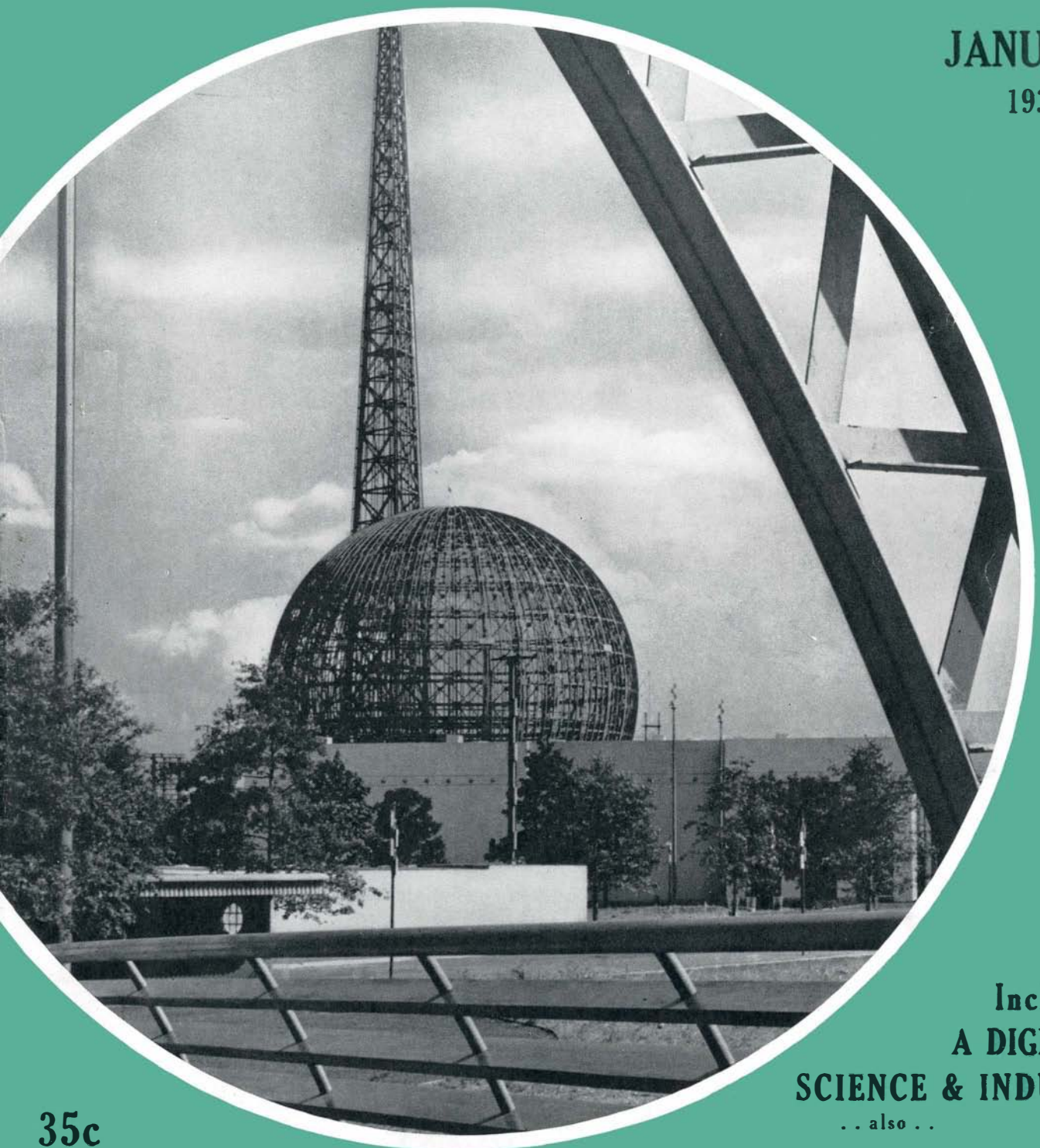
SOLIDS THAT FLOW: Stone, Ice Rubber, Glass

SCIENTIFIC AMERICAN

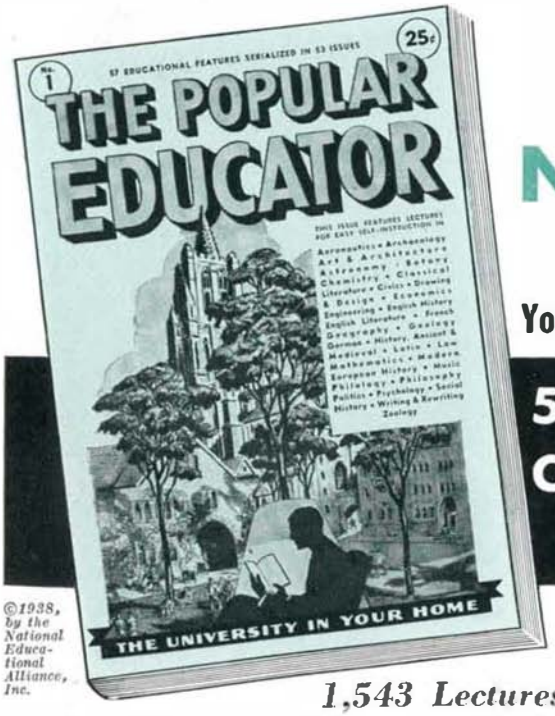


JANUARY
1939

Including:
A DIGEST OF
SCIENCE & INDUSTRY
. . also . .
AMATEUR PHOTOGRAPHY
By Jacob Deschin

35c
a Copy

Photographed by
RICHARD WURTS



Over a Quarter of a Million People Have Enrolled

NEW CLASS NOW FORMING

You Must Register At Once . . . Mail Coupon On Opposite Page

57 New Easy Reading Courses Covering 4 Years High School and 2 Years College

1,543 Lectures

2,437 Pictures—49 Color Plates

Here is such a wide choice of educational opportunities that you will find all courses of instruction which you want and need. And even if you do not feel the need of studying *systematically* a single one of the 57 courses, you will still find in the POPULAR EDUCATOR a vast wealth of articles as fascinating as could be found in any popular non-fiction magazine. Each weekly number will give you the biggest quarter's worth you ever had!

ENGLISH (Speaking, Reading, Writing)—MATHEMATICS—PSYCHOLOGY—etc.

for Only 25 Cents Each!

The POPULAR EDUCATOR is truly "the poor man's higher education." Take, for example, a subject like PSYCHOLOGY. If you had to attend lectures on this subject in person at a High School or College, it would cost you hundreds of dollars—even an elementary textbook would cost you three or four. Yet the *Alliance* teaches you this useful science for a whole year—AT A TOTAL COST OF EXACTLY 25 CENTS! This is an unprecedented bargain!

Prepared by THIS NATIONAL COUNCIL OF DISTINGUISHED

Outstanding Authorities from Leading Universities and Colleges

E. A. Sallers, B.S., M.A., Ph.D.
Louisiana State University
ACCOUNTANCY

Theodore von Karman, M.E., Ph.D.
Guggenheim Aeronautics Laboratory
Frank Malina, Research Fellow
Calif. Inst. of Tech.
AERONAUTICS

H. E. Barnes, M.A., Ph.D.
New School for Social Research
AMERICAN HISTORY

Walter W. Hyde, M.A., Ph.D.
University of Pennsylvania
ANCIENT AND MEDIEVAL HISTORY

Clark Wissler, A.B., Ph.D., LL.D.
Yale University
ANTHROPOLOGY

Albert T. Olmstead, Ph.D.
University of Chicago
Clark Wissler, Ph.D.; N. C. Nelson, M.L.; G. C. Vaillant, Ph.D.; W. C. Bennett, Ph.D.
Amer. Museum of Natural History
ARCHAEOLOGY

Ernest Pickering, B.S.C., M.Arch.
University of Cincinnati
ART & ARCHITECTURE

Clyde Fisher, Ph.D., LL.D.
Amer. Museum of Natural History
ASTRONOMY

G. B. Winton, M.A., D.D., Litt.D.
Vanderbilt University
BIBLE HISTORY

John Hiram Gerould, Ph.D.
Dartmouth College
BIOLOGY

Loren C. Petry, B.S., M.S., Ph.D.
Cornell University
BOTANY

John Presley Fife, Ph.D.
Stevens Institute of Technology
BUSINESS ENGLISH

L. A. Goldblatt, Ph.D.
University of Pittsburgh
CHEMISTRY

C. J. Friedrich, Ph.D.
Harvard University
CIVICS

Dorrance S. White, Ph.D.
State University of Iowa
CLASSICAL LITERATURE

Walter Prichard Eaton, B.A.
Yale University
DRAMA

Andrew M. Vincent
University of Oregon
DRAWING & DESIGN

H. H. Coulson, A.B., A.M. (Cantab.)
St. Louis University
ENGLISH HISTORY

Thomas A. Knott, Ph.D.
University of Michigan
ENGLISH LANGUAGE

Hoyt H. Hudson, Ph.D.
Princeton University
ENGLISH LITERATURE

Elsa Findlay
Columbia University
EURYTHMICS

Earl F. Langwell, Ph.B.
University of Notre Dame
FRENCH

Samuel Tilden Bratton
University of Missouri
GEOGRAPHY

Terence T. Quirke, M.Sc., Ph.D., F.A.A.A.S.
University of Illinois
GEOLOGY

F. W. Pierce, Ph.D.
Penn State College
GERMAN

Henry N. Sanders
Bryn Mawr College
GREEK

Gerald G. Walsh, S.J., B.A., M.A., Ph.D., S.T.D.
Fordham University
ITALIAN

Grant M. Hyde, B.A., M.A.
University of Wisconsin
JOURNALISM

Roy J. Deferrari, A.B., M.A., Ph.D.
Catholic University of America
LATIN

E. Karl McGinnis
University of Texas
LAW

William Whitfield Elliott, A.B., Ph.D.
Duke University
MATHEMATICS

James D. Weinland, Ph.D.
New York University
MNEMONICS

Tibor Kerekes, Ph.D.
Georgetown University
MODERN EUROPEAN HISTORY

Howard H. Preston, Ph.D.
University of Washington
MONEY

Wendelt W. Wright, Ph.D.
Indiana University
PENMANSHIP

P. W. Dykema, M.L.
Columbia University
MUSIC

D. E. Johnson, Ph.D.
State University of Iowa
PHILOLOGY

Walter E. Ekblaw, M.A., Ph.D.
Clark University
ECONOMIC GEOGRAPHY

Frank T. Stockton, A.B., L.H.D., Ph.D.
University of Kansas
ECONOMICS

Organized to Help Millions Broaden Their Knowledge, Through the POPULAR EDUCATOR

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

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

CONTENTS • JANUARY • 1939

THROUGHOUT the New York World's Fair 1939 the keynote of building design will be symbolism, over-topped physically by the symbolism of the theme center—the Perisphere and Trylon. Our cover illustration shows these two unusual structures nearing completion; an article on page 24 of this issue tells of the problems that were met and solved in their design.

SCIENTIFIC AMERICAN, January, 1939. Vol. No. 160, No. 1, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City.

Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

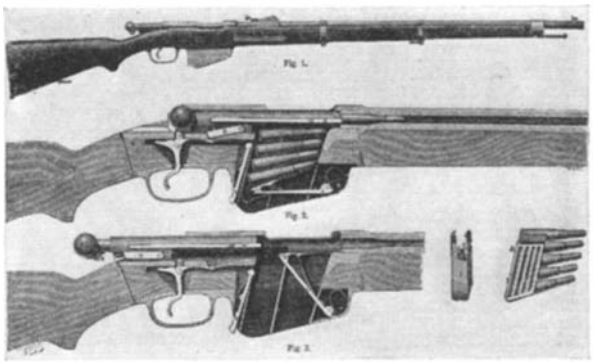
50 Years Ago in . . .

Scientific American

(Condensed From Issues of January, 1889)

PHONOGRAMS—"Subscribers to whom are rented machines can have left at their door every morning the waxy tablets known as phonograms, which can be wrapped about a cylinder and used in the phonograph. On these tablets will be impressed from the clear voice of a good talker a condensation of the best news of the day, which the subscribers can have talked back at them as they sit at their breakfast tables."

MANNLICHER—"Austria, like France, has adopted for the arming of her infantry a gun of small caliber, and has chosen the model presented by the armorer, Ferdinand Mannlicher. This weapon, like the French gun (the Lebel), is of 8 mm. caliber, and fires a steel-incased ball. The closing of the Mannlicher gun differs completely from that of guns provided with a bolt. The object of the inventor has been to suppress the lateral motion of the movable breech, and to effect the opening and closing of the gun by a single horizontal motion, such an arrangement permitting of exhausting the magazine of cartridges without removing the weapon from the shoulder. . . . To consider but the repeating mechanism, the Mannlicher gun may, as regards its simplicity, the strength of its parts, and its operation, be considered as the most perfect one that has been made up to the present."



GAS-CARRIAGE—"At the exhibition of machinery which was held in Munich during the past year, the attention of the visitor was attracted to a vehicle with a motor constructed by the Rhine Gas Motor Works, Benz & Co., of Mannheim. This motor is driven by gas which it generates from benzine or analogous material. . . . The motor . . . is placed in the rear of the three-wheeled carriage over the main axle . . . and the benzine used in its propulsion is carried in a closed copper receptacle secured under the seat, from which it passes drop by drop to the generator, and which holds enough benzine for a journey of about 75 miles. The gas mixture is ignited in a closed cylinder by means of an electric spark."

OIL—"Almost every vessel that encounters heavy seas reports, on reaching harbor, that oil was used in calming the waves with great success, and had it not been for the oleaginous liquid, the ship and all on board would certainly have gone to the bottom. Notwithstanding these multifarious statements, the percentage of vessels lost appears to remain about the same. Even if the oil has no great effect on the angry waters, it certainly produces a powerful influence upon the imaginations of the mariners. They believe it adds to their safety, fears are allayed, good judgment is preserved, and all hands work intelligently."

GAS-ELECTRIC LAMPS—"M. G. A. Tabourin proposes to the Paris Municipal Council to fit each lamp post with arc light, dynamo, and gas engine. He has contrived a dynamo of minute parts and a gas engine ten inches in diameter for coupling up with it, and would put a dynamo and gas engine in the post under each of the gas lamps, as used at present in that city, utilizing the gas supply for feeding the gas engine. . . . Should his scheme prove practicable, we might be enabled to give up the discussion of burying wires, so far as high tension currents are concerned, for it would not require any."

