communications Commission permit the operation of radio telephone equipment in marine service by persons holding a third class radio telephone operator's license which calls only for an elementary knowledge of the radio laws and regulations, and familiarity with the method of operating the equipment.

Paint on a Water-Beaded Surface

Ordinarily, paint must be applied to a dry surface to furnish a satisfactory and permanent finish. This rule need not always be followed, say the manufacturers of Wet-X-Hale paint. They claim that their product will adhere perfectly to wet surfaces, as well as dry, and will eliminate the need for temporary shutdowns or interruption of working hours due to wet surfaces.

The manufacturers state that the mate-

New paint covers a wet surface

rials used in this paint will absorb moisture from the surface being painted, the moisture appearing almost instantly on the paint surface, from which it evaporates. The paint sets and dries with a non-water-reversible film. All colors and numerous types are available for various purposes.

New Steam Generator Tube

A POWERFUL steam generator no larger than an incandescent lamp, and similar in appearance, has just been announced by the Westinghouse Lamp Division, Westinghouse Electric & Manufacturing Company. With a thermal efficiency of 90 percent because the heating coils are directly immersed in water, this flash-type of heater can generate superheated steam from cold water in less than 15 seconds. It is made in 1000-, 1500-, and 2000-watt sizes, with evaporating capacities up to 5.7 pounds of water per hour, and can superheat steam to 350 degress, Fahrenheit.

The cylindrical case of the diminutive steam boiler, 9¼ inches long over all, is made

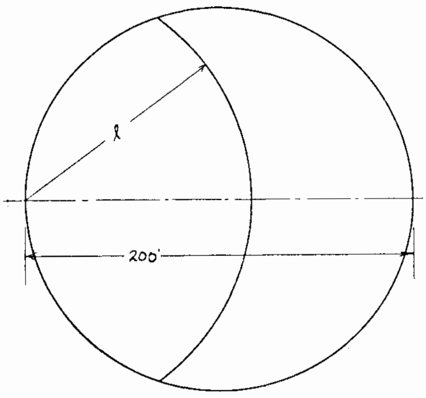
Midget electric boilers generate steam after 15 seconds of operation

of transparent glass, capable of withstanding an internal pressure of 25 pounds per square inch. It is provided at one end with two heavy electrical terminals, sealed directly into the glass. The chemical-resistant glass is capable of withstanding mechanical stress and will also withstand being transferred instantaneously from cold to boiling water, or vice versa, without cracking. A threaded pipe is sealed into the opposite end of the envelope as a steam outlet. Resistance wire coiled on an insulating core occupies most of the interior of the heater, leaving, in fact, space for but five ounces of water at a time.

The generator may be used for many purposes for which either no steam supply has been available or where the economy or convenience of the new method of steam generation is outstanding. The steam generated by the new device may be used for the sterilization of dishes, glassware, instruments, utensils, clothing, cloths, toilets, and furniture. It may be used in the process of steam distillation often necessary in chemical laboratories and in small chemical plants. It will furnish a convenient steam supply for pressure cookers and small steam ovens, and can be used to supply industrial

A Problem for the Mathematical Reader

A FARMER tethers his cow to a stake driven at the edge of a circular pasture, 200 feet in diameter. How long should the



rope be if the cow is to be allowed to graze one half the area of the field?

This problem is offered by Lieutenant-Commander Leonard Kaplan, United States Navy, to readers who enjoy wrestling with things mathematical. No prize is offered for its solution. The correct answer is 115.87 feet but the solution—which is the part having chief interest to the mathematician—will be published in this department next month.

Lieutenant-Commander Kaplan was the author of five problems offered in our April, 1939, number, page 219. The answers were given in the same number, on page 251, but the solutions were not published because they were so long. The solution to the above problem is not so long and will be published. In the meantime, please address all correspondence regarding this problem to Lieutenant-Commander Leonard Kaplan, in care of Scientific American, 24 West 40 St., New York, N. Y., and it will be forwarded unopened.

steam for other small-scale processes. Used as a still, it could produce on short order limited supplies of distilled water for drinking, for garages in isolated places, or for medicinal purposes. The generator can be used to raise the temperature of water to boiling, for dishwashing or for general use as a domestic hot water supply in dwellings.

To Remove Silica From Water

MOST natural waters contain silica which, if the water is used for boiler feed purposes, may react with any calcium present to form a hard deposit of calcium silicate. If the silica content of the water can be kept below five parts per million, the possibility of its concentration and subsequent precipitation as silicate scale is greatly reduced.

Data recently published by the National Aluminate Corporation indicate that silica may be removed from water by treatment with hydrous aluminum oxide and that the oxide may be prepared from sodium aluminate. It was also found that pH control is necessary for optimum results.

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

Kid Pictures

PICTURES of children know no seasons. They furnish one of the most stable subjects in all photography. In any mood, at almost any time, children are "available" for picture-making and need little urging, if any. The matter of dress, too, is hardly of any consequence, their mothers to the contrary notwithstanding. In fact, "dressing up" the children for picture-making is one of the chief problems the photographer has to combat. Not only do the children often appear stiff when subjected to these embellishments, but they fail to behave naturally, with the result that the picture is, in some sense, a failure, no matter how good it may turn out to be technically.

So take your kid pictures when, as, and if the opportunity occurs for unusual shots.

"Gee"

Move close for pictures of children in order to reveal their childish expressions. Avoid contrasty or low-key lighting as much as possible. Don't worry about freckles or lost teeth, but make the most of them. Get them candid-wise or let them pose themselves naturally, in the latter case perhaps aided by a hint or two from you. Babies will give no trouble in this regard because they don't know what you're about anyway.

Don't spare film when the kid shooting is good. Although occasionally you will get just the right expression and pose the very first try, the chances are that you will have to take several in order to afford a selection later on. Any camera will serve the purpose and the use of the enlarging process will make up for any lack of ability to come closer with your particular lens equipment. Where it is found desirable, some diffusion under the enlarger will frequently help to improve the result by softening sharp outlines. Watch out for good backgrounds when you can, but since you cannot always choose, it may sometimes be necessary to shoot against a disturbing background or not to shoot at all. Such a picture as "Gee!", for example, either had to be made as it was or be lost altogether.

Illustrating this piece are a few pictures of children made on different occasions.

"Little Miss Homebody"

"Susie"

"Hi, there"

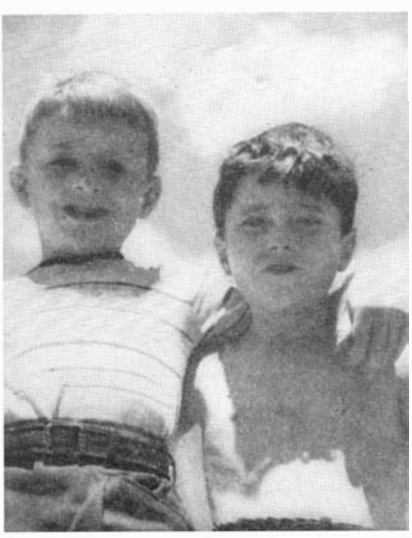
"Hi, there!" was one of those impromptu things that make the photographer's life a happy one. While we were idling with the camera towards the end of a busy picnic day, a mother and her baby, friends of our group, came along to join us. As they reclined on the grass conveniently only a few feet away from the camera, we shot head on from ground level just as the baby was exchanging smiles with someone standing back of us. The pose of the mother's head as well as that of the baby, together with the animation expressed in both faces, seemed made to order.

A week-end visit with friends produced "Little Miss Homebody." One of the secret objectives of the trip was to make a picture of the little daughter of the couple we were visiting, but she was an extremely active child and we had almost despaired. Finally, just as we were about to leave on a few hours' auto jaunt into the country, she sat down in a big chair by a window. There was not much light coming in, but opportunity was knocking and we had to make the best of things. Setting the camera on the window sill to steady it and asking the subject to hold still "for a second" we hazarded a shot at 1/5 of a second, *f*/3.5 lens opening. The negative showed the hands sharp, but the head had moved slightly. The expression and the pose were so charming it seemed a pity to lose the picture just because of a little movement of the head. The solution came in the use of a diffusion lens during enlargement. This effected the desired compromise between the sharp hands and the "soft" face definition, besides affording a pleasant and desirable atmospheric effect.

"Susie" was also enlarged by diffusion, this time in order to minimize the harshness of the high-lighting as well as to assist in reproducing the mood of the subject at the time the picture was made.

"Gee!" was another picnic shot and was one of a group we shot "from ambush." The boy knew the camera was present but appeared to ignore it. At the particular moment this picture was made, he was listening wide-eyed to the sound of an airplane passing by. The person sitting by him moved back quickly so that while the background is somewhat cluttered up, the boy's face and figure predominate. If there were more leisure time than we have at the moment, the paper negative process could be profitably employed in removing most of the objectionable background.

"Pals" was shot against the clouds from an extremely low position. More of the figures was included than shown in the picture, but cropping under the enlarger enhanced the effect by bringing the faces into greater prominence.



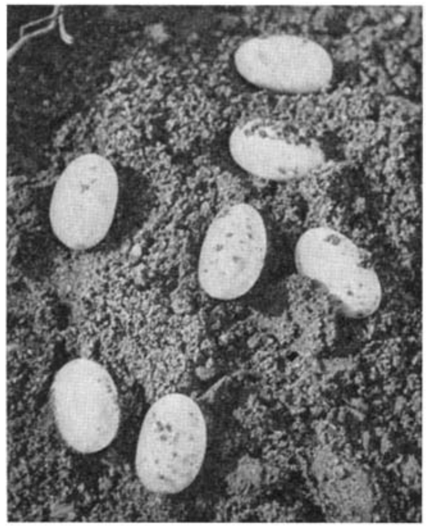
"Pals"

Have You Tried Contrast Filters?