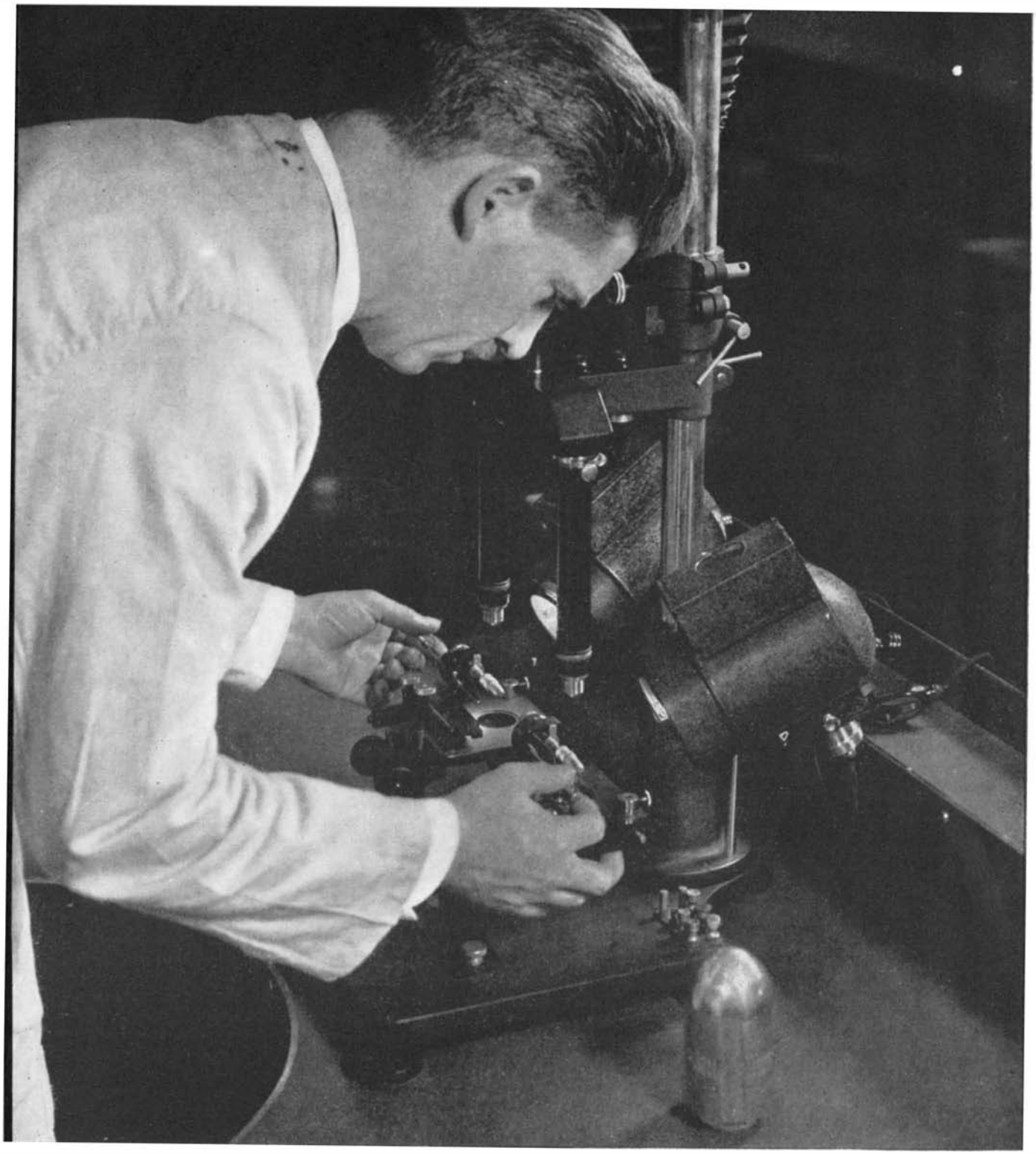
TORNADO—"A tornado which produced disastrous effects in many places on the night of January 9 visited a large region, including portions of New York, Pennsylvania, and New Jersey, and extending up to Canada. Among the more remarkable effects were the destruction of the Reading Silk Mills, in Reading, Pa., the carrying away of the trusses and platform of the Niagara foot bridge, and the explosion of two gas holders in Brooklyn, N. Y."

BIG GUNS—"On December 12 last, one of the 48-ton breech-loader guns of the French battle ship *Admiral Duperre* burst, while firing at a target off Toulon. An officer and five men were killed. This gun was one of the finest examples of the built-up system, of which many disastrous failures are on record. Those who brag so much about these guns, and are so ready to denounce cast guns, have considerable still to learn."

CRIME—"The report of the Elmira Reformatory, now eight years in operation, will be found worthy the attention of the scholar, as well as that of the humanitarian. It shows, so far as so limited an experience can be relied on, that the contamination of a penitentiary tends to encourage those to adopt careers of crime who are not naturally vicious, and, *per contra*, that education and the absence of vicious surroundings serve, at least in the case of first offenders, to wean them from the course they have only just set out upon."

SPEED—"At a recent meeting of the Berlin Physical Society, Dr. Konig gave an account of experiments which he had made with Ottomar Anschutz on the instantaneous photography of projectiles. . . . A cannon ball was projected in front of a white screen illuminated by direct sunlight, occupying in its passage one-fortieth second. During this time four negatives were taken. The firing of the cannon, the momentary exposure of the plate, and the recording of time on the chronograph were provided for by electric currents."

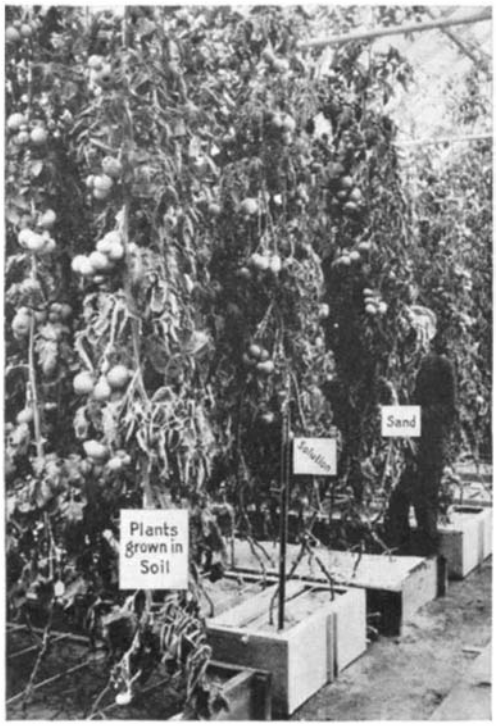
ELECTROCUTION—"The new law of the State of New York, ordering death by electricity as the punishment for capital offenses, went into effect January 1st."



TWO BULLETS FROM THE SAME GUN?

IMAGES of two individual bullets, held in position under this comparison microscope's two objectives, are thrown together in the eyepiece. An "evidence" bullet is clamped under one objective and a test bullet, which has been fired from the suspected gun, under the other. Watching the two bullets in the eyepiece, the expert turns the thumb screws to rotate the bullets. If both were fired from the same gun, a point will be found where the rifling marks, or scratches, of one bullet will match those of the other. This instrument, shown reversed for mechanical reasons, is also used for checking the marks in the primers of two cartridges. It is a valuable adjunct to the work of the Technical Laboratory of the FBI, discussed in the article on page 22.

Courtesy California Agricultural Experiment Station



General arrangement of tank equipment and method of planting in nutrient solutions (above), showing the wire screen and the bedding "mattress." *At right:* Tomato plants grown in fertile soil, nutrient solution, and pure sand irrigated daily with nutrient solution. Photograph shows plants, after seven weeks of constant harvesting, with excellent growth and large amounts of fruit in all three media. General cultural conditions—spacing, staking, and the like—were the same in soil, nutrient solution, and silica

PLANTS BY LIQUID CULTURE

Fascinating Science for Amateur or Commercial Grower . . . Practical Details . . . Formulas, Specific Instructions, Suggestions . . . Window-sill Culture

By C. F. GREEVES-CARPENTER

HYDROPONICS, or the new science of tank gardening, has attained the point where it fascinates and tantalizes the enthusiastic horticulturist, be he the merest amateur or the most advanced scientific research worker. Growing plants in liquid culture media is the adaptation by Dr. W. F. Gericke, of the University of California, of a century-old method for growing individual plants for physiological research. They may now be grown under this system commercially or for the entertainment and edification of the average home-owner.

Many terms have been suggested for the "new" method, such as tank or tray gardening, aquiculture, water culture, hydroponics, and so on. Hydroponics is the designation preferred by Dr. Gericke as it is more specific than others—"hydro" meaning water and "ponos" labor. It is not, however, a method which is going to revolutionize established agricultural or horticultural procedure. Neither is it going to upset the scheme of things so that every apartment dweller and home-owner will be growing his own tomatoes and potatoes, or so that those more esthetically inclined will grow their favorite chrysanthemums, begonias, and the like, in the confines of their penthouses or rooms.

For those who are sincerely interested in the scientifically controlled production of plants, hydroponics offers a fascinating means of achieving their objective in a small space such as on a window-sill or where there is a lack of soil as would be the case in the limited confines of a roof. Experimenters, however, should know that there is little evidence that better plants or larger yields can be grown in water culture than under favorable soil conditions.

WHEN plants are grown in soil, they absorb their nourishment from many chemical compounds which are naturally present in the soil or have been added to it in the form of fertilizer. Water, acting on the introduced chemicals, releases the soluble food and makes it available for the plant roots. In hydroponics, no soil is present, the plant roots being immersed in water to which are added the requisite nutrient salts. There is, of course, an absorption of nutrients by the plants so that, under ordinary conditions, unless one is an analytical chemist and can determine which of the chemicals have been exhausted in the process of the growth of the plant, it is advisable to renew the entire solution frequently (for example, every two weeks) depending on the size and rate of growth of the plants. Changing the solution may be accomplished either by siphoning or by having a tight fitting spigot installed at the time the tank is constructed.

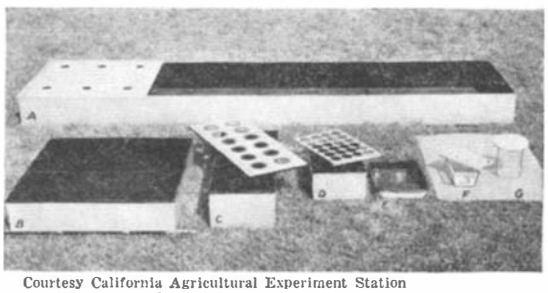
Tanks of wood, concrete, or black iron which have been coated with asphalt paint, make satisfactory containers. These may be of any length and width, but should be about six inches deep. For the sake of facility in figuring formulas, a tank two feet by six feet by six inches deep may be used satisfactorily for the initial experiments. This should first be filled with 25 gallons of water to find the water-level point. A mark should be cut into the side of the tank at this level, as it is most important that the solution not fall much below it.

A "mattress" of wire mesh—one inch for the smaller plants but two inches if larger ones are to be set out—should be coated with asphalt paint. It should then be stretched on uprights so that it is

three inches above the surface of the solution as that distance will permit a certain amount of natural aeration. It is necessary, however, to supply some means of introducing additional aeration to the solution for this is an important factor in hydroponics. In the case of the small tanks mentioned, a bicycle pump inserted in the solution and worked vigorously for a few minutes twice daily will meet this requirement, according to Nathaniel Gould Harrold who has done much research work in hydroponics on a large scale.

ON top of the wire mattress should be spread a litter of straw or excelsior on which are placed pine shavings or other fine, inert material. The thickness of the actual bed of litter depends on what is to be grown in it. If seeds are to be broadcast on the surface, a depth of two inches is desirable, but where cuttings, seedlings, or bulbs are to be set out, a three- to four-inch depth offers a more solid bed for the plants.

When plants are first set out or seeds sown, the solution should have water added until it is brought up to within an inch of the bed. That this first solution has been diluted more than called for in the formula is not important. Once the white "water" roots have been formed, the solution should then be kept up to strength and three inches below the bed at the level indicated on the inside of the tank. If the plants set out in the litter are in an advanced stage of growth instead of being seedlings, the brown "earth" roots will die off when the new "water" roots are formed. All plants, seedlings, or more mature specimens, should have their roots passed down through the litter and wire mesh so that they are immersed in the nutrient solution.



Courtesy California Agricultural Experiment Station

Various types of containers for experiments by the water culture method. They include several sizes of iron tanks (not galvanized but asphalt painted), a granite-ware pan, and Pyrex dish and beaker for special small-scale experiments

When seeds are to be sown, the bed is first moistened with water, after which the seeds are broadcast on the surface of the litter and lightly covered. Cuttings or seedlings, on the other hand, are set out as they would be in soil. In transplanting seedlings, the soil in which they were started should be thoroughly soaked to permit of their easy removal without injury to the roots. They should then be gently washed free of soil particles before being set out in the litter, at which time, as has been mentioned, their roots should reach through the bed into the nutrient solution. Bulbs are planted in the litter as though it were soil, and they will soon put on a healthy root growth if they are in good condition. At all times the litter should be kept moist but never saturated (waterlogged), for that would exclude air from the plants as well as create a tendency for unfavorable bacterial decomposition.

Of course, it is not possible to guarantee 100 percent success, and a lot of trial and error may be necessary before one finds the answer to the successful application of hydroponics to his particular plants, locality, air, temperature, and humidity conditions. Such technicalities as the character (analysis) of the water, the adjustment of the chemicals in the nutrient formula to counteract undue alkalinity, and the like, will enter into the growing of plants by this technique. The pH value (the degree of acidity or alkalinity) of the water is a factor of the utmost importance in growing plants by hydroponics and this may be easily determined by the newly developed litmus papers that have recently been introduced on the market. If the water is alkaline, either dilute sulfuric or nitric acid should be added to bring the reaction of the solution to pH 5 or 6, as shown by simple acidity determining kits. These reactions, pH 5 or 6, are only slightly acid, and the solution should be carefully held to about these points.

The next consideration is the choice of nutrient salts. Many formulas have been packaged and sold through seed supply and mail order houses. Trials may be made with these to determine whether they are suitable for the particular plants it is desired to grow, as well as for the locality and other environmental conditions. If one wishes to try some of the standard formulas which have been developed by various scientists, there are several which have been successfully used by Dr. John M. Arthur of the Boyce Thompson Institute for Plant Research, Inc., at Yonkers, New York.

A SOLUTION developed by Dr. J. W. Shive which is easy to prepare and has been very successfully used is given in Formula I. Another, which was developed by Dr. Arthur and his associates at the Institute, is given in Formula II. This latter formula is used for growing many plants rather than for single specimens. Formula II is in ounces avoirdupois and is calculated for 25 gallons of solution, as is the Shives' Formula (I). Dr. Arthur has found it desirable to add traces of iron, boron, and manganese. Iron chloride, boric acid, and manganese chloride should be made up in saturated solutions and these solutions added to the formulas at the rate of ten drops of boron, five drops of manganese, and ten drops of iron to each 25 gallons of solution. Chemically pure salts need not be used in preparing the formulas as ordinary fertilizer salts will be found equally effective.

Prof. D. R. Hoagland and Dr. D. I. Arnon, of the Agricultural Experiment Station, College of Agriculture, University of California, suggest two formulas as being suitable for growing many kinds of plants. The "T.C." formula is given in Formula III, and the Station states that it "may often be preferred

THE new science of growing plants without soil (in nutrient solutions) has already been discussed widely, but very little more than generalities have been as yet presented to the public. After long effort, we secured the accompanying *specifically detailed* article; it gives full instructions and chemical formulas which will enable you to experiment in this fascinating science.

As a convenience to readers, we list below some of the companies from whom may be purchased the chemicals or ready-made nutrient mixtures for use in hydroponics.

Eimer and Amend
Third Avenue & 18th St.
New York, N. Y.

Ellis Laboratories, Inc.
98 Greenwood Avenue
Montclair, N. J.

Nu-Way Products Co.
230 Fifth Avenue
New York, N. Y.

Garden Chemical Co.
241 Roosevelt Avenue
Livingston, N. J.

John G. Davis
1915 Marin Avenue
Berkeley, Calif.

University Apparatus Co.
2229 Magee Avenue
Berkeley, California

The Hydroponic Co.
Deadwood
So. Dak.

Chemical Garden Co.
555 Asbury Avenue
Evanston, Ill.

—The Editor.

because the ammonia salt delays the development of undesirable alkalinity." The ammonium and magnesium salts should be of technical grade, while the other two are fertilizer salts. The addition of the salts to the water should be made in the order given. To this formula should be added iron, boron, manganese, zinc, and copper. While copper and zinc are essential for plant growth, enough of these elements will usually be present as impurities in the nutrient salts or water so that the addition of copper or zinc can be safely omitted.

The boron and manganese solutions (also the copper and zinc solutions, if used) should be added in the recommended proportions each time the nutrient solution is changed.