A DARK sky standing out in stark contrast to white clouds is not true to nature, of course, but there is no doubt as to its pictorial effectiveness. The yellow medium filter is still the most useful and the most convenient for the purpose. All we have to do is double the exposure or open the lens diaphragm one stop larger than would normally be required without the filter. But a deep yellow filter, requiring only three times the exposure, when using panchromatic film, or an orange, requiring about four times, or a red, calling for six to eight times normal exposure, will provide more dramatic sky backgrounds, though at the cost of over-correction. The disadvantage of using these contrast filters is the relatively long exposure required, but in these days of very fast film emulsions, snapshot exposures may be had even when using red filters.

For the Naturalist

WHAT'S wrong with this picture of snake's eggs? One person tells us the eggs look very large when as a matter of fact they were quite small, roughly a little under 2 inches in length. Some familiar object, preferably a pocket ruler, should have been placed alongside one of the eggs to indicate its true size, or a human hand might have been included in the view, picking up one of the eggs or holding it in the palm. The picture was a snapshot at close range, employing a supplementary lens.



"Snake's Eggs"

Adams Institute

UNDER the personal direction and instruction of Dr. Richard Bettini, Dean, whose family has been actively associated with photography during practically the entire century of photography's existence, a new school of photography has just been inaugurated in New York City under the name of the Adams Institute. Dr. Bettini's grandfather entered the photography profession in 1859, being later succeeded by Dr. Bettini's father. Many internationally famous persons have been photographed by the three Bettini's, including royalty, aristocracy, Popes, Cardinals, and persons high in artistic and other quarters.

Equipment of the school includes an unusually large darkroom furnished with 18 enlargers and other equipment which represents a wide diversification of various types of facilities "so that an individual will have an opportunity to work with and compare the different apparatus on the market." There are three sessions daily—morning, afternoon, and evening—each session lasting four hours and continuing for a period of two weeks.

Ballyhoo Pictures at the Fair

THE Amusement Area at the New York World's Fair is rich in human interest possibilities. Among the most attractive subjects are the barkers at work. Night shots are usually more striking than those made by day because of the more interesting lighting. Fast pan film should be used. Exposures at 1/25, 1/50, and even 1/100, depending on the lens speed, are sufficient to record all necessary detail. Move in towards the front of the crowd in order to avoid obstructions and to get a clear view of the subject.

"Ballyhoo"

Leica 25 Years Old

IN this, the 100th year of photography's existence, Leica celebrates its 25th birthday. With more than 300,000 Leica cameras in use throughout the world, the Leica people recount this camera's achievements: the first to introduce the 24 by 36mm negative size, using 35mm motion picture film; the first to use a collapsible lens mount for compactness; the first to couple the film advance mechanism with the shutter rewinding mechanism; the first to apply a range finder to photography; the first to couple the range finder with the lens for automatic focusing; the first miniature camera to utilize interchangeable lenses; and the first to apply universality of operation to a camera by making available accessories to extend the scope of the instrument.

The New Camera

THERE'S no use going against nature. The most plainly worded instruction book will be half read, if at all, in the enthusiasm of that first period of ownership of a new camera. We are so eager to start shooting pictures that we lose all patience with the hard fact that we should learn how the camera is operated before we start using it. This department would like to suggest that manufacturers and distributors issue two sets of instructions, one extremely brief and giving only the bare essentials necessary for operating the camera, the other more extended and detailed. The brief one would be for use in the first moments of possession of a new camera and would be written in monosyllabic language, just as one would give instruction to a child. Best of all, the dealer should load the camera for the purchaser, set the distance and stop for fixed focus operation, instruct the user to shoot only in broad daylight, and show him where the release button is. After the first roll has been exhausted, the new-camera owner may come to his senses at last and decide to cut out the foolishness and get down to brass tacks.

Balancing the Angle

MEN at work frequently offer striking subject-matter for picture makers, and one of the best viewpoints to adopt for unusual pictures is that of the up-angle. In the present illustration, the men were suitably placed for a good composition. The diagonal was inevitable, but it was necessary to wait for the standing man to get into the position shown before the picture

"Men at Work"

could truly be said to have balance. This balance is facilitated by the fact that the man's body is slightly tilted forward. Unity is achieved, too, by the fact that both men are engaged on one thing and are facing towards each other. A filter was used for the sky.

That Double Chin

OCCASIONALLY you will be confronted with the problem of how to minimize or to some extent avoid representing the double chin of your subject. This is particularly a problem with women. In moderate cases, a shift in the angle of the head is all that will be necessary. Have the subject seated facing on an angle with relation to the camera and then turn her head towards the camera. Caution must be used here, however, to prevent too many folds in the neck, which might prove almost as

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disturbing as a multiplicity of chins. An up-tilt of the head, often very suitable for women, is another dodge. Another, perhaps more useful procedure, is to light the subject predominantly from a high position so that the minimum light reaches under the chin, by reflection, to show just a trace of printable detail there.

Portrait By Candlelight

THE flame of a candle at a distance of about two feet from the subject provides sufficient illumination for an exposure of one second, or a little less, at stop *f*/3.5 when using Super XX or Superpan Press film. To minimize shadows on the face, have the subject face towards the flame. There is a tendency in this type of picture for the subject to stiffen up unduly as if awaiting some catastrophe. Try to induce the subject to assume a natural, easy pose.

"By Candlelight"

Shutter Testing at the Fair

AN opportunity to have the shutter of your camera tested the next time you visit the New York World's Fair, is offered by the Universal Camera Corporation. They write us:

"A new ingenious device for testing shutters is made available for the first time. This tester, an exclusive Univex engineering development, is designed to test all makes of shutters. Visitors can bring in their own cameras, of any make or manufacture, and have them tested for accuracy of shutter speed. This service is available to anyone and the Univex representatives will be glad to test any camera."

No-Border Enlarging

WHEN enlarging on paper with greater dimensions than your easel will take and when it is desired to print without a border, a simple procedure is to pin the four corners to the baseboard in order to prevent slipping or to hold down a paper that is inclined to curl somewhat. A still easier method and one that will leave the print clear of marks to the very corners, is to use double-sided adhesive. This is available in a product known as Twintak. Cut four short strips, remove the linen fabric that covers one of the adhesive sides, and attach to the under side of each of the four corners of the paper. Then place the paper in the desired position on the baseboard, after having previously focused on an ordinary sheet of paper in the usual way, and the paper will stay put wherever placed.

Cleaning Old Prints

HERE is a professional tip that many amateurs can put to good use. One photographer who occasionally has to revive an old print which has become soiled for one reason or another, does so by the simple expedient of applying a thin paste of ordinary starch to the surface of the print. He allows this paste to dry for about 10 minutes. At the end of this period, he holds it under the tap and removes both starch and dirt by running water over the print.

Soft Developer

FOR that contrasty subject, with very strong high-lights and deep shadows, we recently came across a developing solution that just about hits the nail on the head. It is called GD-33, is easily made up from familiar chemicals sure to be found on every normally equipped chemical shelf, and is extremely stable. Made up for tray use, the formula follows:

Metol	75 grains
Sodium Sulfite	1¾ ounces
Sodium Bisulfite	15 grains
Hydroquinone	20 grains
Sodium Carbonate	130 grains
Potasium Bromide	15 grains
Water to	32 ounces

Anton F. Baumann

WIDELY known and admired both as a photographer and a personality, Anton F. Baumann has shot his last picture. A victim to the desire for original viewpoints in photography, Baumann, a master of 35mm technique, died while attempting an unusual picture angle.

"He had just completed a lecture and demonstration tour of a number of southern cities," says the announcement of his death, "and was making pictures when he met with an accident in an attempt to obtain a 'different' angle from a high position.

"Anton F. Baumann entered the employ of the firm of Ernst Leitz as a young boy, being engaged in the research department. When the Leica was introduced he at once realized its possibilities and soon devoted all of his activities to making pictures and lecturing on Leica technique throughout the world. . . . His lectures and demonstrations were a delight to thousands of photography enthusiasts, for they taught them how simple it is to make enlargements from 1 by 1½ inch negatives. When modern color films first appeared, Baumann immediately saw the possibilities of this new medium and devoted much of his time to it. He projected his slides to audiences throughout the country and inspired many photographers to work with this new medium."

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 accompany your request by a stamped envelope.

Duplicate Transparencies From Kodachrome: 35mm duplicates, for screen projection, or enlarged duplicate transparencies up to 11 by 14 inches from original Kodachromes taken with miniature camera. Also, "same-size," enlarged, or reduced-size duplicates from most sizes of Professional Kodachrome. Miniature sizes may be submitted, through dealer, either mounted or unmounted.

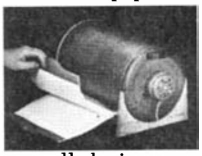
Heavy Duty Photo Flood "Hi-Lo" Switch: Control switch capable of handling group of two, three, or four lamps drawing total power up to 2400 watts. For example—four No. 1 lamps, four No. 2's, two No. 4's plus two No. 1's, and so on. Unit comprises steel box four inches square by two inches high, with toggle switch lever on top and pair of outlets on each of two sides. Finished in neat crackle gray, equipped with rubber-covered, heavy-duty line cord and plug. With switch in "Hi" position lamps burn at normal brilliancy but in "Lo" two pairs of outlets are connected in series, dimming illumination, reducing current drain and heating.

Triple S Superpan Reversible (100-foot length, $6; 50-foot length, $3.25): New 16mm motion picture film. Rated four times faster than Agfa 16mm Superpan Reversible, permitting two lens stops less exposure or corresponding increase in subject range. Speed combined with fine grain and brilliant gradation.

Lafayette Filters and Mounts: Available in 12 sizes to fit all lens diameters 23 to 42mm. Include light and medium yellow, light green, medium green, and red. Mounts consist of barrel and clamping ring which screws over its outer end to hold filter glass in position. Inner end of barrel slips over lens mount and has spring fingers to insure firm grip. When clamping ring is screwed into place it does not reduce inside diameter of mount.

Weston Master, Model 715 ($24): New model featuring separate scales for low brightness range, 1/10 to 50 foot-candles, and high brightness range to 1600 foot-candles. Manufacturers cite example of person sitting near average reading lamp at night reflecting five candles per square foot to indicate extreme sensitivity of low scale. On high brightness side, readings far higher than heretofore are provided with such subjects as beach or snow scenes. "High Light" scale viewing angle cut to 30 degrees for greater accuracy in measuring central point of interest, without being affected by surrounding light. Film speed range increased, providing for film speeds from .3 to 800 Weston. More f/ stop-shutter combinations provided on Master calculator dial. In changing film ratings, touch button and emulsion dial moves smoothly; release and dial locks securely. Hermetically sealed housing around cell keeps moisture out. Streamlined outer case molded to fit hand, with special ribbing to prevent slipping. Decorative chromium strip forms secure ribbon eyelet at end.

SPEEDO PRINT DRYER, *new model* ($14.85): Dries glossy prints plus regular matte or semi-matte papers. All-metal cabinet, with



crackle finish. Insulated Bakelite handles prevent accidentally burning fingers. Scientifically circulated and controlled air warmed electrically. Minimum drying time, with full protection against scorching. Capacity: six 8 by 10-inch prints; five 11 by 14-inch, or more than 400 contact prints 1 by 1 1/2-inch, all in one drying.

KODAK TRANSPARENCY ENLARGER ($18.50 for complete outfit, with three filters, special masks for 35mm and "Bantam" frames, and operating instructions): For making enlarged negatives from Kodachrome transparencies or black-and-white film positives without using darkroom. Accommodates either double-frame (1 by 1 1/2-inch) 35mm film transparencies or No. 828 film. Enlarger loads with either Super XX (XX616) or Panatomic X (FX616). Negatives about 2 1/8 by 3 1/8 inches obtained from 35mm film and approximately 2 1/4 by 3 5/8 inches from No. 828 frames. Operation: transparency, mounted or unmounted, is positioned in enlarger gate and hinged diffusing-glass cover closed over it. No. 1 Photoflood in reflector is held about five inches over gate, and enlarger shutter, operating only on "time," is opened for several seconds. About five seconds suffices with transparency of average density, using Super XX film. From enlarged negatives, any number of contact prints or greater enlargements may be made.

DUFAYCOLOR PF CUT FILM (box of 6, $2 to $17 depending on size, 2 1/4 by 3 1/4 to 8 by 10 inches) IMPROVED DAYLIGHT TYPE CUT FILM (price range same as above): New PF type cut film affords greater speed with artificial light. Primarily intended for artificial light, but adaptable to outdoor shots by using daylight filter. "Dufaycolor Daylight Type cut film affords greater speed," says company statement. "In open areas in sunlight, exposure of 1/50 of a second at *f*/8 yields rich, clean transparencies. The color balance of this film has been finely developed, accurately recording the spectral colors on the exposed transparency."

LEICA SYNCHRONIZED FLASH UNIT MODEL VI ($28.50): By means of new baseplate, synchronization is effected by mechanism of camera itself. No external synchronizing heads, devices, or connecting wires required. Battery case attached directly to special baseplate of camera by means of dovetailed slide which holds it in position. Bulb socket of spring type. Reflector adjustable for two positions depending on bulb size. Small test lamp, located in neck of lamp socket, acts as pilot for effecting synchronization. Firing of lamp may be advanced or retarded by means of small adjusting screw on baseplate. Tripod bushing in end of battery case.

OMAG CHROMEFLASH FILTER: Designed for use with Photoflash illumination when exposing Kodachrome Type A. Available in 19 sizes.

TRU-PAN TRIPOD ($18.75): Designed for 8mm movie cameras. Two-section, selected hardwood legs may be adjusted to several different lengths. Both pan and tilt may be operated or locked independently. Tru-Pan head similar in design to that employed on Bell & Howell All-Metal Tripod.

WALDEN RFD REPLENISHING FINE-GRAIN DEVELOPER ($1 for 16-oz. unit, 16-oz. bottle each of developer and replenisher; $1.85 for 32-oz. unit, 32 oz. each of developer and replenisher): Non-toxic, non-staining temperature control to 80°, Fahrenheit. After each use, developer is poured back into bottle and enough replenisher added to bring solution to neck of bottle. Proper chemical balance thus obtained makes possible development of 25 rolls of 35mm film or equivalent, with 16-ounce unit, or 50 rolls with 32-ounce unit.

J. M. P. SPOT PHOTOMETER (complete with battery, $3.95): Exposure meter for use in enlarging. Operates on Bunsen photometer principle in which spot fades out when calibrated light on one side of paper, which has transparent spot, is adjusted until its light is equal to the light on the other side. Battery is current source. Meter case steel, with black crackle finish. Spot is about 1/8 of an inch in center of white disc 7/8 of an inch in diameter, on which negative image shows. Dial has distinct black figures, easily read in dim light. Index numbers permit setting for any paper speed. Seconds calibrated from 1 1/4 to 160 seconds. Calibration also used for negative density range readings. Readings made direct.

CYKORA NEW SURFACES: Three new surfaces announced: Glossy Single Weight; Commercial Art, Single Weight; Commercial Art, Double Weight. Offered in three contrast grades. Commercial Art surface smooth semi-matte designed to meet special requirements of illustration or advertising art studios.

CARD AND PHOTO STEREO-MIRROR ($2.25 and $3.50): Device for obtaining stereoscopic effect when viewing single pictures. May be used for examining separate photographs, book illustrations, magazine and newspaper reproductions. Employs new optical principle by which a mirror provides an enlarged image in relief. Outfit comprises box 8 1/2 by 6 3/4 by 1 inches, which is ready for use as soon as opened. Contains crystal magnifying mirror 5 3/4 inches in diameter, rectangular miniature

BOOKS for BOOKS

Amateur Photographers

New Ways in Photography, *by Jacob Deschin.* Eminently practical from every point of view, this new book contains nothing of theory and nothing that the advanced amateur photographer will not find valuable in one way or another. It covers the whole range of amateur photography, discussing such things as trick photography, photomurals, retouching, infra-red, and a number of other subdivisions that will not be found elsewhere in as clear and concise a manner. $2.85.

So You Want to Take Better Pictures, by A. P. Peck. *A friendly, face-to-face chat with the camera owner who has his developing and printing done at the photo shops, yet wants to know enough about his camera and its uses to enable him intelligently to utilize it to best advantage. Over 200 pages, dozens of illustrations. $2.10.*

Universal Photo Almanac and Market Guide. How, when and what to photograph in order to make money with your camera; where to sell different types of prints. $1.00.

Amateur Film Making, by George H. Sewell, A.R.P.S. *Useful to the beginner as well as the expert movie maker. Tells about films, cameras, exposure, film editing, story telling with the camera, and so on. Illustrated. $1.60.*

Champlin on Fine Grain, *by Harry Champlin.* A complete hand-book on the entire subject of fine grain, including formulas and how to compound and use them. $1.85.

Photographic Hints and Gadgets, by Fraprie and Jordan. *How to make all kinds of photographic accessories; from film clips to cameras to lighting equipment, and so on; 250 articles and nearly 500 illustrations. $3.60.*

Portrait Photography, *by H. Williams.* Fundamental principles of composition and lighting, paving the way to satisfactory results in this particular branch of photography. $4.35.

Photographic Enlarging, by Franklin I. Jordan, F. R. P. S. *One of the most interesting and authentic books on enlarging. Its 224 pages cover every phase of the subject and 75 illustrations, many of them salon-winners, show the value of correct technique. $3.60.*

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BOOKS BOOKS

Stereo-Mirror 5 1/2 by 2 1/2 inches and groove for picture to be viewed. Card or photo is reflected by concave mirror; image in concave mirror is reflected in miniature Stereo-Mirror.

Agfa Twin Eight Hypan ($2.25 for 50 foot 8mm film): New reversible film designed for use in Double 8 motion-picture cameras. Rated three times faster than Agfa single 8mm films, without loss of fine grain and brilliance. Provides balanced panchromatic color sensitivity for use by daylight or artificial light; wide latitude; high resolving power; brilliant gradation. Protected against halation.

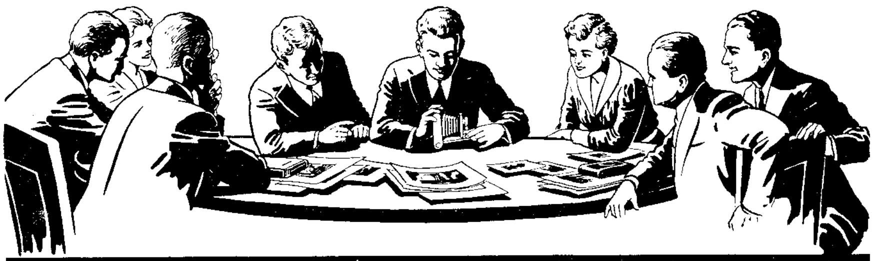
Kodaslide Projector Model 1 ($18.50): For 2 by 2-inch slides. Made of molded material in highly polished black finish.

Base measures 2 7/8 by 5 1/4 inches; projector 4 5/8 inches high. With 10-foot throw, its four-inch projector lens yields 26 by 38-inch screen picture from 35mm transparency, or 30 by 44-inch picture from No. 828 (Bantam) transparency. When projecting distance is 15 feet, 46 by 66-inch screen picture is had from Bantam transparency. Illuminating system utilizes spherical glass reflector, three condensing lenses, disk of special heat-absorbing glass to prevent overheating of slides. Uses 100-watt projection lamp, candelabra bayonet base, T-8, 4cc filament lamp costing $1.15. No slide carrier, slides being simply fed through slot equipped with light springs which hold slide correctly in plane of focus. Tripod socket built into base of projector. Case available ($4) covered with durable black material, for carrying projector and to serve as support for it during projection. Cover of case may be tilted by means of elevating screw. Kodaslide Ready-Mount Changer, recently announced in these columns, may be used on Model 1.