FOR the first of these five added chemicals, a level teaspoon of iron tartrate should be dissolved in a quart of water, and this should be added at the rate of a cupful to every 25 gallons of solution each week, or more frequently should the plants appear to be of poor color.

For the boron solution, a level teaspoon of boric acid should be dissolved in a gallon of water, and 1½ pints of this should be added to every 25 gallons of nutrient solution.

For the manganese solution, a similar quantity of crystalline chemically pure manganese chloride should be dissolved in a gallon of water. Prof. Hoagland and Dr. Arnon recommend the dilution of one part of this solution with two parts of water by volume and the addition of a pint of the diluted solution to each 25 gallons of nutrient solution.

For the zinc solution, a like quantity of crystalline chemically pure zinc sulfate should be dissolved in a gallon of water, and four teaspoonfuls of this solution should be added to each 25 gallons of water.

For the copper solution, a teaspoonful of chemically pure copper sulfate should be dissolved in a gallon of water. This should then be diluted at the rate of one part to four parts water, and one teaspoon of the diluted solution should be added to each 25 gallons of the nutrient solution.

Aside from the chemical elements derived from air and water, plants require at least eleven other elements. This is true, of course, whether the plants are grown under hydroponics or in soil. These chemicals, in the case of hydroponics, must be added to the water in proper form and concentration, so care must be exercised in this respect. In the natural process of growth, it will be found that certain plants require larger quantities of some chemicals than of others and it is also true that at certain stages in their growth they will absorb more of one chemical than of another. In order to avoid the tediousness of continual analyses of the solution, one practice is to empty the tank once every two weeks as has been mentioned, but, even so, water will have to be added in the interim to keep the solution at the desired level.

When the tank has been drained for one of these semi-monthly changes, it should be half filled with 12½ gallons of water; then the nutrient chemicals should be added and the balance of the water should, when possible, be run in under pressure to insure an even distribution of the chemicals throughout the solution. The entire operation of draining and replenishing the tank should be done as quickly as possible to avoid any chance of the roots drying out.

Soil-borne diseases are, naturally, nonexistent in hydroponics, but insects, fungi, and bacteria are apt to be just as prevalent as in plants grown in soil. Mildew is likely to prove troublesome due to the humidity which is possibly increased by the moisture in the tank, but using dusting sulfur on the plants will keep this in check.

Temperature as well as strength and duration of daily sunlight are factors equally important whether plants are grown by hydroponics or in soil. Recent experiments in supplemental artificial lighting have been worked out by Lawrence C. Porter and his associates at the General Electric laboratories. These indicate that on cloudy days and during the winter days of shortened hours of sunlight, supplemental electric lighting is decidedly beneficial if applied for three hours every winter or cloudy day. A metal reflector should be bent so that the light beams are equally distributed over the tank area, and a 150-watt Mazda lamp will suffice as the light source. This should be suspended on a pulley above the tank so that it may be raised with the growth of the plants.

Courtesy Nathaniel Gould Harrold

When tall-growing plants are raised in nutrient solutions, firm supports must be fastened to the tanks

TOMATOES, potatoes, melons, beets, carrots, and other common plants respond very favorably to the controlled conditions which prevail under hydroponics. Roses, chrysanthemums, begonias, gladioli, and many other flowers may also be grown with marked satisfaction.

Hydroponics offers an intriguing field of investigation for the enthusiast. Once flowers or vegetables are successfully grown by this unique cultural technique, experiments may be made in attempts at controlling the flavor of vegetables or the color and odor of flowers, but with what success only individual research will show. Conditions are certainly more closely controlled than in soil, and with that as a starting point the investigator has much in his favor.

Formula I

Monopotassium phosphate KH_2PO_4	7½ teaspoonfuls
Calcium nitrate $Ca(NO_3).4H_2O$	20 "
Magnesium sulfate $MgSO_4.7H_2O$	12½ "
Ammonium sulfate $(NH_4)_2SO_4$	2½ "

Formula II

Nitric acid HNO_3 concentrated (69.5 p.c.)	3.84 oz.
Ammonium hydroxide NH_4OH concentrated (58.6 p.c.) sp. gr. 0.90	.88 oz.
Sulfuric acid H_2SO_4 concentrated (95 p.c.)	.67 oz.
Phosphoric acid H_3PO_4 (90 p.c.)	1.29 oz.
Potassium hydroxide KOH	.48 oz.
Calcium oxide CaO	.47 oz.
Magnesium oxide MgO	.55 oz.

Formula III

Ammonium phosphate (monobasic)	½ oz.
Potassium nitrate	2½ oz.
Calcium nitrate	2½ oz.
Magnesium sulfate (Epsom salt)	1½ oz.

RADIUM HOUNDS

Devices that Bay on the Trail of Lost Particles of a Dangerous Element . . . When a Pig Ate Radium . . . An Elephant Easier to Hide Than Stolen Radium

By ROBERT B. TAFT, M.D.
Author of "Radium—Lost and Found"

RADIUM is a gleaming sword in the treatment of disease, but it is a two-edged sword that has an unfortunate habit of getting lost. If the tiniest particle disappears, it is not only costly to replace (radium is worth 24,000 times its weight in pure gold) but also becomes an immediate menace to the lives of those who may unwittingly come in contact with its destructive rays. Actually, 107 cases of radium losses have been reported to me by members of the medical profession during the past few years. The potential danger lurking in a few milligrams of lost radium is so great that scientists have invented ingenious devices to recover it.

Radium is always handled in such minute quantities that occasional loss is inevitable. Thus, in treating cancer patients, doctors rarely use more than 100 milligrams—just about enough to cover the head of a pin. The amounts are so small that they must be mixed with other powdered salts and applied in tubes and needles made of extremely thin platinum or silver. On the cap of these tiny containers is an eyelet to which a piece of fine wire is fastened. The wire facilitates handling, but is only a partial insurance against loss.

Startling results in tracing lost radium are obtained by the use of some exceedingly clever devices known as "radium hounds." A rudimentary but effective "hound" is an electroscope consisting of a piece of gold-leaf with one end fastened to a metal support and the other hanging free. When electrically charged, the gold-leaf is repelled from the metal rod, and stands at right angles to it. Should the instrument be brought near a particle of radium, however, the electricity is partially discharged and the gold-leaf begins to drop. When the instrument is brought *very close* to the radium, the gold-leaf drops back to its normal position.

A tiny silver needle containing $1000 worth of radium was salvaged at the Presbyterian Hospital in Newark, last year, by the use of this modern divining rod. The needle had accidentally fallen into a pile of soiled dressings during the treatment of a cancer patient. Doctors discovered the loss only after the refuse had been thrown into the hospital incinerator. The silver container, of course, had by that time melted away; but since radium is virtually indestructible, even at terrific temperatures, hospital authorities knew that the missing supply was still intact somewhere in the roaring blaze. When the furnace had cooled, the ashes were carefully removed in buckets and placed underneath the "radium hound." No response came until the 23rd bucketful was reached; at that point the gold-leaf fluttered—and dropped. In a few minutes the search was successfully completed.

THE moment a quantity of radium is reported missing, everyone concerned leaps into action. A hasty preliminary search of the laboratory may be made with a piece of willemite or an ordinary fluoroscope. Willemite is a fluorescent mineral which glows in the presence of radium rays. The fluoroscope reacts similarly, but neither method is effective except at very close range. If these fail, the more sensitive "hounds" must be commandeered.

Sometimes, when the gold-leaf electroscope is not sensitive enough, a device known as the Geiger-Müller counter is brought into play. This instrument consists of a tube connected at one end to batteries supplying an electric current; the other end leads to a system of vacuum-tube amplifiers. Radium rays, if present, reduce the resistance between the two ends; the electrical impulses thus set up are magnified to operate a loudspeaker. So sensitive is this instrument that 20 milligrams of radium can be detected at a distance of 135 feet.

While treating a patient in a Canadian hospital, a doctor lost a brass capsule containing 50 milligrams of the precious element. A preliminary check-up showed that the capsule was lodged somewhere in the city's sewage system. Engineers supplied the physician with a map of all drain pipes, most of which were more than 15 feet below the street surface. Armed with a Geiger-Müller counter, the doctor then started from the hospital and slowly followed the path of the pipes as marked on his map. In the middle of the third block the clicks of the counter suddenly began to grow in volume and speed; and the trail grew warmer until the rapidity of the count told the physician that he was directly above the lost radium. A worker descended a nearby manhole and fished out the lost capsule.

In a Sioux Falls hospital a few years ago, a fantastic radium hunt began after a nurse momentarily placed a radium needle on the surgical table. The needle accidentally stuck to a piece of adhesive tape and was thrown away with a pile of refuse. By the time the loss was discovered, the rubbish had been carted off and dumped on a pig farm 40 miles away. Two University of Minnesota physicists were hurriedly dispatched to the farm, where they began testing endless piles of rubbish with their electroscopes. In the middle of their search, the gold-leaf began to quiver, but a moment later it resumed its normal position, despite the fact that the electroscope itself had not been moved. This recurred several times before one of the searchers noticed that the leaf quivered only when the herd of feeding swine nosed by. Acting on the unexpected clue, they divided the 500 pigs into groups and repeated the test until the leaf fluttered again. By the process of elimination, they finally reached one solitary pig. A butcher was called and the radium was recovered.

Uncanny as these detectors already are, technicians strive constantly to perfect their accuracy and sensitivity. A few years ago, the National Physical Laboratory in England devised an instrument called the "radium hen"—so named because the presence of radium makes the apparatus cluck just like a hen after it has laid an egg.

SCIENCE, which discovered radium, has developed virtually fool-proof means of safeguarding its use, and recovering it if lost. Sometimes radium is carried off by sewage pipes and lost in the ocean or rivers, where detection is nearly impossible. But in such cases, the radium has been deposited where it at least can do no harm. Apart from the financial loss, no one need worry.

Despite the fact that radium is worth $25,000 a gram, with the present United States supply only 300 grams (roughly, 11 ounces) doctors seldom worry about loss because of theft. Disposal of the stolen product, for one thing, would be practically impossible. The market is confined almost exclusively to the medical world, and any irregular source could be immediately traced. A stolen elephant, moreover, would be easier to hide than a pin point of radium. The

(*Please turn to page* 47)

OUR POINT OF VIEW

It's On the Way

TELEVISION, problem-child of the laboratory, appears to be ready to turn the long-promised corner. Announcement has been made that television (now called "video") programs will be presented on regular schedule by two or more eastern stations, beginning next spring. Congratulations to the earnest workers who have made great strides in this science—and particularly for their commendable reluctance prematurely to foist an imperfect service on the public. May the regular programs be as fine in quality as the admirable private demonstrations which we have recently seen!

Radio's Influence

FOLLOWING the recent "radio terror" broadcast, commentators and editorial writers did a pretty thorough job of plumbing the reasons for the public's unreasoning, instant credulity. Largely, it was assigned to a jittery state of nerves brought on by the war crisis through which the world had just passed. Such criticism was levelled at the producers of the air-drama and such vociferous demands were made for broadcasters to censor themselves that it is hardly likely that such a dramatization with such possible consequences will be repeated.

Yet in all our wide reading about the unfortunate incident, we recall not one hint of certain broader implications. Too much was said of war psychosis and nothing of the normal human equation. We had thought that the Brooklyn Bridge would find no "buyers" now, yet the confidence men who periodically "sold" that structure in the old days had a harder job than the broadcasters of H. G. Wells' drama, for the latter *explained* over and over what they were doing. It begins to look as though there must be something inherent in the radio, in the mystery of a voice coming from an unseen speaker through a gadget of wires and tubes, that inspires unquestioning confidence. Otherwise, despite the war psychosis explanation, why did not more people question this particular broadcast as did one man we know who did not hear the original announcement? When his family got excited, he told them: "Turn to other stations. If it's true that a great meteorite has fallen, all stations will be hysterical about it."

The lesson that seems to be taught—here more dramatically under what might be called purely test conditions than ever before—is that a few words over the radio, dramatized just so, exert a powerful influence over millions of our people. With a given set of conditions, a psychosis carefully built up by radicals, reformers, politicians, or "revolutionaries" of whatever stripe, it would appear that only a few suave promises, hysterical diatribes, or epithets hurled at this or that would set the people off. Perhaps the most important thing is for all who use the radio in any way to look inward, clean their own houses, and try to do some honest thinking and honest talking. If they do not, there may be a revolution among listeners—a revolution of the radio switch in a counter-clockwise direction until a click is heard.—*F. D. M.*

Premature

FREQUENTLY during recent years this journal has been urged by some of its readers to conduct certain scientific investigations, chiefly of "dowsing," or water witching for underground water with the traditional forked hazel bough.

What, from an editor's point of view, would provide more fun—not to name worthier considerations of science and usefulness—than temporarily to abandon hard sedentary work at a desk in the heart of a great city and take to the open fields to test the abilities of dowsers!

No adequate investigation of water witching ever has been made. True, Sir William Barrett and William Besterman, in their book "The Divining Rod," report on numerous tests. Water is located, they finally conclude, by those who are endowed with a subconscious supernormal faculty, cryptesthesia. Unfortunately, the book reads like the special pleading of advocates. It largely lacks objectivity. It leans. Science did not receive it favorably.

To investigate dowsing, we have been urged, simply test dowsers in the field: results count. But this scarcely seems necessary since there is no question that dowsers do locate water. So, however, do others, and there is the rub. To *prove* dowsing would require something different—something that would provide an entirely undebatable answer. For this the human factor—the hands holding the forked bough and the brain behind the hands—would have to be eliminated. Science asks for pointer readings on unsentient apparatus. Apparatus has no motives. It does not even fool itself.

Just how would such apparatus be designed? On exactly what working principle? We doubt whether anyone knows (some appear to think they do, and bring up such terms as "magnetism," "attraction"—unexplained in themselves). Until a working principle behind dowsing is found (if there is one) science is unable to proceed. An investigation would be fun but that is all it would be.—*A. G. I.*

How Much?

"HOW much will it cost?" is a question that has wrecked many a promising piece of projected research. Here should be a common meeting ground where science and industry see eye to eye in their efforts toward technological progress, yet all too often it is the stumbling point where progress is halted. It is the exceptional case where a research worker can say definitely just how long a certain project will take to complete or what his expenditures will be before he reaches his goal. Even the goal is often indefinite and frequently changes as work progresses. Research can in no way be compared with industrial production.

If industry is to realize the greatest benefits from the work of the pure scientist—who, indeed, is the dominant though retiring figure of present-day industry—he must be freed from the fetters of financial limitations, must be permitted to pursue his studies and experiments with a minimum of interference. By permitting such a course, the farsighted industrialist will find that his research laboratory will pay big dividends, often in a way that was unthought of when the work was started.

Charles F. Kettering, probably the best known research worker in the nation, recently uttered a plea for a better understanding between those who pay the bills and those who delve into the secrets of nature. Realizing that costs must be met, records must be kept, he suggested that industry in general apply the actuarial type of accounting to research, rather than cost accounting. Thus the costs of research would be allocated by a statistical average taken over a number of years and over a number of research problems.

As industry gains a greater appreciation of pure science research and its effect on the applied science that results in new products, expanded markets, and better business conditions, costs of research will assume a less important place in the scheme of things and the laboratory worker will be encouraged to pry into many corners of which little is known, unhampered by the specter of dollars and cents.—*A. P. P.*

THE CONQUEST OF THE

Palestine's Biblical Lake, Containing Sufficient Potash and Other Chemicals to Supply the World for 2000 Years, is Now Being Actively Exploited

THE successful completion of extensive works upon the southern shores of the Dead Sea, in Palestine, for the recovery of potash and other valuable salts, similar to, but on a much larger scale than, the works established at its northern end a few years ago, calls attention to what has been done in winning these prized salts from the brine-laden waters of this remarkable inland lake. Hitherto, potash has been obtained chiefly from Germany and France; more recently from the United States and Spain.