Drum Dryer ($2.50): Electric print drying device consisting of chromium squeegee plate in cylindrical form. Heated by a common electric light bulb. General construction such that enclosed area quickly heats, giving satisfactory drying surface. Takes up little space.

Ka-I-Ko Reel Loader ($2.50): To be used with all spiral adjustable type developing tanks. Reel is placed in loader, exposed roll attached to grips, and the protective paper covering gently pulled out. These three motions load the reel which is then ready for developer. Loader is all metal, rustproof.

Hyper Cinor Lens Attachment: For doubling viewing angle of 8mm Filmo camera lenses. Includes provision for focusing. When normal use of lens is desired, attachment is unscrewed and removed with a few quick turns. Example of use: When using the normal lens the camera must be about 20 feet away to photograph a person six feet tall. With the Hyper Cinor Lens Attachment in place camera need be only half as far away. Supplied in models for Taylor-Hobson 1/2- inch $f/2.5$ lens used on Filmo 8's and for T-H 1-inch $f/2.7$ and B&H Lumax 1-inch lenses for 16mm Filmos.



CAMERA ANGLES ROUND TABLE

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. **Is it possible to change a positive movie film to a negative? If so, how? If you have any information on how to make prints, using movie film, I would appreciate it.—J. K.**

A. A positive movie film is used to make a negative by the contact printing method. In our June, 1938, "What's New" column we announced the introduction of the Kodak 16mm enlarger, by which these small movie positives may be directly enlarged on 616 film. The resulting negatives are then used for making contact prints or, if desired, still larger pictures by the enlarging process.

Q. **I am thinking of buying another camera. How can I decide what camera and lens will suit my purpose? The pictures I take are distant scenes and snapshots of interesting objects seen when walking around with the camera. For years I have been interested in making color pictures and would like to know if you can give me some information on the subject. How do the Kodachrome, Dufaycolor, and Autochrome processes differ?—H. A.**

A. Portability is probably one of the first considerations in your case. Price and size of negative are others. If you can afford it, we would suggest the purchase of a camera that will permit the interchange of lenses so that a telephoto or wide-angle lens may be used, when and if acquired. For such work as you describe, a lens with a speed of *f*/4.5 should be ample. Adaptability for various types of work is one of the things to look out for, particularly if you plan to have but one camera. Although it is said that no single camera is capable of meeting all situations, many reasonably priced outfits can come so near to this ideal as to be satisfactory.

As to color photography: This has been simplified today insofar as the production of color transparencies are concerned. If you plan to do much color photography, the sizes of color film available may have some bearing on your choice of a camera. Kodachrome, Dufaycolor, and Filmcolor (Autochrome, formerly available in plates, has been superseded by Filmcolor in cut-film form but with the Autochrome emulsion) are all similar in the sense that the color screen and the panchromatic emulsion have been combined, so that exposures may be made in the same manner as ordinary black and white film. The color screen faces the lens and the panchromatic emulsion back of it receives the exposure through the screen. All three types are available in cut film ranging from 2 1/4 by 3 1/4 inches up to the professional sizes. In addition to cut film, Kodachrome is also available in 35mm, 18-exposure rolls, and in the 6 by 13cm stereo size cut film; Dufaycolor is available in the various amateur roll-film sizes as well as in filmpacks.

Q. **Can you tell me the reason for the vertical line of stain running through the center of certain negatives stored in negative enclosures?—S. E. L.**

A. This is a common difficulty experienced by photographers who file negatives in enclosures having a glued or pasted seam down the center. The nature of the adhesive, plus moisture, is probably the cause. You should use enclosures with an edge seam and file the negatives in a dry place. The stain may be removed by hardening the negative in one of the hardening baths, such as the SH-1 Formalin Hardener, and then placing the negative in a 1 or 2 percent solution of potassium cyanide until the stain disappears. Cyanide being a deadly poison, make sure the room is well ventilated and, after use, discard the solution down the drain only after having made sure that there is no acid in the sink or trap.

Q. **I desire information on the use of powder for flashlight photography. Would you say that its use is the answer to getting flashlight action shots as cheaply as possible? I know that bulbs are positive, give no smoke, and so on, but outside of that would the use of powder be just as good? Please describe the technique of using powder satisfactorily.—H. B. B.**

A. Flash powder today is used almost exclusively by newspaper and commercial photographers when it is required to cover a large area, particularly outdoors at night. The low cost of flash powder as compared with that of flash bulbs is greatly offset by the disadvantages of the former. The immediate swing to flash bulbs by both amateur and professional photographers as soon as these became available is a certain indication that the higher cost of the bulbs has proved no drawback to widespread acceptance.

From your query we gather that you are aware of the main advantages of the bulb over the powder, so we won't dwell on them. You probably also know that small-size bulbs, proportionately lower in cost than the larger ones, will provide sufficient illumination at normal distances to give well-exposed negatives at small stops. In our opinion, cheapness is the only advantage that powder has to offer over the bulb, for average working conditions. Mention must be made of the hazard attending the use of powder—that of untimely explosion. Special care must be used both in storing and igniting powder. Flash powder is fired in a device known as a flash-pan, provided with some automatic method of ignition. The powder must lie exposed and not confined in a container of any sort. A brief flash is obtained when powder is heaped in one spot, a longer flash when the powder is spread over the pan, thus insuring the maximum of light. Instructions are supplied with each container of powder.

***Q.* Since I do not own a scale with which to weigh chemicals when mixing developer, can you tell me how to measure out chemicals, using tablespoon measurement?—F. H. J.**

A. We would if we could but we can't. The fact is, chemicals vary in weight and so would necessitate a different table of measurements for different chemicals. While the weighing of chemicals for the compounding of photographic solutions does not always have to be critically accurate, the use of a tablespoon system of measurement would be stretching the point a little too far. By employing one of those vari-sized spoon sets used in weighing out cooking recipes, it is altogether possible to figure out a method for preparing formulas, but a weighing scale would be necessary to fix the quantities. Scales are not expensive and sometimes may be picked up second hand for much less than their original cost. In this connection, the dollar Weigh-Spoon device mentioned in our "What's New" column some time ago should be suitable. If you employ standard developer formulas, these, as you probably know, are available ready prepared in dry form, requiring merely a stated quantity of water to make them ready for use. One manufacturer solved the problem you have in mind by providing wooden measures in each package of chemicals. These are sold under the name of "Mak-a-tube" (developer), "Mak-a-fix" (fixer), and so on.

***Q.* What causes a partial reversal of the negative image in the course of development?—P. R.**

A. The reason may lie in fogging caused by the use of an unsafe light in the darkroom or in extreme over-exposure while in the camera. Another cause is the use of an oxidized developer.

***Q.* I write music as a vocation and follow photography as a hobby. When I receive an order, for, say, 50 copies of the same piece of music, I would like to be able to make the first copy by hand and from that reproduce the other 49 copies with the camera. Can you tell me how I can photographically copy music on both sides of the same sheet of paper?—H. K. J.**

A. Aside from the method of individually sensitizing each side of the paper, you can employ a double-coated paper expressly made for the purpose you have in mind. However, because there is so little demand for this kind of paper, it will be necessary for you to purchase a fairly large quantity. But since moderate quantity reproduction is required, this should offer no problem. We understand that a paper of this type, sold in large rolls, is obtainable from the Gevaert Company of America, 423 West 55th Street, New York City. The company will cut the paper up into the sizes you specify. We would suggest that you write to the company and state your problem, making clear your requirements, which will include the facts that the paper must be non-glossy and thin and flexible enough to permit folding without cracking.

***Q.* What do I have to do in order to print on special cards some of the pictures which I have taken?—Mrs. C. W. R.**

A. The first step is to convert the cards into regular photographic paper by sensitizing them according to the formula given in our reply to E. W. D. in the September, 1938, issue. When that has been done the rest of the procedure will be similar to that employed in the contact printing routine.

***Q.* My No. 1 Auto Self-Timer exerts, in my opinion, a very great pressure, so great that I am afraid to use it lest it shall break or bend the tiny trip bar located under the cable release socket. Please advise if there is any danger of damaging the shutter in this manner. —A. K. B.**

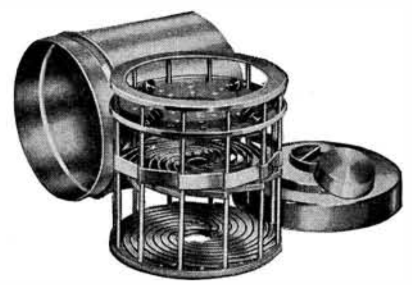
A. The pressure you refer to is necessitated by the nature of the timer's design, but will do no harm to the shutter. There is no adjustment on the No. 1 timer for the pressure required to set up the delay mechanism, as there is on the No. 2 timer. You can, however, feel secure in using this timer without danger of damage.

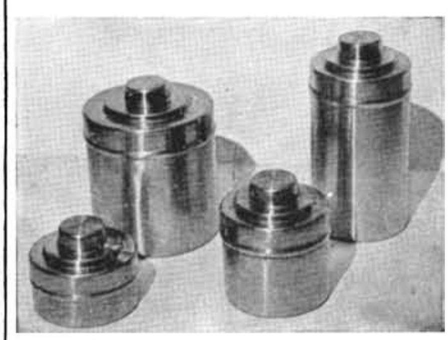
***Q.* How can I enlarge from a wet negative?—R. L.**

A. Make a glycerine "sandwich" between two pieces of clear glass. Apply a little glycerine in the center of one glass, lay the wet negative on it and apply another drop on top of the negative. Place the other glass on top of the negative. When sandwiched together, the glycerine will spread, covering the entire negative and thus preventing premature drying of the negative while being projected in the enlarger.

***Q.* What is a good way to copy a photograph made on a matte surface —L. D. G.**

A. In order to overcome the disadvantage of the matte effect for copying purposes, and to help bring out shadow detail, immerse the print in water, let it soak a while, and then lay it face down on a sheet of plain glass. Squegee it down firmly until all bubbles and air pockets have disappeared. Make sure the glass is clean before you lay down the print. Face the print, through its glass "cover," towards the camera, and light it evenly by using two light sources of equal intensity, one on each side.