Until quite recently most people looked upon this hot, barren, and isolated region of the Dead Sea as of little value commercially. True, the waters were known to be impregnated with valuable salts, such as potash, bromine, and magnesium chloride, but the problem was to recover them on a commercial scale. To extract these coveted salts called for considerable pioneer and experimental work extending over many years. It was necessary to ascertain the exact salt content of the waters and whether these salts could be recovered by solar evaporation. This called for years of patient study and research in a hot and desolate region many miles from any center of supplies, and these had to be brought in.

Potash is a white powder, and approximately 90 percent of the potash produced to-day is used as a fertilizer. It can be used in the natural state, or mixed with phosphates or nitrates. It also finds a place in the manufacture of explosives.

Bromine is a dark, reddish brown, highly corrosive liquid, which is easily made volatile, giving off heavy vapors. It enters commerce largely in the form of its salts, of which sodium bromide, potassium bromide, and ammonium bromide are used in almost every civilized country. The principal outlet for bromine, however, is as ethylene dibromide, used with tetraethyl lead to form anti-knock compounds (that is, Ethyl fluid) which, when added to gasoline, assure smooth running in high-compression automobile engines used in most modern cars.

The Dead Sea, a great storehouse of valuable chemicals—a veritable Eldorado—forms part of a depression, a rift, in the earth's surface. The rift extends much farther than the boundaries of Palestine, running down the Jordan Valley and the Dead Sea to the Gulf of Akaba and, crossing to the African continent, reaching the great lakes in Central Africa. In the neighborhood of the Dead Sea this depression reaches its greatest depth, the surface of the Dead Sea being 1290 feet below the level of the Mediterranean. It is the lowest lying body of water on the face of the globe.

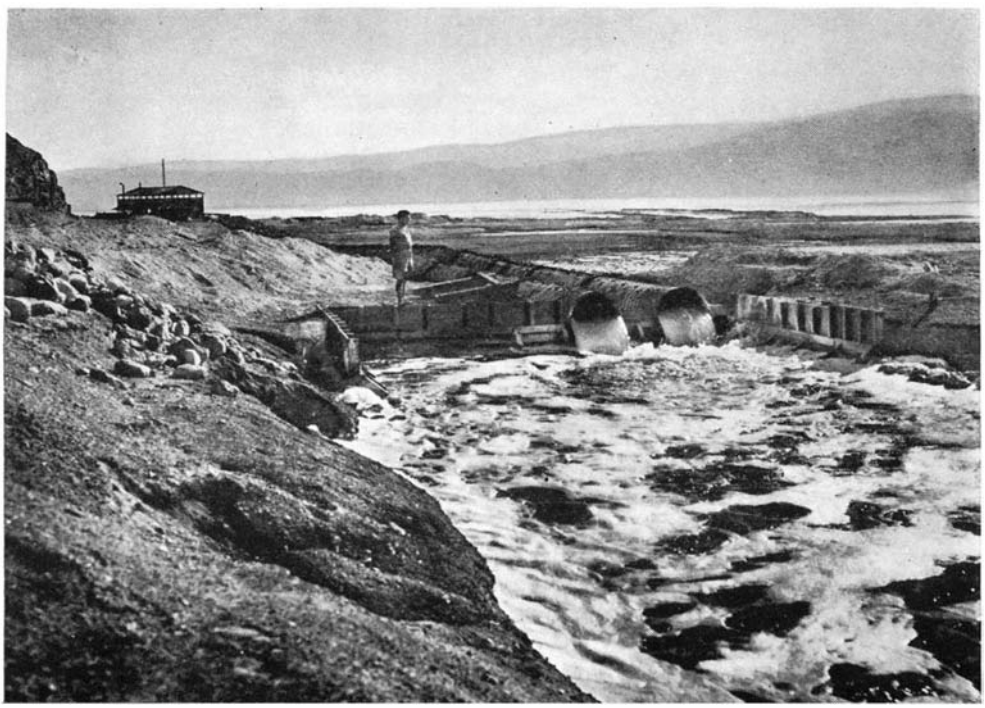
THE region of the Dead Sea is weird yet awe-inspiring, with its mountains of rock salt, its picturesque gorges, its caves, quaint little oases, and hot springs. There are the hot baths of Kalirrhoe where Herod came, when stricken with his last sickness, in the hope of finding that recovery which he sought in vain. On both the western and eastern side the Dead Sea is hemmed in by towering barren mountains, with scarcely any shore line. Everywhere there is evidence of great volcanic disturbances in past ages. No doubt the presence of sulfur, bitumen, and possibly oil, played their part in causing the overthrow of Sodom and Gomorrah and the other cities of the plain. Where Sodom and Gomorrah stood no one really knows. Ruins of a lost city have been found at the north-western corner of the Sea, and some scholars believe they mark the site of either Sodom or Gomorrah. Others place the site of these cities at the southern end. The name of Sodom has, at any rate, been given to the new potash camp at that end. On the north-western side of the Sea rises Mount Nebo, from which Moses viewed the Promised Land.

The Dead Sea has a length of about 50 miles, an average breadth of nine miles, and a maximum depth of 1300 feet. It is estimated that, from the River Jordan and the other smaller streams, there pours into the Dead Sea on an average over 280,000,000 cubic feet of water daily.

As the Sea has no outlet, this water is entirely dispersed by solar evaporation—evidence of the great heat of the region. The waters of this strange lake are so salt and bitter that no fish can live in them, and their specific gravity is so high that it is impossible for a human body to sink. That is not to say that a person could not drown in the Dead Sea. Whereas in the oceans the percentage of mineral salts is but 3½, in the Dead Sea it reaches no less than 25 percent. Place a fresh egg in the water and it will float away like a cork.

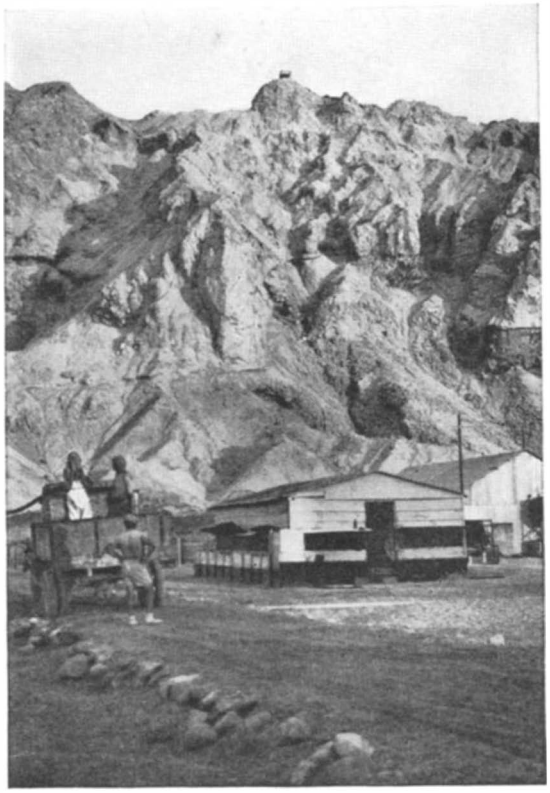
When the potash company started operations at the northern end of the Sea,

The southern end of the Dead Sea, a pumping station, and brine discharging from wooden pipes into an open canal or ditch which carries it three miles to a second pumping station



DEAD SEA

By HAROLD G. SHEPSTONE, F.R.G.S.



Jebel Usdum's cliffs of salt towering up just behind the camp established at the newer and larger plant at the southern end of the Dead Sea. Atop the salt hill is a lookout post in which are guards who watch for Arab attackers

they required the whole of the area there for their works. This was the spot visited by tourists from Jerusalem. So a small area at the north-eastern corner of the Sea was set apart as a tourist rendezvous known as Kallia. It developed into a thriving resort, with restaurants, cafes, bathing and boating facilities and with a fleet of motor coaches carrying visitors to and from Jerusalem some 25 miles distant by road.

A popular time to visit Kallia is at full moon, when the writer has counted as many as 200 bathers in the water at one time. During one of the writer's visits to Kallia a young woman was drowned within a few feet of the shore and within her own depth. Apparently she had stumbled when entering the water, and was no doubt rendered partially unconscious through the pain set up by the water reaching the eyes. Her body did not sink, but her head, the heaviest portion, was under water. At Kallia no diving is allowed and bathers are warned not to get the water into their eyes. The workers at the potash plants are not allowed to stay in the water more than a quarter hour at a time unless there are facilities for a douche in fresh water.

As a result of the experiments carried out by Mr. M. A. Novomeysky, the managing director of Palestine Potash, Ltd., a complete plant for the recovery of potash was first erected on the northern shore of the lake. Laying out these works, with their model settlement where some 500 Jews and Arabs with their wives and families dwell, was no light undertaking. Roads had to be built to the site, and a power-house, pumping station, refinery, and workshop erected. The desolate Dead Sea region suddenly became a place of great activity.

For two miles along the shore, and running back on either side of the River Jordan, are the evaporating pans, each from 7½ to 30 acres in extent, covering a total of more than 1200 acres. The brine is pumped into these pans by a great suction pipe laid on the bottom of the Sea and extending outward to reach a depth of 175 feet. Soundings showed that at this depth the water contains twice as much potash and bromine as on the surface. The pipe is 2500 feet long, 30 inches in diameter, and laying it proved to be no small feat. After sections of the pipe had been welded together on the bank, six days were spent in launching it, due to unfavorable weather and other causes. It was necessary to send down a diver to bolt the sections together. The Syrian diver employed found it impossible to work in the brine-saturated waters and an experienced diver had to be brought out from England. On the other hand, at the newly established works at the southern end of the Sea, the water is being pumped from the surface, as here it was not found necessary to lay a pipe to any particular depth.

A sluice gate between the pans, by means of which the level of the flow of the brine is regulated. Note the incrustations of mineral salts on the timber work

At both the northern and southern plants the brine is pumped into the farthest and highest of the pans, which are so arranged as to allow a constant slow movement of the brine from one pan to another, in a zigzag, downward flow toward the Dead Sea. The pans are provided with sluices, permitting regulation of the flow or temporary shutting off of any of the pans when needed. In the course of such a tardy flow, the brine becomes more and more concentrated. Common salt is the first salt to be deposited in the pans. On further concentration carnallite, or crude potash, separates out.

The carnallite is harvested mechanically as soon as three to four inches have been deposited. It is then conveyed to the field mixers in the refinery, where it is decomposed with cold water and, on further treatment in the refinery, muriate of potash is produced to any desired degree of purity. The brine left after carnallite separation—the "final brine"—contains the entire bromide in a concentrated form of magnesium bromide, which is conveyed by pumping to the bromine factory, where liquid bromine of a high degree of purity is ex-

Arab workmen on the carnallite fields, heaping up the carnallite near the railroad tracks in readiness for its removal. They are wearing high rubber boots to protect their skin against the harmful effects of the heavily concentrated mineral salts

tracted from the magnesium bromide.

Another portion of the final brine is left to concentrate further in pans till a specific gravity of 1.37 is reached. This occurs during the hottest part of the summer, when the thermometer touches as high as 160 degrees, Fahrenheit. At this point crystals of magnesium chloride separate out in the shape of long needles which are collected and further treated for the market. The remaining brine contains all the calcium chloride, which can also be extracted by a fairly simple method.

THE present output of the northern plant is 30,000 tons of potash and 1200 tons of bromine a year. Since the flat land at the northern end of the Sea, suitable for building pans, is limited, the company acquired about 23 square miles of ground at the southern end of the lake, where, during the past three seasons, engineers have been busy, as already stated, building a power-house, pumping stations, refinery, warehouses, laying out the necessary evaporating pans, and establishing a camp for the workers.

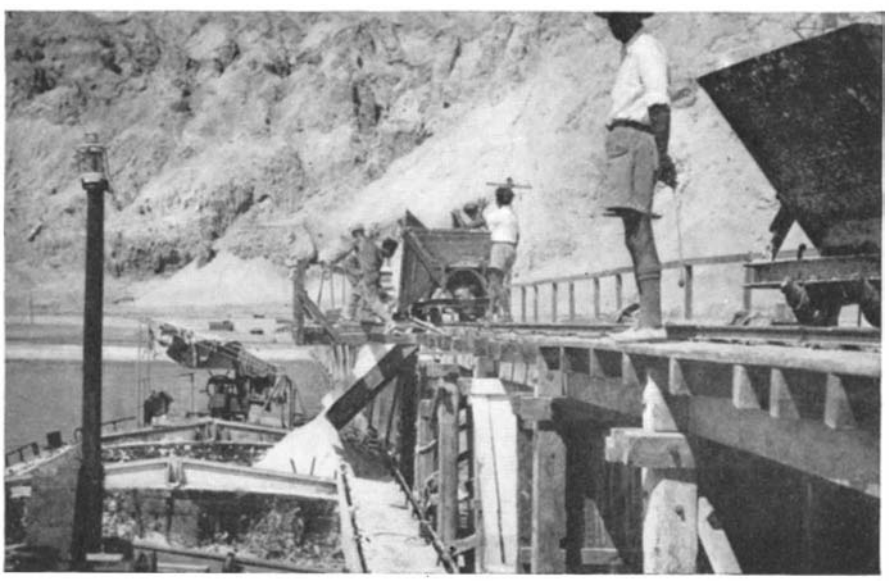
The settlement is at the base of Jebel Usdum, a mountain of rock salt six miles long and from one and one-half to two miles wide.

The establishment of a model commercial plant and settlement in this hot and isolated region presented many problems. A whole season was spent in surveying the section. Then came the erection of a pier. Everything had to be conveyed to the site by water from the northern end of the Sea. The transference of the necessary lumber, machinery, and stores was a formidable task in itself, for the local resources furnished nothing. At the end of two seasons' toil, however, the evaporating pans had been built, brine was being pumped into them, and potash was being sent in specially-built barges to the northern end of the Sea for shipment to the world markets.

While it has been found necessary, owing to the great heat, to send the staff and workers at the southern end of the Sea away for a week's respite every fourth week during the summer months, the Dead Sea region can scarcely be described as unhealthy. The air is much warmer at the southern end of the lake than it is at the northern end, the thermometer rising in the summer months to as high as 160 degrees, Fahrenheit, at midday and seldom dropping to below 100 degrees during the night. Lying 1290 feet below sea level, there is more oxygen in the air—six percent more—than at normal sea level. There is an entire absence of fog; the atmosphere is dry and the air clear. There are no mosquitoes or troublesome sand flies. As the salts obtained from the waters form the basis of many drugs used to combat and cure disease, it is thought that breathing the air that contains them in suspension is beneficial, while the waters are also highly radio-active, comparing favorably in this respect with the waters of those spas that are esteemed for their curative properties. These are the reasons given by scientists who have investigated the matter for the healthy condition of the toilers at the Dead Sea. Malaria and other diseases attributed to tropical conditions are unknown among them.

As already stated, it is believed that, with their southern plant working at full capacity, the company will be in a position vastly to increase the present output of potash, and other salts in proportion. British government experts who have made independent investigations declare that there are more than 1,000,000,000 tons of potash, over 800,000,000 tons of bromine, and other salts in proportion, in this single sheet of water—sufficient to supply the world's present needs for the next 2000 years. Moreover, these valuable salts are continually being added to. They are steadily brought down by the Jordan in solution from the hot springs of Tiberias and also pour into the lake from the hot springs in the immediate neighborhood. The Jordan alone pours into the Dead Sea about 40,000 tons of potassium chloride yearly.

WITH the exception of a single raw material—Diesel oil for generating electric power—all the raw materials used in the production of the potash and other valuable salts—that is, the waters of the Dead Sea, the sunlight, and fresh water from the Jordan or nearby wells—are available on the spot.



Potash being loaded into a 100-ton barge at the southern pier, immediately below Jebel Usdum, in preparation for towing to the northern end of the lake

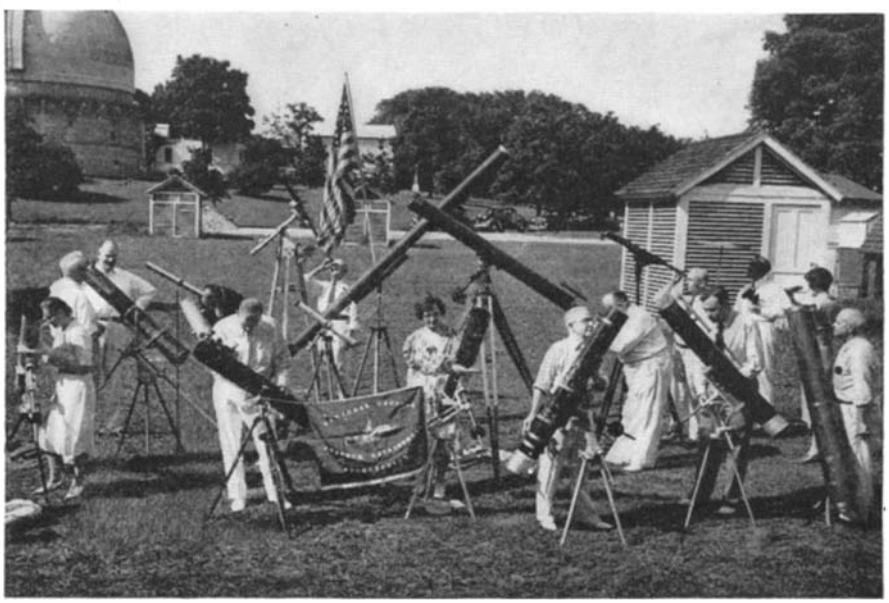
More Than One Man's Fun

KALAMAZOO, Tacoma, and Washington, D. C., from which the photographs on this page originate, are but three American centers where clubs of amateur astronomers and telescope makers thrive today. There are similar clubs in at least three-score others. Ideally combining the scientific and mechanical urges with the pleasure of hobnobbing with fellow hobbyists—studying astronomy, for example, in meetings, building telescopes together and thus throwing mutual light on each other's difficulties—these clubs of amateurs provide an outlet for what some believe to be a wish, perhaps unconscious, on the part of many, that they had chosen a career in science when they were youths.

Above: Kalamazoo Amateur Astronomical Association contains 36 members who own 21 telescopes made by themselves. A monthly meeting in some member's home permits observation; discussion and talks on astronomy or optics are given. A "night club" of this kind is less damaging to purses than another kind

Right: Tacoma Amateur Astronomers with home-made telescopes meeting in Rainier National Park with amateurs from nearby towns for a weekend of observing

Below: National Capital Amateur Astronomers' Association, with 71 members (of whom 17 men and seven women made their own telescopes) meet near the National Observatory



Persons of all vocations and ages are brought together by this common interest in astronomy and optics—though the actual telescope-making phase of these astronomical club activities seldom finds practical expression in youths less than 16 or 18 because it is work that requires more maturity, more general judgment and especially more patience and tenacity than most minors have developed. In fact, these same qualities, in the measure usually given an adult, rather than special skills beyond quite common "handyman" grade, are the main desideratum. The work is not easy—rather it is quite difficult—and this is the probable reason why it has made such strong appeal to persons of better than common intelligence. A department for the amateur "telescoptician" is published in every number of Scientific American.

THE IMAGE-SLICER

A New Apparatus Used with the Spectroscope Cuts Star-Images into Sections, Rearranges these End to End, and Multiplies the Efficiency Very Greatly

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 realizes that the astronomer's Enemy No. 1 is cloudy weather; but the weather is his Enemy No. 2 as well. Often, especially in a climate like that of the eastern United States, the sky will be clear from horizon to horizon, and the stars brilliant on a dark background, and "snappy"—and the experienced observer takes one look at the violent twinkling, even of stars in the zenith, shakes his head, and does not even bother to open up the observatory dome.

Sad experience has taught him that on such a night of "bad seeing" the image of a star will not come to any sharp focus. If he sets his eyepiece to the position which, on good nights, gives a sharp, clear image, he will see instead a large, fuzzy, and continually changing spot of light—shrinking perhaps for one good moment to something like a respectable star-image, and then exploding into a great flickering patch. Nothing has happened to the star, of course—the Earth's atmosphere is to blame.

WHEN the air is quiescent and steady, light passing through it is deviated by refraction, but by a fixed amount (depending upon the angle which the rays make with the vertical), so that the stars are clearly seen, but shifted in apparent position. Allowance for this shift demands more or less tiresome calculations, but can be fully made. But when the air is turbulent—full of streaks of different density—the rays from the star which enter different parts of the aperture of the telescope will be differently deviated. Each small bundle of them will come to a focus at a point corresponding to the direction in which it entered the instrument; but the combined effect of the whole will produce a blurred image, which will change continually as the wind carries different bodies of air across the line of sight. Windy nights are therefore unwelcome to the observer. Things are worst of all when the wind changes abruptly as the height above the ground increases. Where one layer of air slides over the other violent eddies are formed. The aviator flying through feels "bumps," and the astronomer, far below but trying to look through, gives up any precise work.

On an ordinary night the telescopic image will be fairly sharp, though blurred at times, and will dance about more or less. Observers are accustomed to describe the degree of steadiness by a scale of "seeing," ranging from zero on a bad night such as has been described to 5 on an ideally good one. Such estimates are purely empirical, but by comparison of the figures assigned by different observers with the same telescope, or by the same observer with different telescopes, at the same place and time, a fairly reliable scale can be derived.

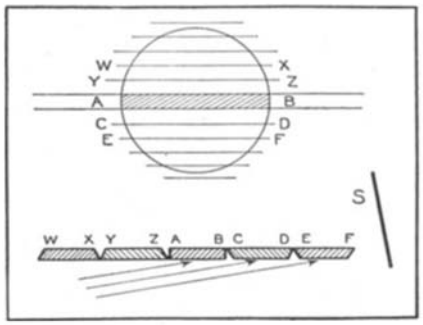


Figure 1: **Showing diagrammatically the principle of the image-slicer, as redrawn from the author's sketch**

A more open scale, running from zero to 10, has been suggested; but it has been said of someone that, being of a cautious temperament, he saved the designation 10 for conditions so ideally good that they never *could* actually happen, kept 9 for a situation so good that it never *did* happen, and called the very best nights "seeing 8."

When the seeing is bad, observations which demand the resolution of fine detail, such as measures of close double stars or study of the planets' surfaces, are impossible and most others are seriously disturbed. For example, if one seeks to photograph the faintest stars accessible with a great telescope—say the 100-inch—even moderately poor seeing expands the images on the plate so that a longer exposure is necessary to get the faintest of them above the "threshold" of visibility. This wastes time. Moreover, if the exposure is long enough to produce fogging of the plate by the general background of the light of the night sky (about half of which originates in the Earth's atmosphere) there is no gain in prolonging it further. The very faintest stars can therefore be photographed only on steady nights.

Bad seeing is also a serious enemy to the spectroscopist. To produce a sharply defined spectrum, in which lines closely adjacent in wavelength are separated, the light must enter the spectroscope through a narrow slit, only a few thousandths of an inch wide. The image of the star is thrown on this slit by the main telescope. The front surface of the slit-plate is polished, and reflects the light which does not enter the slit back to an appropriate guiding eyepiece so that the observer can see what is happening. If the seeing is very good, the star-image will be small—almost a point of light—and by careful use of the slow-motions of the telescope it can be kept upon the slit so that not much light slops over at the edges. But this happens only on the best nights. Usually the star-image is more or less fuzzy, overlaps the slit on both sides, and dances about faster than the guiding devices can follow it, so that a large part of the light is wasted. Under working conditions, 10 percent or even less may get through into the spectroscope.

TO widen the slit lets in more light, but only at the expense of spoiling the sharp definition of the spectrum—which is, above all else, needful in many types of investigation.

To put a condensing lens in front of the slit, and make the star-image smaller, is possible; but this would make the angle of the cone of light which converges upon the slit greater. To get the whole of this wide angle beam, diverging behind the slit, upon the lenses and prisms (or mirrors and grating) of the spectroscope demands changes in its optical construction; and, when the effect of these is calculated, it is found that they just undo any gain which might otherwise be hoped for.

The problem of getting more light into

the slit, under given conditions of seeing, had been given up as hopeless; but it has just been attacked successfully, by a quite different method, by Professor I. S. Bowen, of the California Institute of Technology—widely known for his identification of the principal nebular lines a few years ago. His solution is simple in principle—though rather complicated to explain in detail. The spectroscope slit, crossing the middle of the (roughly) circular image of the star, cuts out a narrow slice from it, AB, Figure 1, upper drawing, and throws away the rest. Suppose that we could in some way cut out parallel slices of equal width, such as *CD*, *EF*, *WX*, *YZ*, and divert the corresponding light into other parts of the slit, *arranged in tandem along its length*, as illustrated in the lower part of the figure. We could then get all the light through the slit (barring the inevitable losses due to instrumental imperfections) and gain correspondingly.

The actual slicing of the image is accomplished with ingenious simplicity by means of a system of small mirrors, each set up above a part of the slit, such as *AB* or *EF*, and with its reflecting surface inclined at an angle of 45 degrees so that a beam of light traveling parallel to the slit-plate, in the direction indicated by the arrows, would be reflected straight down into the slit.

SUPPOSE we could set up the spectroscope itself with its axis at right angles to the telescopic beam of light, so that the latter followed the direction of the arrows, and would form an image like that in the upper drawing upon a screen set up at right angles to it, as represented by *S* in the lower drawing (where the screen is supposed to stand at right angles to the plane of the paper). Each of the small mirrors would then automatically cut off a slice of this image, and reflect it into the slit (away from the reader), and the problem is solved.

In practice it would not be convenient to put the spectroscope in this position; but it is very easy to catch the telescopic beam (which in Figure 1, lower drawing, must be supposed to be coming downward at right angles to the page) upon a simple mirror which turns it sidewise in the direction of the arrows.

The tiny mirrors must be only about 1/30 of an inch long, and but a few thousandths of an inch wide. Such small surfaces, standing alone, could not be accurately enough figured and adjusted; but by making a series of larger blocks of glass of the proper shape and mounting them so that the end of each one projects just the proper number of thousandths of an inch beyond the one preceding, the arrangement may be practically realized. The detailed arrangement, by which each mirror-surface is fixed exactly in the right position, so that it takes its own slice of the image without either overlap upon the next or waste space between, and other refinements of the adjustment, could hardly be explained without a precise scale drawing. Indeed, an inspection of the device itself (which the writer has had the privilege of seeing) can be satisfactorily made only with the more powerful type of hand-magnifier. Every adjustment of the tiny pieces must be correct

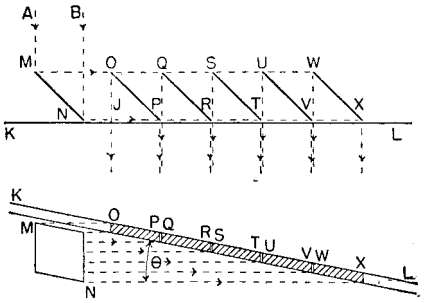


Figure 2: **Drawings by Prof. Bowen, from a technical article in *The Astrophysical Journal* (Vol. 88, No. 2), plan below, elevation above. *AB* represents a cylinder of rays. Regarding these drawings Prof. Bowen there states: "In this diagram the beam of light is assumed to come from a lens of large focal ratio and, consequently, to approximate a cylinder of uniform cross-section, equal to that of the image, in the immediate neighborhood of the focus. This beam, bounded by the rays *AM* and *BN*, is intercepted just before it reaches its focus by the 45-degree mirror *MN*, which is placed near one end and slightly to the side of the spectrograph slit *KL*. This mirror is so adjusted that the reflected beam bounded by the rays *MOQSUW* and *NPRTVX* is parallel to the plane of the slit jaws and just grazes their surface. The mirror *MN* is rotated about the initial direction of the beam (*AM* or *BN*) into such a position that the reflected beam crosses over the slit *KL*, making a small angle with it"**

to a ten-thousandth of an inch; and the technical skill required for its construction is hardly less admirable than the ingenuity of its design.

When the star's light has thus been put through the slit there is more to do, for the effective source of the light entering the spectroscope makes up in length what it lacks in breadth, and has the same area as before. With no alteration in the optical system of the spectrograph, the spectrum formed upon the plate will be much wider than before. The spectral lines will be longer, but no more intense at any given point on their length, so that there would be little saving in exposure-time. This main purpose of the instrument is attained by placing a plano-convex cylindrical lens just in front of the plate. This lens runs lengthwise of the spectrum, and compresses the image greatly at right angles to the dispersion, and so makes the lines much shorter and more intense, without affecting their relative positions at all. Here again much attention has been given to the details of design. The great spectrograph of the 100-inch telescope is fitted with a battery of Schmidt cameras, which bring the spectrum to a focus not on a flat plate but along a curved surface. To satisfy the conditions just described the "cylindrical" lens must follow this curve on its outer surface, and be like a portion of a cylinder which has been bent along its length into a circular arc. To make such an affair out of glass would be very troublesome and costly; but some of the new water-white plastics were found to be admirably adapted for the purpose.

It may be permissible to report that these preliminary tests of the "image-slicer" in actual operation show that under rather ordinary observing conditions the exposure time may actually be reduced to a quarter of that which would otherwise have been necessary. Further details should be left to be announced by the observers.

The larger the telescope, the more trouble it collects from the air. Hence the image-slicer will probably be even more valuable as an accessory to the 200-inch telescope than with any existing instrument. Its usefulness is not confined to times of bad seeing. For example, the image of a star low down in the sky is drawn out by refraction, no matter how good the seeing may be, and appears as a spectrum, with the red nearest the horizon, and the blue highest up. With an ordinary slit it is next to impossible to get the whole of this image in, and the observer must bear in mind what region of the spectrum he wants to get and guide on the colored image accordingly. But the image-slicer will take in the whole thing and solve this problem also.

FOR bodies which appear as luminous surfaces, such as nebulae, and perhaps a planet like Neptune, the new instrument will be of equal advantage. A great deal of work will still have to be done before its possibilities have been fully explored. But it is already evident that a major advance has been made in the detailed study of stellar spectra. With the new device, the 100-inch telescope should accomplish as much as the 200-inch could do without it.

It is particularly gratifying to record that this notable service to astronomy has been done by an investigator who has spent most of his time in problems of pure physics. It has been said, over and again, that co-operation between astronomers and workers in allied fields would be full of promise. This is a very fine instance of its successful results.—*Princeton University Observatory, November 5, 1938.*

EVERYTHING FLOWS

Industry is Finding Many Practical Applications of Science's Studies of the Flow Phenomena of Apparently Solid Matter as Well as of the Liquids

By R. N. TRAXLER, Ph.D.

A NEW kind of scientist has come to the fore. He is studying almost everything that pertains to our existence, comfort, and enjoyment. He has gone so far as to give himself a new name —rheologist. As this word signifies, he is interested in the problem of the flow of materials. This subject has been studied intensively only in recent years.