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By Katherine Glover

JUST over a decade ago Scientific American published a long series of articles entitled "Uncle Sam—Spendthrift." These articles discussed, with sharp emphasis, wasteful American methods which were depleting our forests and natural resources. The present volume shows the amazing work that has been done in recent years to salvage what is left of natural resources, to protect our farming lands against destructive erosion and wasteful farming practices, and to cut timber scientifically and reforest old timber lands. This is a significant picture of future possibilities.—(Well illustrated, 382 pages, 5 3/4 by 8 1/4 inches.) $2.85 postpaid.—*F. D. M.*

THE NATURE OF THE CHEMICAL BOND

By Linus Pauling

THE professor and the student will find this volume an aid in keeping up with the rapidly advancing theories of physical chemistry. Problems of chemical binding are discussed, as are also the structures of atoms and molecules. The theory of the treatment is based chiefly on the results of the quantum mechanics, with special emphasis on the resonance phenomenon. (6 by 9 inches, 429 pages, 72 figures.)—$4.60 postpaid.—*L. B. P.*

GIVE YOUR HAIR A CHANCE

By John W. King

MUCH common sense about hair is contained in this small book dealing with hair care, dandruff, baldness, grey hair, and scalp diseases. It debunks hair fads, hair pomades, and false notions about dandruff. (157 pages, 5 by 7 1/4 inches.) —$2.10 postpaid.—*A. G. I.*

THE BIRTH OF THE OIL INDUSTRY

By Paul H. Giddens

LEGITIMATELY dramatized, this historical survey of the early days of oil in the eastern United States makes reading that is as interesting as it is informative. It begins with observations on petroleum in 1627, describes the early petroleum springs and wells of the east, and carries through the uses of petroleum as a medicine to the drilling of the famous Drake well in 1859. Then the real fun starts: The mad rush for land, the maze of flowing wells, problems of transportation, market development, taxation, battles of the oil fields, boom towns, and all the myriad of startling developments that resulted from the development of our stores of "black gold." (216 pages, 6 by 9 inches, a number of interesting photographs and maps.)—$3.10 postpaid.—*A. P. P.*

MAN THE WORLD OVER

By C. C. Carter and H. C. Brentnall

ADULTS who did not shine in geography in school may make up their deficiency by reading this book, though it doesn't look or read like a schoolbook and isn't even big enough to hide behind. It deals with the earth's peoples, industries, products, climates and so on, and has many maps showing special regions, industrial or climatic, but no ordinary maps. The treatment is rather light and easy; it isn't a student's book. (508 pages, 6 by 8 inches, numerous illustrations.)—$3.10 postpaid.—*A. G. I.*

HOUSE CONSTRUCTION DETAILS

Compiled by Nelson L. Burbank

VERY little discussion and an amazing number of illustrations, photographs, working drawings, and cut-away sections fill this complete book for architects, contractors, and builders. Actual construction details, with dimensions, are given here to cover practically every conceivable detail in house construction. A Shopcrafter's Corner gives plans and dimensions for many incidental pieces, such as cabinets, foot stools, shelves, benches, and the like. A section is devoted to modern homes, in which there are drawings of the exteriors of a large number of types of houses.—(Complete index, 317 pages, 8 3/4 by 11 1/4 inches.)—$3.10 postpaid.—*F. D. M.*

USES AND APPLICATIONS OF CHEMICALS AND RELATED MATERIALS

By Thomas C. Gregory

POTENTIAL, as well as actual, manufacturers and consumers of chemicals and chemical products will find this volume useful for the great mass of data which it contains. Manufacturers, research directors, and sales executives will find in it answers to questions concerning commercial applications for new chemicals or by-products. Although 5167 chemicals are listed, the book is not a dictionary; rather it gives industrial uses, including patented processes described by patent number, potential applications, and sales possibilities. All products are titled by common name and are in strict alphabetical order. The listings usually include German and French names, and in the case of drugs, the Latin equivalent is also given. Nine pages of synonyms and cross references. (665 pages, 6 by 9 inches.)—$10.10 postpaid.—*L. B. P.*

DICTIONARY OF SCIENTIFIC TERMS

By C. M. Beadnell, C.B., F.Z.S.

GENERAL dictionaries of the English language often err in defining scientific terms—give only traditional definitions or else lag behind the times. This is purely a reference book containing definitions of technical terms used in the sciences, written by a scientist. (235 pages, 4 1/2 by 7 inches.)—$3.10 postpaid.—*A. G. I.*

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By Oliver Justin Lee.

AN unusual book, packed full of facts about astronomy, especially on the measurement of astronomical distances. One chapter tells, though not in great detail, how a precision screw for a measuring machine is made and tested. (169 pages, 5 by 7 1/2 inches, 14 illustrations.)—$2.60 postpaid.—*A. G. I.*

PHOTOCHEMISTRY AND THE MECHANISM OF CHEMICAL REACTIONS

By Gerhard K. Rollefson and Milton Burton

IT has long been known that light plays an important part in certain chemical processes. Only recently, however, have such processes been studied extensively and photochemistry made a tool for the study of the detailed mechanisms of reactions. The authors of this volume, while maintaining a critical attitude, have endeavored to present the subject so that the reader will not only understand its background,

FOR OTHER BOOKS YOU WANT, SEE PAGES 166 AND 181

but also realize its possibilities. Approximately one third of the book is given to presentation of the fundamental concepts required for an understanding of the effects produced by the absorption of light and the behavior of the reactive states produced in this manner. The remainder is devoted to specific reactions which can, in part, be regarded as supplementary material for the earlier chapters. Many original references are given, nine pages of appendixes, 17 pages of subject and author indexes. (445 pages, 6 by 9 inches, 59 diagrams.)—$5.85 postpaid.—*L. B. P.*

SILK SCREEN STENCIL CRAFT AS A HOBBY

By J. I. Biegeleisen

A HOBBY that anyone—man, woman, or child—can follow with enjoyment and even profit is offered in this clearly presented book. Lamp shades, table cloths, greeting cards, invitations, program covers, and a multitude of other things can be produced in colorful designs, singly or in quantity, by the easily mastered silk screen stencil process. The author gives all needed instructions and has amplified the text with a number of pertinent drawings and photographs. (140 pages, 6 by 9 inches, 39 illustrations.)—$2.10 postpaid.—*A. P. P.*

AMERICANS

By Emil L. Jordan

SERIATIM, the author gives separate historical narrative accounts of the contribution of each racial and national stock to the New World—Indian, Viking, Spanish, Portuguese, French, Dutch, British, Negro, Chinese, German, Irish, Scandinavian, Slavic, Italian, Jewish—thus enabling the reader to judge which stocks have contributed the most. This is no dry-as-dust history but is eminently readable; your reviewer forgot he was reading for review. The style is preponderantly narrative and occasionably a bit spicy. (459 pages, 5 1/2 by 8 1/2 inches, 8 illustrations.)—$3.60 postpaid.—*A. G. I.*

CHEMICAL PIONEERS

By Williams Haynes

IN the details of their accomplishments, the story of these 15 builders of progress is of great interest to us today; their constructions have become our great chemical industries. (288 pages, 5 1/2 by 8 inches, 58 illustrations, index.)—$2.60 postpaid.—*L. B. P.*

MAN AND HIS LIFE-BELTS

By E. T. Bell

CYNICS will enjoy this book. Beil is a noted science teacher who has written other cynical but penetrative books, using a sharp pen. He is aggravating, irreverent, iconoclastic, skeptical, enjoyable (unless the reader were a conformist, in which case the effect would be most irritating) and always witty. The "life-belts" are government, scientific invention, economic science and religion (of which he disposes). He says: "The happiest people today are those who know nothing." This sounds true, anyway! (340 pages, 5 3/4 by 8 1/2 inches.) —$3.10 postpaid.—*A. G. I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

SO far as your scribe recalls, the 30" reflecting telescope described below is the largest yet made by any amateur since this journal revived the art of amateur telescope making 13 years ago. J. H. Hindle, of Witton, Blackburn, Lancashire, England, built it and, when invited to describe it, wrote the following:

"THE mirror is a Chance disk, 3 1/2" thick, with a focal length if 120". The aperture is 30" (*f*/4). It is floated on a system of triangular supports, contacting the underside of the mirror at 18 points.

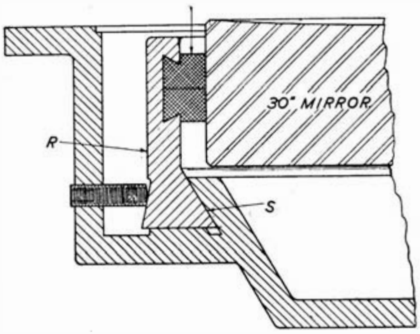


Figure 1: Cross-section of the cell

[Hindle's well-known system, described in the book 'Amateur Telescope Making,' page 229.—Ed.]. A cross-section of the mirror cell, with reference to the edge support, is shown in Figure 1. The annular ring, *R*, is divided into 12 segments, each of which has vulcanized fiber inserts, *I*, which come against the mirror. Two whole fiber rings are turned, dovetail shape, then sawn into 12 sections, and forced circumferentially into position. Each segment of ring, *R*, is forced by means of two screws to its final position against the inclined surface, *S*, and in this position the fiber inserts are bored out a few thousandths larger than the mirror itself. In this way an adequate edge support is provided, and it is impossible to pinch the mirror by tightening the screws. When these are released, however, and the segments backed off or lifted out there is ample clearance for the extraction of the mirror.