We commonly think of gases and liquids as mobile and subject to flow, and of solids as rigid materials that do not deform, but before the critical eyes of the rheologist, everything flows! How rapidly the material deforms and how far depend upon the temperature and pressure to which it is subjected. The following examples and discussions of the flow occurring in stones, petroleum products, rubber, synthetic resins, and paint, suggest only a few of the rheological problems that are encountered in the preparation and use of materials with which we are familiar.

Traveling through the mountains and hills one becomes aware of the deformations that occurred in the rocks during the stupendous movements which took place in past ages. One sees places where molten rock has poured into fissures in colder stone. Rivers of lava have picked up bits of cooler rock and carried them along like twigs. The heat from the molten stone gradually softened the floating fragments, resulting in their elongation in the direction of flow.

Stones may also flow at atmospheric temperatures. Such a phenomenon is well illustrated by a tombstone located in Rock Creek Cemetery at Washington, D. C. This stone, which was mentioned in Scientific American many years ago (Feb. 21, 1903) was placed in a horizontal position in 1853 and originally supported by four short columns located at the corners. During the 86 years that have elapsed since it was put in place, the marble slab has sagged without cracking; flow presumably occurred along the cleavage lines of the crystals of calcium carbonate composing the stone. The kind of deformation undergone by this stone is known as plastic flow and is distinguished by the fact that a definite amount of force, characteristic of the particular material, is necessary to initiate the movement. After this force or yield stress has been exceeded, the material flows like a simple liquid. In the case of the tombstone the weight of the marble, supported only at the corners, was sufficient to start the deformation and maintain it at a very slow rate until the caretaker inserted a fifth column at the center of the slab and arrested the movement.

Professor E. C. Bingham has called attention to other examples of the molecular flow or slippage along crystal planes in stone at atmospheric temperature and under moderate pressures. In the white marble veneering on the façade of St. Mark's Cathedral in Venice, the stone after centuries bulges out to the extent of several inches over a distance of about six feet without showing the presence of any cracks or fractures. He also states that at the Palace of the Alhambra, in Granada, Spain, one of the two doors which has been christened "La Mezquita" exhibits an ancient facing of three slabs of marble. The building has subsided, causing a considerable thrust upon the marble facing but the stone, "instead of breaking or of rupturing its casings, has simply bent and curved as if it were wood."

IN the great petroleum industry flow is a subject of paramount practical importance. Removal of crude oil from the earth, its frequent transportation to the refinery through hundreds of miles of pipe, its passage through the involved processes that create a multitude of useful products, and finally most of the uses and applications of petroleum products, present unusual and interesting problems to the rheologist. The ideal lubricant for your auto or airplane motor should be sufficiently mobile at low temperatures to lubricate and protect the moving parts of a cold engine without becoming so thin and fluid at elevated temperatures as to lose all usefulness as a protection for the moving parts of the engine. Present-day lubricants are being tailored to fit the specifications laid down by the rheologist. The flow characteristics of heavy oils and greases change with temperature. As the molecular activity of such materials is reduced by decreasing temperature they often cease behaving like water and other simple liquids and become plastic in nature. This complication of the flow characteristics is due probably to the development of an internal structure through orientation or arrangement of the molecules present. These orientations are definite enough to result in alterations of the way in which the material is deformed by an applied force but in most cases do not proceed to the point of causing the appearance of crystals.

The sagging James Martin tombstone in Rock Creek Cemetery, Washington, D. C. The string and cigarette case show the extent of the sag caused by the flow of the stone. (The notch in center of stone is due to rain water erosion and is not, as it may seem, a crack or break.)

Photo by Dr. E. C. Bingham

Photo by Dr. Robert Balk

An example of flow folding in marble. This stone was not in a molten condition when it folded into the sinuous shapes shown here. Pressure and, especially, time are quite well able to account for this result

The low temperatures at which these unusual and anomalous flow characteristics appear are frequently encountered during the winter months. Any alteration in the structure of the oil or grease which removes those properties detrimental to its lubricating value offers substantial economic return to the user, because of greater protection to his machines.

Asphalt, which is obtained from the distillation of certain kinds of petroleum or is dug from naturally-occurring deposits, is used in many places because of its unique rheological properties. Recently, engineers of the Mississippi River Commission tried a new type of revetment for the protection of the river levees above New Orleans. A mattress composed of asphalt, mineral dust, and sand, and containing wire reinforcement, was prepared on a barge from which it was fed into the water over a large roller. One end of the blanket was fastened to the inside of the levee but above the normal flood water line, the other extending to the bed of the river. Thus, the inner surface of the levee and a portion of the bed of the river is covered with a flexible, elastic blanket which resists the scouring, erosive action of the strong currents of soil-laden river water. Sudden shocks will not rupture this type of mattress because of the strength imparted by the reinforcement and the elasticity of the asphaltic mixture. An elastic material will deform under an applied force but returns to its original position after removal of that force.

A QUARTER of a century ago an auto tire gave 3000 to 5000 miles of service. Now we like to boast of the 20,000 or even 30,000 miles we have driven at high speeds on a particular set of tires. In order to bring about this improvement the rubber is blended or compounded with various chemicals that confer greater mechanical strength combined with the retention of flexibility and elasticity for long periods of time. The rubber is worked and kneaded between great rollers. During this calendering considerable heat is developed, the added ingredients are thoroughly dispersed, and the flow properties of the rubber are greatly altered. It has been discovered that the properties of a sheet of calendered, plasticized rubber are different in the direction of calendering than at right angles to that direction. This unique behavior has been taken as an indication of the presence and orientation of long molecules or aggregates of molecules known as micelles.

Various theories have been proposed to account for the great elasticity of rubber. One interesting view is that in any highly elastic material the molecules or groups of them are arranged much like a mass of coiled wire springs. A push or pull on the material compresses or extends these long molecules or molecular aggregates and when the applied force is removed the "coils" return to essentially their original position. The elastic properties of rubber can be reduced or destroyed by heat or excessive working, and may be lost if the material is maintained in a stretched condition for a long period of time. This last phenomenon is illustrated by the behavior of a rubber band which is left undisturbed about a bundle of papers for a considerable time. The rubber no longer possesses either elasticity or mechanical strength; the little coils appear to have become brittle and to have lost their ability to return to their original position.

Since the day that Dr. Baekland perfected the first commercially useful synthetic resin from formaldehyde and phenol (carbolic acid) the applications of these materials in our complicated, industrialized civilization have become too numerous to list. Drinking cups, ash trays, telephones, dental plates, beautifully colored walls and cabinets, are a few examples of the many useful articles formed from synthetic resins, called by one rheologist "organic glasses." The desired object is fabricated by placing a powdered resin mixture in a hot mold and applying pressure. Under such conditions the resin particles melt together and flow into a single mass which takes the form of the mold. During the molding operation the nature and properties of the material may or may not be altered.

In general, there are two types of synthetic resin in use today, which are differentiated by their rheological characteristics: the kind that takes a permanent set during the molding operation and cannot be softened again at elevated temperatures, and the so-called thermoplastics that are rigid at ordinary temperatures but soften as the temperature is raised.

CONTROL of the consistency (resistance to flow) of the synthetic resins during their formation is very important. The reactions between the constituent raw materials, which are usually considered to be polymerizations and condensations (intermolecular combinations which will continue indefinitely unless halted by a drop in temperature or by chemical means), must be stopped at the proper point if the finished article is to possess satisfactory properties. Great ingenuity has been displayed in devising instruments for measuring rapidly and accurately the progress of these reactions as indicated by the changes in the fluidity of the product. The flow properties of the finished resins vary from the characteristics of simple fluids to those of plastics possessing distinct elastic effects. Elasticity becomes the dominant property in the synthetic rubbers. In discussing these substances one authority has said ". . . and perhaps in many cases it is only a question of definition whether a substance must be considered as a resin or as a rubber." It is interesting that some kinds of resins show great flexibility (a bar or sheet of them can be bent around a sharp edge without cracking) but do not possess the ability to snap back into position after being deformed. The materials showing these unique and useful properties have been considered by certain investigators as existing in a gel (jelly-like) state, the lattice-work structure containing a

Photo by Dr. Robert Balk

Flow in molten rock. The black mass at the left, and radiating lines, are obsidian (volcanic glass) which flowed into cracks formed in the lighter-colored stone

relatively high content of a very viscous liquid, which prevents an elastic return after deformation.

When a finely divided solid is suspended or dispersed in a liquid the mixture frequently possesses unusual rheological properties. House paints are excellent examples of such mixtures. The same distinctive flow properties frequently appear when a liquid (for example, an oil) is dispersed in another liquid (water, for example) with which it is not miscible. Mayonnaise is such a suspension or emulsion. Even a catalogue of the present-day applications of dispersions, suspensions and emulsions, ranging as it would through cosmetics, foods, drugs, dyes, leather and photography, would require considerable space. The suitability and usefulness of these materials for their intended purpose depend to a great extent upon their flow characteristics, and consequently in recent years a vast amount of research has gone into the development of new methods of measuring the various rheological properties. We are now beginning to understand how these properties are affected by different variables: the particle size, size distribution, shape, and amount of the dispersed material present have been found to have a profound influence on the characteristics of the mixtures. Of course the viscosity of the liquid employed is important and in certain cases chemical reactions occurring between the dispersed material and the suspending liquid also have a pronounced effect. Since these chemical reactions can occur only at the surface of the dispersed material, their effects will be most apparent when the particles or droplets are small (thus presenting a large surface area per unit weight or volume).

Some heavy, slow-moving dispersions or suspensions become fluid when they are stirred, again returning to their original high consistency after standing for some time. Such mixtures are said to be thixotropic. With the passage of time orientation of the particles probably occurs, producing a structure in the mass which can be destroyed, at least partially, by mechanical agitation. Then, when the agitation is stopped, orientation begins to develop again with consequent increased resistance to flow or deformation. Another explanation, but the reverse of the above, has also been proposed in order to explain the phenomenon of thixotropy. It has been suggested that at rest the rod- or needle-like particles are in an unoriented arrangement, like a log jam in a river. The interlocking of the dispersed particles accounts for the resistance to flow shown by the mixture. When, however, the mixture is stirred the particles arrange themselves parallel to the direction of movement, like logs floating down a stream, and the mixture possesses greater fluidity. The difficulty with this explanation is that thixotropy also has been found to occur in suspensions of spherical bodies which cannot arrange themselves like logs. They can, however, orient themselves to form a structural framework which can be broken down by mechanical agitation (stirring).

Many of the paints and lacquers in use years ago were difficult to apply because the brush marks would not disappear. Thanks to the rheologist, the objectionable property of poor brushability, which is chiefly due to the presence of thixotropy in the paint or lacquer, has been to a great extent eliminated. For many years little progress was made in devising new paints and protective coatings, or in improving those already in use. Then, immediately following the World War, a new era in paint chemistry was ushered in by the appearance of the lacquers derived from a compound of cotton and nitric acid, and known as nitro-cellulose. The synthetic resins mentioned above have also been developed into very useful varnishes.

With the advent of the quick-drying cellulose and synthetic resin paints there appeared numerous problems for the student of flow. A finish which has been sprayed or brushed on a vertical surface must not flow under its own weight, but small irregularities and brush marks must disappear before the finish dries. Such conditions demand a fine balance in the flow characteristics possessed by the paint. As an illustration of the success attending the work of the modern varnish chemist, is the fact that synthetic resin finishes are now used on airplanes and, although they are dry and hard in a few minutes, they present a perfectly smooth surface.

ANYONE who has walked on the wet sand of the beach has noted that often the moist sand suddenly becomes dry around his foot, but the sand immediately appears wet when the weight is removed. This phenomenon is known among rheologists as dilatancy and is dependent upon the almost unbelievable fact that pressure applied to a packed granular solid causes the mass to expand in volume, thus creating larger spaces between the particles. In the case of the beach sand the moisture on the surface which made the sand appear wet was drawn by the forces of capillarity into the larger interstices between the grains created when weight was applied to the packed granular mass. When the foot was raised the sand particles drew back together and the excess water was squeezed out of the smaller interstices between the grains and back to the surface. Dilatancy has an important bearing on the design of foundations, dams, or any structure composed of compacted granular materials. Incidentally, if the housewife wishes to get the maximum amount of ground coffee into a can she should not press it down but should shake or tap the filled container.

As we look into the future we can visualize rheology playing an increasingly greater part in the solution of the problems affecting man's comfort, convenience, and well-being. We see his transportation on sea, land, and air being made more comfortable and safe; we recognize the creation of more nourishing, attractive, and palatable foods; we find rheology marching side by side with the other sciences to fight a successful battle against diseases which have affected humanity since the beginning of our records. We see every human activity influenced by the work of the rheologist because—everything flows!

MINERAL WASTE REDUCED*

Froth flotation tests in the Bureau of Mines Laboratories. Research is continually under way in these laboratories to increase the recovered values of minerals

Conservation Progress . . . Agriculture, Industry Benefit . . . Miners Profit by Former Wastes . . . Greater National Security in Strategic Minerals

By PAUL M. TYLER

Chief Engineer, Nonmetal Economics Division, Bureau of Mines, Washington, D. C.

GETTING something for nothing may be impossible, like perpetual motion, but industry manages year after year to get more without spending more. Forward-looking scientists and engineers still deplore the inefficient use of materials, mechanical energy, and man-power, but even a brief glance backward reveals that progress is being made, and quite rapidly.

Nowhere is waste more deplorable than in the production and use of minerals. Our supplies of mineral raw materials cannot be renewed; there is no possibility of getting a new crop. It took nature millions of years to segregate deposits that man can consume in a very short time. Few individual mines have an active life of more than a decade or two, and some of our useful minerals, provided we keep on consuming them at the present rate, may become as extinct as the dodo, for all practical purposes, within the brief span of one man's lifetime. Owing to the fast-increasing dependence of our civilization upon mineral raw materials, the idea that we are likely to rob future generations of their birthright commands the interest of government bureaus in conservation. Industry can scarcely be expected to take the same lofty interest in posterity—and it is debatable whether a miserly curtailment of useful consumption would be in the public interest even in the long run—but industry as well as Government has a stake in increasing the marginal utility of the minerals that it requires and in getting them more economically.

THAT better technology permits extracting more values from a given mineral deposit and thus enlarges our reserves of usable minerals is abundantly proved by the fact that waste dumps, tailings, and slag piles from the mining and treatment operations of fairly recent years are already being worked over, and sometimes re-worked again, as new methods make possible better commercial recoveries of the values. The implications of such developments upon the mining industries and upon the self-sufficiency of the Nation, however, are better revealed by reviewing the changes that have taken place during a definite period.

A quarter century ago, the Bureau of Mines published a thought-provoking little bulletin (No. 47), entitled "Notes on Mineral Wastes." In this bulletin, Dr. C. L. Parsons, the Bureau's chief chemist at the time, outlined certain opportunities for conserving mineral raw materials and, more important, expanding their economic utility. This summary affords a convenient backsight from which we can check up a few of the predictions then made and review the actual changes that have occurred during the intervening years.

Modern scientific agriculture is based upon the mineral industries in much the same way as the industrial and social accomplishments of the present-day machine age are predicated upon ample supplies of mineral fuels and metals. A great number of chemical elements are requisite to the growth of the plants that provide our foods and fibers, and three of them—phosphorus, nitrogen, and potassium—are exhausted from the soil so rapidly that they need to be replaced artificially and regularly through the medium of fertilizers.

In 1912, the United States—in fact, the entire world—had to go to Germany for its potash. To escape this complete dependence, efforts were being made to unlock potash from feldspar, leucite, alunite, and other rocks, and from seaweed. The fact had just been discovered that potash also was present in the brines of Searles Lake, California. All these sources were tapped during the World War emergency, but more prophetic yet was Doctor Parsons' remark, after describing the German

*Published by permission of the Director, U. S. Bureau of Mines.

deposits of soluble potash: "No like deposits are known in this country, although if a large number of widely separated bore holes could be sunk in selected areas it is by no means improbable that beds would be found." Many years later, the Bureau of Mines and Geological Survey undertook a drilling campaign and now we have found that virtually inexhaustible supplies of potash, some of it very high grade, extend in non-outcropping beds beneath a wide area in New Mexico and Texas. Commercial production began in 1931.