"The tube is constructed from solid-drawn steel conduit, such as is used for electrical

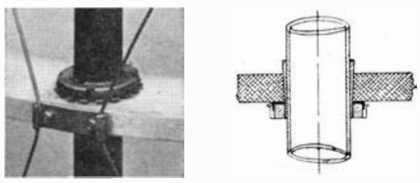


Figure 2: The tube construction

wiring purposes, and the lengths are threaded through circular rings of heat-treated, high tensile aluminum alloy. These rings are securely clamped to each tube by means of a taper fitting such as is used for attaching ball bearings to a straight shaft (Figure 2). The diagonal bracing is of high tensile steel wire, which is pulled taut by means of screws at the bottom end of each tube, near the mirror mount. A perfectly rigid tube of minimum weight is thus obtained.

"The four arms of the spider carrying the diagonal are of phosphor bronze sheet, mounted on the extreme end ring, with provision for concentric adjustment.

"The diagonal mirror is 7" minor axis, and about 1 1/2" thick, mounted in an aluminum and brass cell which has a tubular stem, so that electrical means of slightly raising the temperature of the back side of the plane, to avoid dewing, can be adopted, as described in 'ATMA' by Dr. Steavenson.

"The primary mirror is not perforated. It is collimated with reference to the brass sleeve which forms the center of the spider, returning its reflection precisely concentric with a ground spot, exactly in the center of the mirror itself. The eyepiece support can be readily detached from the tube if necessary, and there is a considerable range of adjustment longitudinally. Being supported at three points, the final adjustment—that of setting the eyepiece tube exactly on the optic axis, and parallel to it—is comparatively simple.

"The polar axis is built from a 5" steel tube, with 1" thick walls, and the ends plugged solid. It is supported in ball bearings, one immediately below the fork, and the other immediately below the worm wheel. The general design of the mount

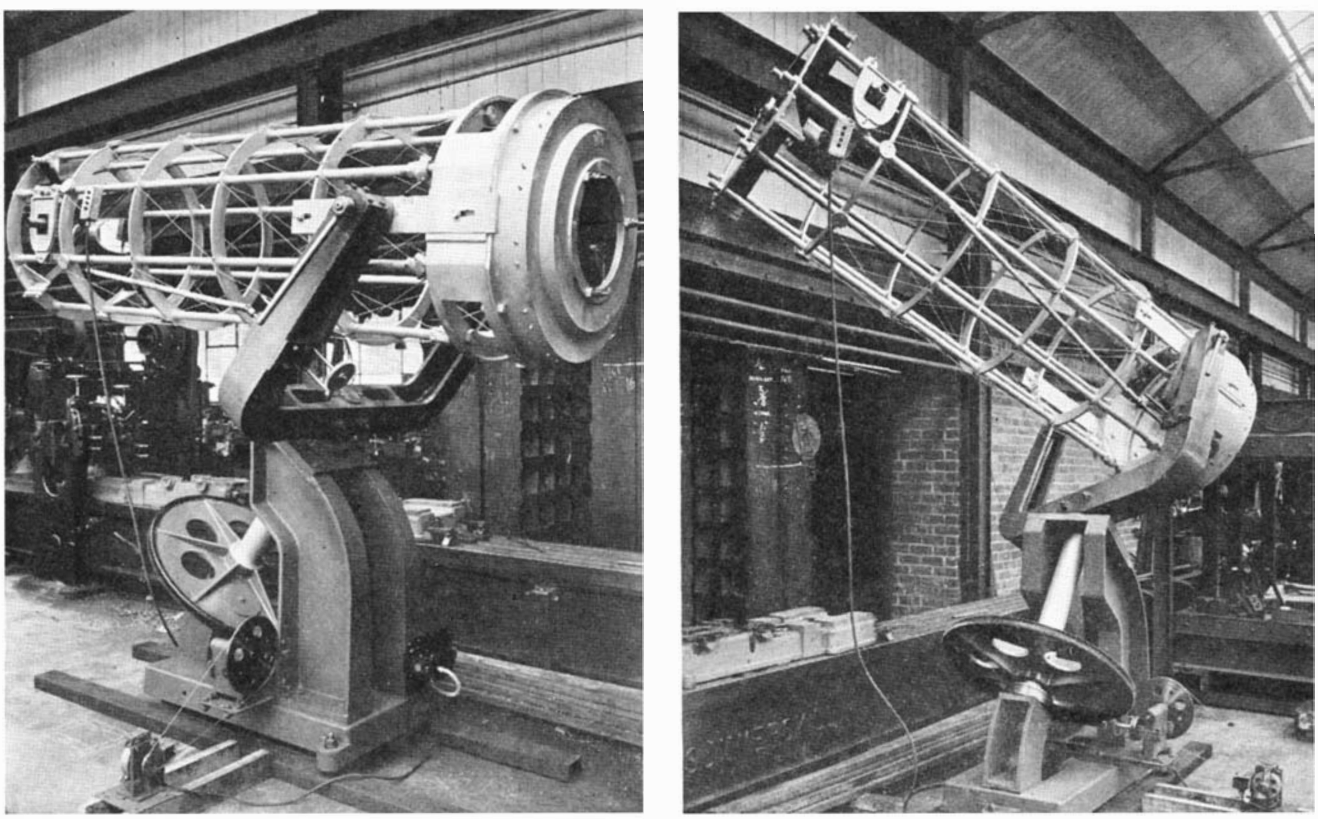


Figure 3: The nearly completed telescope erected in Hindle's plant (Union Engineering Works)

for a latitude of 51 1/2° is clearly seen from Figure 3, the fork itself being a substantial iron casting of 'U' section, split where it slips on the top of the polar axis, to which it is firmly attached by compression bolts. A segment of a worm wheel on the trunnion of the tube enables the telescope to be adjusted in declination, through the medium of a worm and spur gear, with a flexible joint to a broom handle

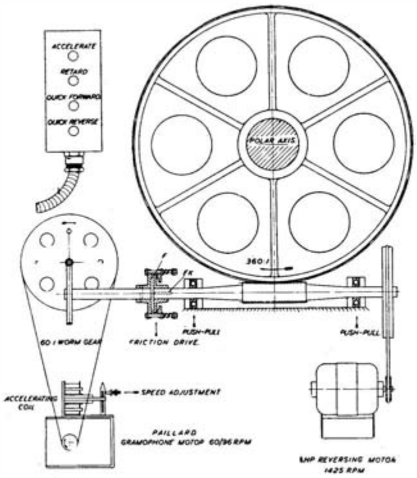


Figure 4: **Details of the drive**

within reach of the observer. When the inclined steel handle and its nut are released, the tube can be moved to any approximate position by hand.

"The drive to the polar axis is possibly to some extent novel. The worm wheel on the polar axis is definitely fixed to it, the usual clutch being dispensed with. That enables the wheel itself to be more precisely mounted, and the engagement of the worm and wheel more definitely adjusted. The primary drive is by gramophone motor, through a 60-to-1 worm gear, which, in turn, through a friction drive, rotates the main worm shaft and the wheel on the polar axis, the latter reduction being 360-to-1 (Figure 4). Particular attention is directed to the small worm gear, which is carefully assembled and runs in ball journals to reduce friction to a minimum, so that the gramophone motor is not overloaded. The pitch of worm and wheel is 10 D.P., that is $\pi/10$, and the pitch-circle diameter of the worm is 0.75", so that the angle of the thread is 7 1/2°, which practically gives irreversibility. The compression springs on the friction drive enable the necessary power, with an ample margin, to be transmitted to the main worm shaft.

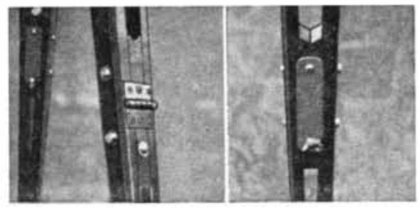
"The gramophone motor is to be independently mounted so that no vibration or electrical hum can be transmitted to the telescope. At a speed of about 60 r.p.m. the normal speed of the polar axis is secured, and this is capable of permanent and delicate adjustment. Energizing a small A.C. electro-magnet entirely releases the brake on the governor of the motor, and allows it to run at top speed. This occurs when the accelerating button is depressed, to overtake an object in the field of view. The retard button simply interrupts the gramophone motor circuit, allowing the object to overtake the telescope.

"Rapid adjustment in right ascension is effected by means of a separate 1/4 h.p. motor, which runs in either direction as desired. Due to the greater power of this motor, the friction drive loses control, and

THE BEGINNER'S CORNER

TRIPODS instead of fixed pedestals are desirable in many instances for first telescopes, because first telescopes usually are small enough to be portable. Light, flimsy tripods, however, are too shaky for a telescope, because the telescope magnifies the shakes in the same measure as it magnifies the object looked at. Hence a really solid, he-man tripod should be built, instead of the too common "pansy frail." Give it good husky legs. Usually, however, you will want it portable, but its length will defeat this unless you make it jointed—and then comes the question of a joint that won't, in turn, defeat the effort to make it rigid.

One kind of folding legs is shown in the accompanying photographs of a tripod made by F. M. Garland, 1006 Davis Ave., Pittsburgh, Pa. These fold outward and upward, rather than inward, and thus nest closer when folded. The tripod has three hinged central braces in addition, made of strap metal slotted for adjustment and provided with a wingnut for tightening. These braces are far enough above the knee-joints of the legs so that they will not extend below the latter when the tripod is folded.



Main feature of Garland's tripod is the knee-joint which, once locked, is as solid as a human knee in a plaster cast. On the outer—not the inner—side of each leg is a heavy backflap hinge, as shown in the left-hand closeup, and on the inner sides are metal straps pivoted at their tops on a screw and side-slotted near their bottoms. Each slot has a bolt and wingnut for tightening.

Other stiffening and strengthening details show in the photographs. The tripod shown weighs about 15 pounds and is very rigid. The refractor seen on it is an old 3 1/2" Brashear.

TELESCOPTICS

(Continued from preceding page)

the polar axis makes a complete revolution in about a minute. Owing to the limitation of power that can be transmitted by the friction drive, and the practical irreversibility of the small worm gear, the gramophone motor is quite unaffected by the rapid adjustment taking place, and continues to run on as usual. Immediately, therefore, after the 1/4 h.p. motor is disconnected, the friction drive instantly resumes its functions without *any lag or loss of time whatever*. During normal working, the 1/4 h.p. motor rotates idly, very slowly."