We still buy potash from abroad, much of it still from Germany, but new discoveries have been made in other countries, as in the United States, and no longer must we pay four times as much as it costs to lay it down on our shores. If we chose, we could promptly produce more than we are likely to consume.

The microscope assists the Bureau of Mines principal mineralogist in his identification of mineral specimens for the purpose of advising producers as to their commercial uses

Nitrogen, needful for munitions and industrial purposes as well as for agriculture, likewise was supplied by a foreign monopoly. During the World War, a possible blockade of the ocean lanes to Chile, if long maintained, would have precipitated a crisis that might easily have turned the balance in favor of Germany, which had already developed the nucleus of an industry for capturing nitrogen from the air. Whereas in 1913, the world drew nearly 56 percent of its nitrogen from Chile, 37 percent from coal, and only 7 percent from the air; by 1934, almost 75 percent came from the air, and 18 percent from coal, while only 7 percent was furnished by Chilean sodium nitrate. Production grew, meanwhile, from 851,400 to 2,108,500 tons.

THE third principal plant food, phosphorus, was plentiful in the United States even in 1912, but received attention at that time because Florida miners were throwing away two or three times as much as they saved. These appalling losses now have been largely reduced; the introduction of flotation and the allied art of oiling-and-tabling doubled at one stroke the possible economic recovery from current production, permitted old tailing ponds to be re-worked profitably, and expanded the already large reserves of commercial phosphate rock.

Phosphorus is a vital element in animal and human nutrition as well as an important plant food. Unless we replace it in our heavily-cropped soils, not only will the nation be threatened with decreased crop yields and higher prices for foods and fibers but the health of our animals and even that of our people may suffer tragic damage. Last spring concern over our supplies reached fever heat. However, a Congressional Committee appointed to investigate has been deluged with data that dispel doubts as to our huge reserves; the latest news smoked out by the investigation is the probable existence of billions of tons in bedrock beneath Florida land-pebble deposits—but that is another story.

Sulfur is another mineral that was being exported a quarter century ago, since it was produced more cheaply in Louisiana and Texas than anywhere else in the world; but we were also importing for its sulfur content nearly $3,000,000 worth of Spanish pyrite, mostly for making sulfuric acid for fertilizer manufacture. Even then, about one fourth of our acid was made at copper and zinc smelters, but, in the far west, metallurgical stacks were belching out enough sulfur dioxide to make three times the quantity of acid then used in the entire country. Inasmuch as many of our smelting plants are in relatively sparsely settled regions, it is still more economical to make acid from sulfur or pyrite near the point of consumption; but significant progress can be recorded in salvaging the waste sulfur gases, largely through integrating and expanding the activities of the smelting works themselves.

The harmless disposal of noxious fumes has become more of a problem than it was 25 years ago, and unless the recovered acid can be utilized nearby for making some useful product that can be used locally or is valuable enough to stand the cost of shipping it elsewhere, the conversion of sulfur dioxide into sulfuric acid creates a worse nuisance than the gas itself. Now, however, the metallurgist has a new bag of tricks that enables him to recover the sulfur in elemental form.

In the ceramic industries, great strides have been made in the substitution of domestic for foreign materials and in the betterment of materials. The adherence of potters to rule-of-thumb methods and their reluctance to try a new ingredient in their batch could not be dispelled so long as differences in the practical working properties of materials from different mines, especially clays, could not be explained convincingly by ceramic chemists. Some of these mysteries are being cleared up. The Bureau of Mines, in co-operation with other agencies, is working toward the duplication of the highest-grade kaolins by beneficiating (or processing) relatively impure clays. Improved technique, including the application of froth flotation, affords the means for fractionating and re-combining these components in uniform and reproducible proportions. A potter who hitherto dared use only a kaolin from a single locality in Czechoslovakia or a designated brand of Cornish ball clay can soon obtain a synthetic clay that will not only work the same way but may be more uniform in quality.

THROUGHOUT the gamut of ceramic industries—porcelain, enamels, stoneware, tile, glass, refractory products, and even common brick—the touch of science and the insistence upon ever-better products has called for better and better raw materials; this demand has been met not by exotic materials from far-away lands but by beneficiating those that lie at our own back door.

In addition to its use in pottery, high-grade clay is employed even more extensively in paper and increasingly also

in rubber and other industries. American clays formerly were deemed unfit for such purposes but now, thanks to proper preparation at the mines, are often preferred and generally are used instead of foreign clays except in a few localities where the hard facts of geography coupled with the advantages of water-borne transport make them overly expensive. That such processing pays is indicated by the fact that a certain domestic clay sells as high as $60 a ton, displacing not only imported clays but also costly satin white for coating the finest paper. Bleaching clays are now exported from the United States in fairly large quantities, whereas in 1912, despite a duty, imports of English fullers' earth were increasing steadily.

Typical of former waste products for which new uses have been found is arsenic. Formerly 25,000 tons a year of this poisonous element were discharged into the atmosphere by the copper and lead smelting plants of the United States, but most of this wastage has been stopped. By cooling the stack gases, the arsenic fumes can be caught in bag houses or precipitated electrically. Now we use annually 35,000 tons of white arsenic, which has become one of our chief weapons in the far-flung warfare against insects and weeds. Over one half of this arsenic is imported from other countries in which it likewise is a by-product and consequently can be recovered so cheaply that costs of transportation largely determine the price.

The utilization of so-called mica "waste" has progressed to the point where it is mined for its own sake and not as a by-product. Leading its many uses is the surfacing of roll roofing, now grown into a large industry indeed; present signs portend plainly a tremendous expansion in consumption of ground mica in the paint industry. Long ago we exhausted the current supply of waste from mica mining and factory scrap, and after absorbing by-product flake from clay washing, we have taken to mining schists to augment our supplies of ground mica.

Chemical plants that once worried over getting rid of their calcium chloride are now able to sell all they can make. Widely used for dust laying, it is increasingly employed in the construction of stabilized roads, ice control on highways and sidewalks, dust-proofing coal and other materials, refrigeration, and sundry other industrial uses.

New uses for bromine were sought eagerly for many years, but after it came to be used in the production of Ethyl gasoline, supplies from by-product sources became so hopelessly inadequate that the Ethyl-Dow Chemical Company in 1934 began pumping raw sea-water in ever-increasing quantities simply to extract the bromine.

Bromine's sister element iodine, although seemingly destined always to be a Chilean monopoly, by virtue of its association with natural nitrates, likewise has altered its status during the quarter century under review. Research developed American supplies and means of recovering it from oil-well waste waters in California. We still import the element from Chile but the price has tumbled from $4 to 81 cents a pound.

Natural graphite continues to be imported, thwarting several attempts to draw economically upon our large domestic reserves, but to offset this we are substituting manufactured graphite, artificially made from anthracite or coke, for important uses; and by modifying our foundry and fine steel making practices, we no longer depend upon certain qualities of foreign graphite that formerly were deemed essential. During the World War, we were tremendously concerned as to our ability to bring graphite halfway around the world from Ceylon and Madagascar to supply our munitions plants, but graphite has ceased to be listed among the strategic minerals.

Fluorspar, barite, and asbestos are industrial minerals that we keep on importing in substantial amounts, but by progressively reducing mining waste and perfecting methods of treatment, our dependence upon foreign supplies has become less and less.

Developing a practical separation of minerals in a magnetic machine. Such research has resulted in large gains in conservation of our mineral resources

AMONG non-metallic mineral products, probably none has made more substantial progress than Portland cement, the annual production of which doubled some years ago its 80-million barrel mark, first passed in 1912. Technologic advances in the manufacture and utilization of cement have paced the increase in output, but more important perhaps is the benefit upon other industries. Largely in consequence of the increased use of cement, the production of sand and gravel has trebled in volume, a tremendous growth has occurred in the use of crushed stone, and great quantities of otherwise worthless slag are finding a profitable outlet as aggregates for mixing with cement to make concrete. To show the inter-relationship of industries it may be well likewise to note that all these industries owe much of their growth to the demand for good roads created by the automobile and conversely that the number of automobiles and sales of gasoline wherewith to run them would never have expanded to their present proportions had we been unable to use these materials for making good roads cheaply.

The foregoing examples cover only the industrial minerals discussed in the analysis and forecast made by the Bureau of Mines 25 years ago. There is no need to recite similar developments in the equally broad field of metals. Enough has been said to show that progress, remarkable progress, has been made toward eliminating waste, that minerals generally can be won more economically than ever before, that consequently they cost less in terms of human effort and less in comparison with other commodities, and that our country has grown more nearly independent of foreign supplies of minerals.

TALES THE BULLET TELLS

FBI Experts Co-operate with Local Officers . . . Apply Laboratory Science to Study of Evidence . . . Give Full Reports . . . Attend Local Trials

By J. EDGAR HOOVER
Director, Federal Bureau of Investigation

THE value of the scientific examination of firearms evidence is well known to law enforcement officers and an ever increasing use is being made of such evidence both in the investigation and prosecution of criminal cases.

The section of the Technical Laboratory of the Federal Bureau of Investigation which is devoted to firearms identification has had a very rapid growth. Over 560 cases requiring technical study of firearms evidence were examined during the year 1937. This is an increase of nearly 400 percent over the number of cases received during the year 1934. Cases were received from every state in the Union. Over 40 percent were submitted by state and local law enforcement agencies. In many cases, a firearms examiner from the Technical Laboratory was called to appear in court to testify regarding his findings, and there has not been a single instance in which the firearms testimony has been successfully refuted. The services of an FBI firearms examiner as an expert witness are furnished as a matter of co-operation without charge to law enforcement agencies in criminal prosecutions.

The FBI Technical Laboratory is equipped to handle many different types of firearms examinations. A most common type of examination is that in which test bullets from the gun of a subject are compared with those found at the scene of a crime. Such examinations are very often made with prosecution of a certain suspect being dependent upon the results of the examination. In such cases, if an identification is effected, enlarged charts are prepared in the Laboratory to illustrate the firearms identification so it can be explained more easily to the Jury.

Law enforcement agencies are more than ever before utilizing the FBI Technical Laboratory for firearms examinations as an aid to their investigation of a crime, even though no suspect is in custody. The investigation can be materially assisted if, from the examination of an evidence bullet, the caliber and type can be ascertained. As an aid to such comparisons, the FBI Technical Laboratory maintains a reference collection of standard ammunition specimens.

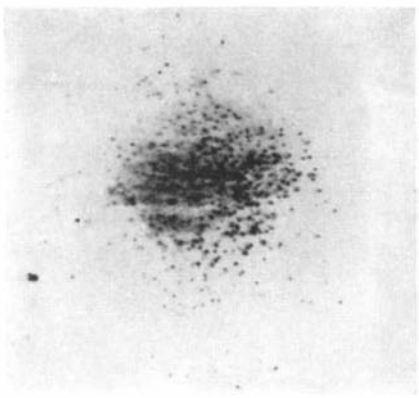
The firearms section of the Technical Laboratory also maintains a file of rifling specifications of the principal types of weapons manufactured in the United States and foreign countries. This file is of particular assistance in enabling the examiner to determine the type and make of gun from which the evidence bullet or shell was fired. Exact measurements of the rifling marks on the evidence bullet can be secured if the bullet is not badly deformed. These measurements can then be compared with the rifling specifications and very often the type of gun from which the bullet was fired can be ascertained. This information can be of great value to the investigation of a case in apprising the investigating officers that particular attention should be paid to a suspect in possession of that type of weapon.

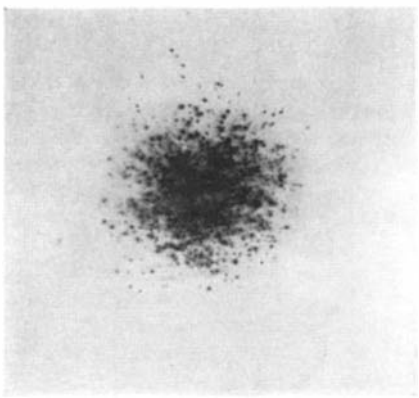
THE Technical Laboratory also maintains a reference collection of firearms which now numbers over 400 specimens. This collection offers valuable assistance for comparison purposes where unusual types of weapons are submitted for examination.

Examinations may be made with a view of determining the exact powder residue pattern appearing on clothing. Frequently, clothing of a person who has been shot is submitted to the Laboratory along with a weapon belonging to a suspect who admits the shooting but claims it was done under conditions of self-defense and at a certain distance from the murdered person. First, the powder residue pattern, if any, around the entrance hole of the bullet in the victim's clothing is determined. Then, shots are fired with the suspected weapon through material similar to the clothing of the victim and the powder residue pattern surrounding these test shots at various distances can be ascertained. In the event a powder residue pattern similar to that surrounding the entrance hole of the bullet in the victim's clothing can be obtained, the probable distance from which the original shot was fired by the suspect can be determined.

Various other examinations in connection with firearms can be performed. Tests to determine penetration and trajectories are often conducted when the results of such tests have a direct bearing on the crime in question.

It has been suggested that local law enforcement agencies submitting evidence for examination should observe and record all information relative to the condition and position of the gun and ammunition specimens when found, always keeping in mind the possibility of developing latent fingerprints of value on the gun and ammunition specimens. The gun as well as the bullets and shells recovered should be handled with extreme care in order that the microscopic marks of identification thereon will not be distorted or obliterated. Great care should be exercised in packing the specimens for shipment and each specimen should be marked by the investigator in





Test shots to show powder "tattooing" on cloth. *Left:* Muzzle of tested gun at six inches distance; and, *right,* three inches. (About half size)

order that the specimen can be identified, if necessary, in court.

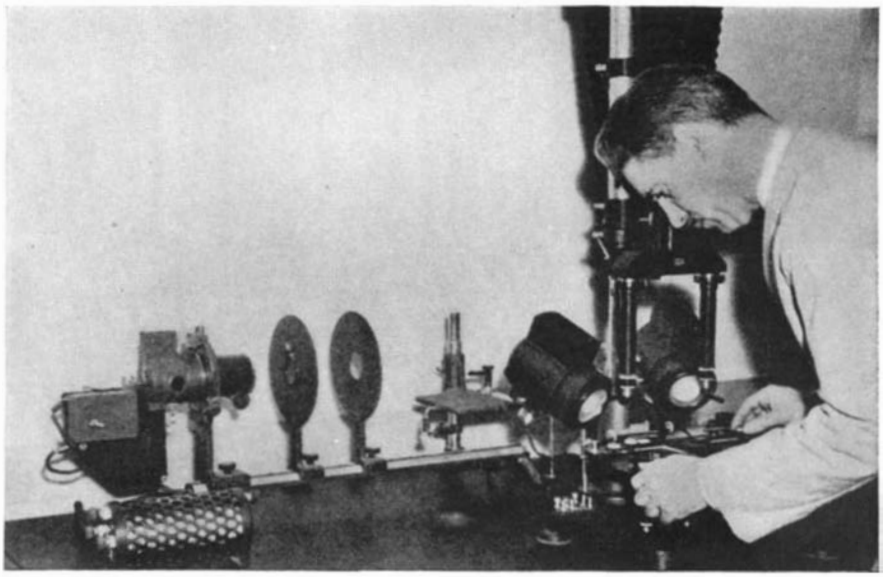
Whenever there are found marks caused by the explosive, they are examined to determine, if possible, the kind of powder used. By an examination under the microscope, the difference between smokeless and black powders may sometimes be determined. The grains of black powder appear to resemble coal in shape and are black or brownish-black. The grains of smokeless powders are made in particular shapes which enable them to be identified by use of the microscope. Many of them are formed into tubes, like spaghetti, or ribbons, which are then sliced to make the powder. Smokeless powders are usually entirely consumed by the explosion, whereas black powder usually leaves a residue.