Weights of individual parts of the instrument are as follows:

Mounting, including fabricated R. S. C. foundation, baseplate, polar axis, fork, bracket, and footstool castings	2399 lbs.
Tube with flat and its cover	577 lbs.
Cell and mirror supports	385 lbs.
Mirror	196 lbs.
Total	3557 lbs.

This ends Hindle's description. Readers of "ATM" and "ATMA" will recognize him as a co-author of those books. By vocation he is a manufacturer of looms—those very heavy ones of 30 tons or so such as are used in weaving the dryer felts of cotton, thick and wide, used by papermakers. The same readers will recall the picture of a 30" mirror on a grinding machine, on page 245 of "ATM" (fourth edition, of 1935): this is the same mirror.

Hindle enjoys making telescopes. Having made them, he gives them away! However, lest about 10,000 readers obey that impulse to rush applications for free 30" reflectors by cable, we hasten to add that he hasn't exactly given away his two large telescopes, a previous 20 1/2" and this 30", in quite that way. He has, however, commendably arranged to place them where they will work hard for astronomy. The 20 1/2" (see its photo in "ATM," page 453) has been in the hands of Dr. W. H. Steavenson, a prominent English variable star observer, more widely known by hundreds of astronomical friends in Britain and America as "Steave," who contributed the chapter on dewing of optical surfaces, in "ATMA." The new 30" is being mounted in the grounds at Cambridge University Observatory by arrangement with Sir Arthur Eddington, where it will be available for the use of the Professor's staff. Later Dr. Steavenson hopes to be in a position to make regular use of the newer instrument himself.

LAST month in this department there was a long article by Hendrix and Christie, of the Mt. Wilson Observatory, on the Schmidt camera, and now we have the following comments on that article written by Prof. C. H. Smiley, Director of the Ladd Observatory at Brown University and a leading exponent of the Schmidt camera:

"It is with some hesitancy and considerable distaste for the task that this criticism of the article by Hendrix and Christie in last month's Scientific American is written. I am deeply indebted to Mr. A. H.

Joy of the Mt. Wilson Observatory and to a lesser extent to Mr. Hendrix for valuable assistance and advice in 1937 in connection with improvements made on the Ladd Observatory Schmidt camera which had just been completed. I am well aware that Mr. Hendrix has made more Schmidt cameras than any one else on earth. If I were asked where the outstanding authorities in astronomical optical work were located, Mt. Wilson Observatory and Hendrix and Christie would come first to my mind.

"Even so, one of the sentences early in the article by Hendrix and Christie seems to me to be distinctly unfair—'Several articles have been written about the Schmidt camera since the inventor set forth its principles in 1931, but little that is new has been included in these discussions.' It is true that Schmidt was a genius and that he did state most of the important facts in his original article. However he did *not* give a mathematical design for the correcting plate, he did *not* give any method of testing nor was his method of making a correcting plate revealed to the public until after his death. These important deficiencies have been taken care of by papers by F. B. Wright, B. Strömgren, H. A. Lower, Y. Vaisala, A. DeVany, and others.

"One might overlook a single ungenerous remark in the early part of the article but a considerable amount of material presented in the latter part of the article has previously been *published* by others, yet the article does not indicate this. A recent letter from Christie suggests that Hendrix and he knew all these things before others published them. I do not question the veracity of this statement. However, priority in scientific matters is usually established by publication in a journal generally available to others. On this basis, F. B. Wright and B. Strömgren should receive credit for their publication of the mathematical design of the correcting plate, and other acknowledgments of *priority in publication* should have been made.

"In brief, I feel that the ungenerous and misleading statement concerning earlier publications and the failure to mention the people who have made information on the Schmidt available generally are unfortunate, particularly so in view of the fact that Hendrix and Christie have had most of the information presented in this article for the past five years and have withheld it from publication during that interval."

RULE for finding sagitta of a mirror, expressed directly in sixteenths of an inch, offered by Joseph Dwight, Hyannis, Mass.: Divide aperture by focal ratio.

To measure depth of sagitta on a mirror while roughing out, Lloyd Anderson, 11909 Vicente Blvd., West Los Angeles, Calif., puts a small drop of soft pitch at the center and places a steel straight-edge across the mirror, pressing the pitch down. Then, with a calipers, he simply measures the thickness of the pitch. Automatic feeler!

FOREIGN telescoptics is one of the hobbies of R. L. Beardsley, 2515 W. 21 St., Los Angeles, Calif., who reads about 769 foreign languages. He says G. O. Bjordal, Box 111, Askim, Ostfold, Norway, is one of five TNs in that town who would like to receive photographs of American TN's telescopes. They read English.

CURRENT BULLETIN BRIEFS

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

Television Cyclopedia, compiled by M. N. Beitman, is a pocket-size booklet which will bring the reader completely up-to-date in television nomenclature and practice. Thoroughly illustrated with drawings and photographs, it covers the entire field from "Aberration" to "Work Function." An appendix puts forth the fundamental principles of television as a running story, interestingly told. *Scientific American Book Department, 24 West 40th Street, New York City.—50 cents.*

New Horizons of Industry Through Research is a 62-page booklet that presents "a tour through the present into the future." It covers scientific research and its applications in industry throughout a broad field ranging from automobiles and chemicals through health and homes to roads, rubber, vision, and wood. It is essentially a highlighted survey of what will be accomplished in the future, based upon accomplishments of the present. *Department of Public Relations, General Motors Corporation, 1775 Broadway, New York City.—Gratis.*

Metallizing Handbook is a 26-page booklet which gives complete details on metal spraying, together with a series of pictures which shows specific applications. The equipment necessary for such work is listed. *Metallizing Company of America Inc., 562 West Washington Boulevard, Chicago, Illinois.—Gratis.*

Typical Nickel Alloy Steels and Cast Irons Employed in Diesel Construction is a single sheet tabulation which covers these metals as used in light, medium, and heavy Diesel engines. It tabulates engine parts, recommended compositions, mechanical properties, and heat treatment. *The International Nickel Company, 67 Wall Street, New York City.—Gratis.*

The Industrial Uses of Presto Sound Recording Equipment is a 12-page pamphlet, illustrated with a number of photographs, which describes this type of high-grade recording equipment and sets forth a number of the uses to which it can be put. *Presto Recording Corporation, 139 West 19th Street, New York City.—Gratis.*

Sealair Windows is a 10-page, completely illustrated booklet which shows and describes all-aluminum windows in stock and standard sizes. It should be of particular interest to the home owner who is considering building or rebuilding. *The Kawneer Company, Niles, Michigan.—Gratis.*

Practical Television by RCA is a 40-page book which is particularly concerned with circuit design, antenna installation, and reception. It is published for service men, dealers, schools, and anyone interested in a survey of television as it stands today. It presents a general discussion, technical description of receiving circuits, details of television receivers, a section devoted to general service problems, and a group of television definitions. *Obtainable from RCA distributors or direct from RCA Manufacturing Company, Camden, New Jersey.—25 cents.*

News Photography Record is a stenographic report of the second annual short course in news photography at Kent State University. It covers, in lecture form, practically the entire field of photography, from the latest developments in cameras and equipment to color photography, photography by polarized light, news photography, and so on. *A. Clarence Smith, Associate Professor of Journalism, Kent State University, Kent, Ohio.—$2.58.*

Dyes is a 12-page illustrated booklet which has been prepared to correct certain misconceptions. It clarifies, for example, the situation as regards the dependability of American dyestuffs and the identification of color-fast merchandise. It also tells of the research which is being carried on to assure the American public that our dye industry will retain its present high standards. *E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware.—Gratis.*

Allied's Radio Builder's Handbook is a 30-page, thoroughly illustrated booklet which gives the reader some theoretical background, together with a knowledge of radio circuits. A short section is also devoted to amateur radio—how to operate an amateur radio station and how to send and receive in code. A group of circuit diagrams gives the reader something concrete to work on. *Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois.—10 cents.*

An Address by Edward G. Budd is a short, compact reprint which gives a brief but thorough survey of railroad travel in the United States as it is today. It gives a better over-all idea of how the railroad picture has changed within the last few years than could be obtained from many a long-winded technical discussion. *Edward G. Budd Manufacturing Company, Philadelphia, Pennsylvania.—10 cents.*

Philippine Mining Year Book contains a complete history of the various mining districts in the Islands, the history of the leading producers, and a review of the base metal industry. The book is profusely illustrated and presents complete statistics and directories of companies, mines, personnel, and results obtained. *Ralph Keeler, Post Office Box 769, Manila, Philippine Islands.—$1.00.*

The American Way in Industrial Research is an 8-page illustrated reprint which describes specifically the work of Mellon Institute and other institutions which are today shaping our industrial future by the work which they are doing in various fields of research. *Mellon Institute of Industrial Research, Pittsburgh, Pennsylvania.—Gratis.*

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

Battle of Baths

TWO bath preparations similar to bath salts, both bearing French names, were involved in a recent suit for unfair competition and trade-mark infringement. The manufacturer of a bath preparation bearing the trade mark "Bain de Champagne" brought suit against a competitor selling a bath preparation under the name "Bain Mousseux," charging that the names were confusingly similar to each other. It was pointed out that the word "Bain" meant bath and that accordingly the plaintiff's trade mark meant bath of champagne whereas the defendant's trade mark meant sparkling bath. The defendant's preparation when added to the water in a bath conveyed a sparkling or effervescent character thereto. The plaintiff contended that the word "sparkling" used in the defendant's name would immediately suggest champagne and for that reason the defendant's name would necessarily be confused with plaintiff's.

The court, however, pointed out that in sound and appearance the two names were quite different and that furthermore the word sparkling suggested many other products besides champagne. Since the defendant's name was merely descriptive of one of the characteristics of the preparation the court refused to restrain the use thereof.

Chorus

THOSE of us who have difficulty in remembering more than the chorus of a song and find ourselves humming or singing the chorus of a song over and over again will receive a certain amount of moral sustenance from the judicial declaration that the chorus forms a substantial portion of a song. In a recent suit for copyright infringement the owner of the copyrights on two songs charged that a printing company was guilty of copyright infringement because it had sold printed copies of the choruses.

One of the defenses raised was that the mere copying of the choruses did not constitute an infringement of the copyrights because the choruses did not constitute substantial and material parts of the songs. The Court held that this defense was without merit, stating:

"The chorus of a musical composition may constitute a material and substantial part of the work and it is frequently the very part that makes it popular and valuable."

Turn Around

IN a recent decision of a Federal Court the trade mark Run-R-Stop was held to be infringed by the trade mark Stop-A-Run. In the suit in question the manufacturer of a fluid to be used in stopping runs in silk stockings charged a competitor, making a similar product, with unfair competition and trade-mark infringement. The Court found that the plaintiff had used its trade mark Run-R-Stop for many years, had spent a great deal of money in advertising, and had clearly established a secondary meaning for the name which indicated to the purchasing public that the product was manufactured by the plaintiff.

The Court recognized the differences between the two names but came to the conclusion that, due to the euphonious similarity between them and due to the further fact that the packaging and dressing of the two products were very similar, the use of the name Stop-A-Run by defendant was likely to lead to confusion and constituted trade-mark infringement.

Addendum and Dedendum

THE Court of Customs and Patent Appeals has allowed a patent on toothed gearing in which the teeth of the driving pinion are all-addendum and the teeth of the driven wheel are all-dedendum and with a pressure angle lying between 22½ degrees and 30 degrees. The terms addendum and dedendum as applied to gearing means that the teeth are outside and inside respectively of the pitch circles. The pitch circles are circles passing through the pitch point of the gears and which are coaxial with the axes thereof.

The Patent Office had refused to allow the patent on the grounds that the provision of pinions in which the teeth were all-addendum or all-dedendum was old and that the pressure angle of the teeth was more or less optional. On appeal the Court of Customs and Patent Appeals reversed the Patent Office and held that the pressure angles referred to in the patent were critical and produced new results which were not attainable prior to the invention.

In reaching its decision the Court was influenced by the affidavits of several experts who told of the many years of experimentation required to develop the gearing and also stated that the particular angles referred to were critical.

Jewelled Shroud

THE utility of a design has no bearing upon the validity of a design patent. This principle of patent law is illustrated by a recent suit for infringement of a design patent for an automobile exhaust shroud.

Briefly stated, the design patent related to an exhaust shroud having a sloping top surface in which a glass reflector jewel was mounted so that the headlights of a car approaching from the rear would be reflected by the jewel. After considering the elements of the design or appearance of the shroud and finding that they were of more or less conventional character the court briefly considered the utility or function of the new design. In this connection the court pointed out that any utility resulting from the new design had no bearing upon the validity of the patent, stating:

"Moreover, we must keep in mind that the utility of the combination of the glass jewel and the exhaust shroud is not involved. Utility plays no part in determining the validity of a design patent."

Professional Misrepresentation

A RATHER novel defense was raised in a recent proceedings brought by the Federal Trade Commission against a manufacturer of a soap and ointment used in the treatment of skin diseases. The Federal Trade Commission charged that the manufacturer was guilty of unfair methods of competition because of misrepresentations appearing in certain of the advertisements and advertising circulars of the manufacturer.

One of the defenses raised by the manufacturer was that the advertisements in question appeared in a professional journal and that the physicians who read the journal would not be misled due to their medical knowledge. A Federal Circuit Court of Appeals rejected this defense on the grounds that if the advertisements were false and misleading it was immaterial whether or not individual readers were actually misled.

The Court also stated:

"Conceding the somewhat violent assumption that prospective patients never read medical and nursing journals, we do not concede either the ethics or the law of a proposition which puts a premium on a failure in wickedness."

B. O.

RATHER intimate and personal issues were considered by the Patent Office tribunals in a recent opposition by a prominent soap manufacturer against the application for the registration of the trade mark "Nobio" by a deodorant manufacturer. The Court of Customs and Patent Appeals found that the soap manufactured had popularized the letters "B.O." by extensive advertising and had identified them with the words "body odor." The deodorant manufacturer contended that his trade mark "Nobio" was, in fact, an abbreviation of the sentence "Natural Oils Ban Intimate Odors" which also appeared on his label.

The Court found that the soap manufacturer would be damaged by the registration of the trade mark "Nobio" and refused to permit the registration, stating:

"It is evident, we think, that, although the terms 'Nobio' and 'B. O.' do not look exactly alike, the term 'Nobio' will be pronounced as though it were spelled 'No-B-O'; that appellee intended that its term 'Nobio' should be understood as meaning 'no B. O.' (no body odor), and that it will be so understood by the purchasing public."

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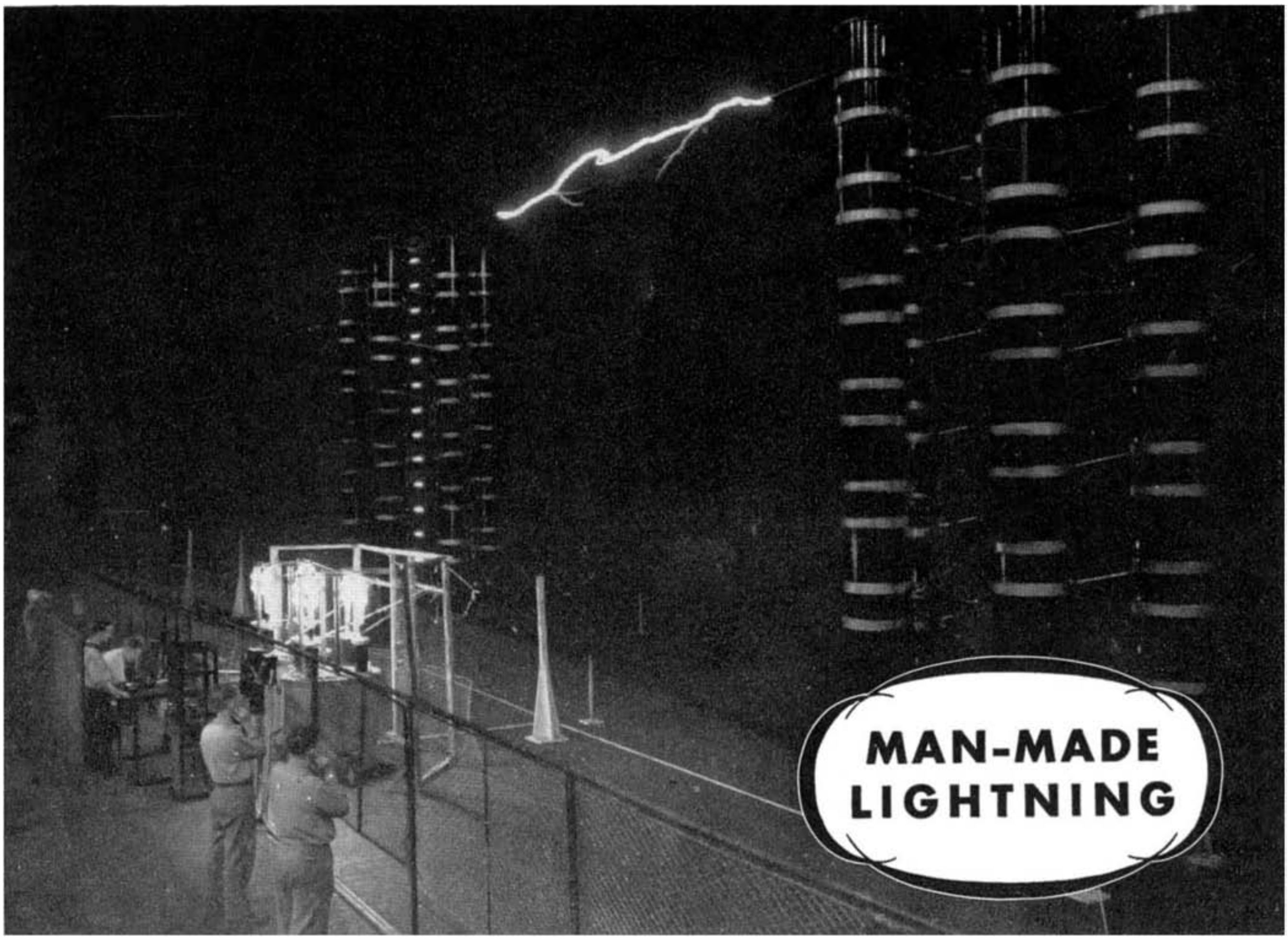

-and the "HOUSE OF MAGIC"

In the G-E building at the NEW YORK WORLD'S FAIR, ten million volts of man-made lightning crash and thunder—thousands see for the first time the modern marvel of television—trace, in the great mural by Rockwell Kent, mankind's upward struggle—see dramatized, in the "House of Magic," the most recent achievements of G-E research.

SAN FRANCISCO'S Treasure Island has been painted with light by General Electric. Here, the new G-E short-wave radio station W6XBE carries news of the Fair to distant lands. In the G-E exhibit, the Magic Kitchen tells of new standards of living—the "House of Magic" reveals new wonders of science.

WE INVITE YOU to see these and the other features of the G-E exhibits at the Fairs, not only because they are entertaining and spectacular, but because they reveal the secret of America's progress. They show how American industry, by developing new products, improving them, and learning to make them inexpensive, has made it possible for millions of people to have more of the good things of life. In this progress of creating MORE GOODS FOR MORE PEOPLE AT LESS COST, which has made the American living standard the highest in the world, G-E scientists, engineers, and workmen have played an important part. Visit the G-E exhibits and see for yourself this work of General Electric research, which today is building even higher living standards for the people of America.

G-E research and engineering have saved the public from ten to one hundred dollars for every dollar they have earned for General Electric

GENERAL ELECTRIC

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