The distribution pattern of burned and unburned powder around the hole made by the entrance of a bullet is useful in estimating the distance of the weapon from the object. If practically no "tattooing," as this is called, appears around the entrance hole, it is assumed that the weapon was held more than two or three feet from the object. The amount of spreading of the powder marks from the entrance hole indicates, with reasonable accuracy, the distance at which was held a weapon fired at less than two feet. That is, these distances vary for the different calibers, powder charges, lengths of barrels, and amounts of wear. When it is ascertained what kind of ammunition was used in a particular case, and the weapon is found, then by using the same ammunition, tests may be made through which it may be estimated at what distance the weapon was held to cause "tattooing" similar to that observed.

BY chemical analysis also, the nature of the powder may be determined. In this connection, the fact that the powder contains nitrates or nitrites enables a very sensitive chemical test to be used. A solution composed of diphenylamine and concentrated sulfuric acid applied to the powder marks indicates the presence of nitrates or nitrites by an intensely blue color. This test is sometimes useful in determining whether a death is a suicide or a murder, by indicating the presence of burned powder on the hand, from which it is "lifted" by paraffin.

As an example of FBI co-operation with local peace officers, consider this recent case. On January 3, 1938, Everett B. Hughes of Pueblo, Colorado, shot and killed his wife. He was subsequently arrested and confessed the shooting but strongly maintained that he had acted in self-defense.

Hughes presented the following version of the crime—a version which was difficult to controvert because there were no eye-witnesses to the shooting:



An "evidence" bullet is clamped under one objective of the comparison microscope, a test bullet under the other. Adjustments bring markings into juxtaposition

His wife, the victim, hated him and had threatened to leave him in favor of another man. On the night of the killing she had become particularly belligerent and had seized a revolver and had started advancing toward him, giving every indication that she intended to kill him then and there. He had no chance to escape, and being in fear of immediate death, he had seized a .22 rifle standing nearby and had fired a shot which passed through her head and caused her immediate death. He was then extremely frightened and took the victim's body to a spot in the country nearby where he buried it in a shallow grave.

Hughes claimed that the burial was not occasioned by a feeling of guilt but was merely the natural consequences of his fright.

The Sheriff's Office at Pueblo, Colorado, believed that this was a cleverly planned and deliberate murder and intensive investigation was launched into the circumstances surrounding it.

It was found that Hughes had, a few days before the murder, secured from the victim a number of sheets of paper bearing her signature on the bottom. He had secured this writing under pretext, advising his wife that they were to be used to write verses on in connection with festivities in the Hughes home on New Year's Eve. Hughes had written a few verses on these slips of paper, but he had kept some and had written typewritten letters to his son and daughter over the victim's signature, which stated that the victim hated him and was soon to leave him. He had even typed a letter to himself which contained a similar message. These circumstances indicated that Hughes had been planning the murder of his wife for some time.

Examination at the scene of the crime indicated to the investigating officers that the murder had been brutally and quickly executed. Although Hughes maintained that his wife had been shot while moving toward him in one part of the house, a chair, in another part of the house, contained stains that resembled blood. It appeared that Hughes had shot his wife while she was sitting in this chair unaware of danger.

The section of the chair containing stains, and the .22 caliber rifle belonging to Hughes, were transmitted to the Technical Laboratory of the FBI for extensive analysis and tests. Findings of the examiners were furnished to the Sheriff's Office at Pueblo, Colorado, and two of the examiners were present as witnesses when Hughes was tried for murder in March. The expert who made the examination of the chair testified that the chair contained stains of blood. This testimony nullified the statement of Hughes that the victim had been shot in another part of the house while moving toward him.

OTHER testimony was given by a firearms identification examiner from the laboratory to the effect that Hughes' gun had fired the shot which took the victim's life. Further testimony given by this examiner was of vital importance in attacking Hughes' version of the crime. As a result of tests conducted in the laboratory, he was able to state that the gun used in the murder would make a powder residue pattern similar to that which surrounded the victim's fatal wound only when held within less than one-half inch from the object through which the bullet passed. This absolutely contradicted Hughes' statement and gave valuable support to the State's contention that Hughes had held the gun almost in contact with the victim's head while she was sitting in the chair, possibly sleeping, and had then pulled the trigger. Hughes' story of shooting his wife while she was advancing toward him and still at some distance was thus discredited.

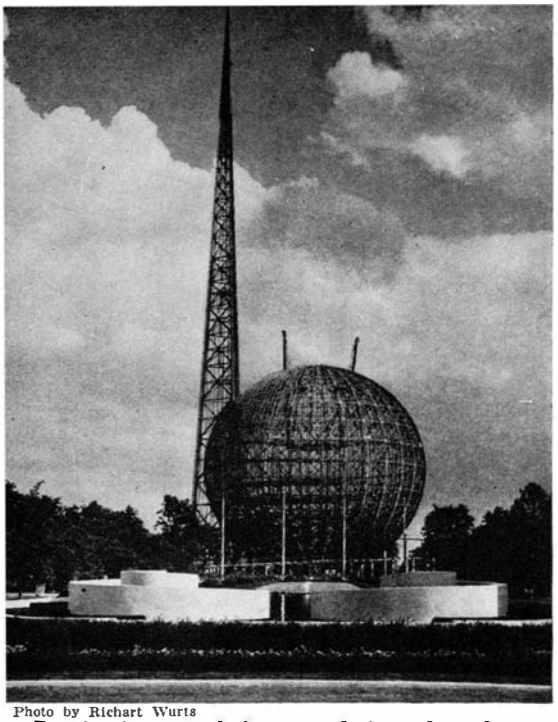


Photo by Richart Wurts

Dominating, even before completion, where they will be the center of attraction at the 1939 Fair

STEEL IN THE THEME

New York World's Fair Theme Center . . . Perisphere and Trylon . . . Design and Construction Presented Unusual Engineering Problems . . . Unique Structures

THE most unusual sight at the New York World's Fair of 1939 will never again be more than a memory. At least that is the opinion of those engineers, designers, and construction men who had a part in fabricating and erecting the steel for the Perisphere and Trylon, Theme Center of the Fair.

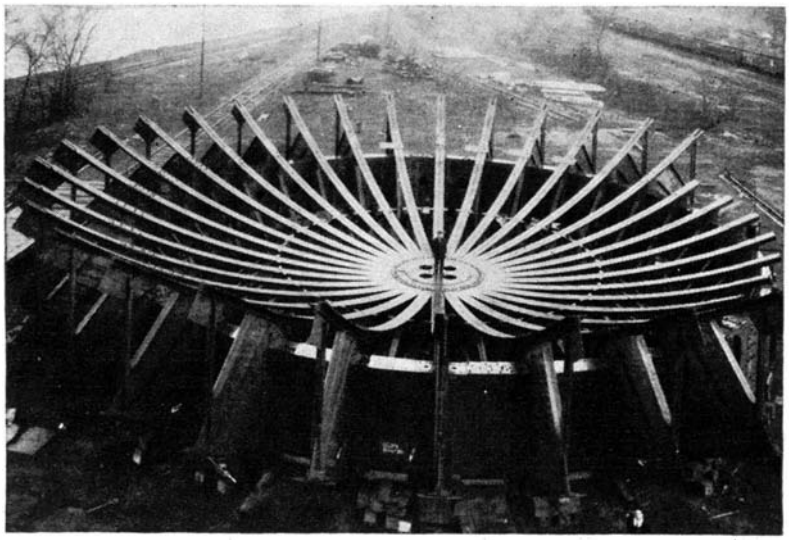
Whoever said that "looks are deceiving" might have had the Perisphere in mind. Externally, this huge sphere is indeed the essence of simplicity, but internally it is one of the most complex engineering jobs ever tackled and completed successfully.

The Trylon stands as a sentinel over the Theme Center's major structure. It will function during the Fair as a direction finder for traffic from all points of the compass. Traffic control in the Fair grounds proper will be guided from this tower. But from an engineering point of view, the Trylon follows customary practice in design and construction.

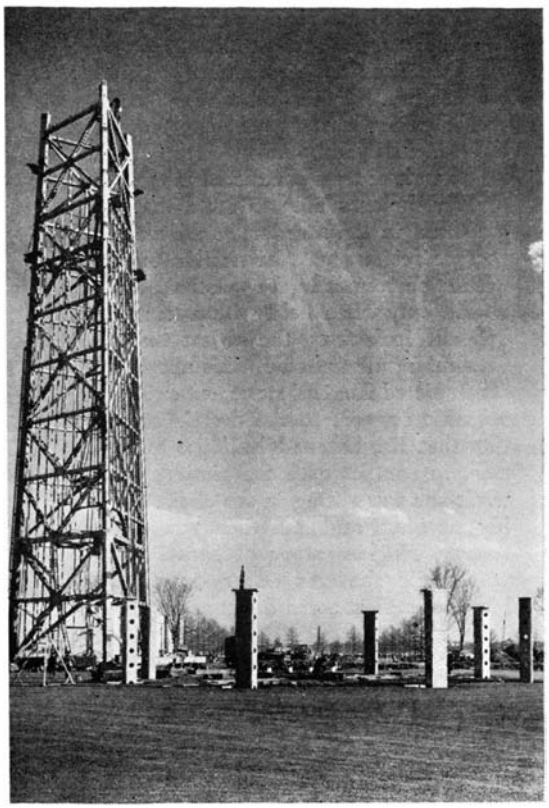
"Never in our many years of constructing bridges, buildings, and other steel structures in practically every country in the World and under all manner of weather and climatic conditions, have our engineers ever met with a problem more unique or interesting than the Perisphere," said L. A. Paddock, President, American Bridge Company, subsidiary of U. S. Steel Corporation.

Although the Perisphere will appear as a single globe when finished, it is actually a sphere within a sphere. In this structure, however, the two spheres do not have a common center. The inner sphere, which will contain huge revolving platforms, is raised a distance of three feet, although it will be attached firmly to the outer sphere by means of trusses to form a single shell. This type of construction was necessary in order to provide space for the heavy drum girders and other steel members which are required for the support of 9,000,000 pounds which the Perisphere will weigh when finished.

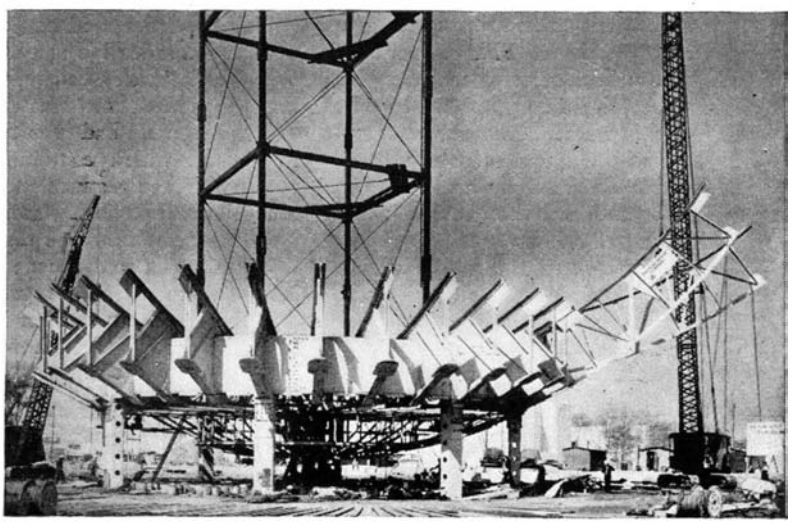
"In buildings of today, comparatively few of the structural steel members are curved, but in this Perisphere all pieces, except columns and center plates, will have curved or warped surfaces to fit the contour of the spheres, and it is these conditions which, in certain instances,

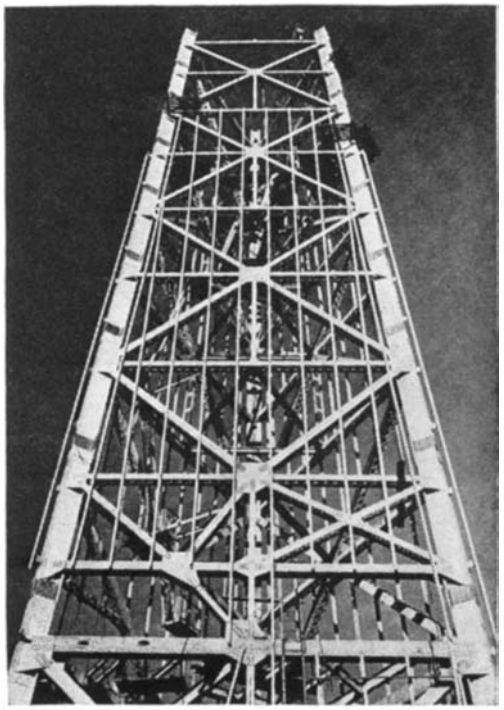


Factory test-assembly to assure fit of lower part of the Perisphere.
Below: **The Trylon starts upward as Perisphere supports are erected**



Large, assembled, curved girders are lifted into place and rivetted as the Perisphere begins to show its shape





An idea of the size and weight of Perisphere structural steel may be gained from this photograph of rivetting operations under the huge sphere's curve near the base

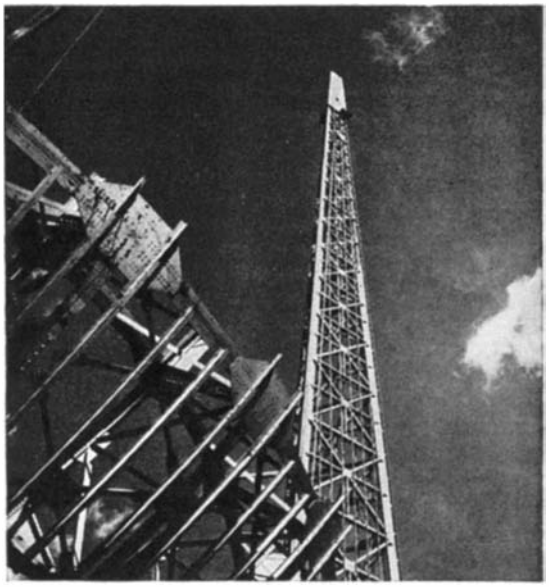
gave our engineers mathematical headaches," Mr. Paddock said.

In order to make absolutely sure that every piece would fit exactly as planned by the engineers, the main trusses were assembled and the field splices reamed while assembled in a jig at the Ambridge, Pennsylvania, plant, and then dismantled for shipment to the Fair site.

A huge ball such as the Perisphere, standing as high as an 18-story building, will present considerable resistance to the wind. This factor introduced one of the important problems. When finished, the Perisphere will be able to withstand a wind of 90 miles per hour. There is nothing alarming in this, however, for although a wind of this velocity produces a pressure of 30 pounds per square foot on the flat surface of a bridge truss, it produces a pressure of only 15 pounds per square foot on the surface of a sphere, as was determined in wind-tunnel tests. Therefore, there need be no fear that the Perisphere will blow off its pedestal and go bouncing across the meadows.

THE Trylon, which towers 700 feet high—taller than the Washington Monument—is unusual among tower structures because in the past they have generally been left open so that the structural steel is visible and so that they would offer a minimum of resistance to the wind. The covering on the Trylon made it necessary to introduce added strength in structural steel to overcome wind resistance, but even so, the top of the Trylon may sway through an appreciable arc as do all structures of great height.

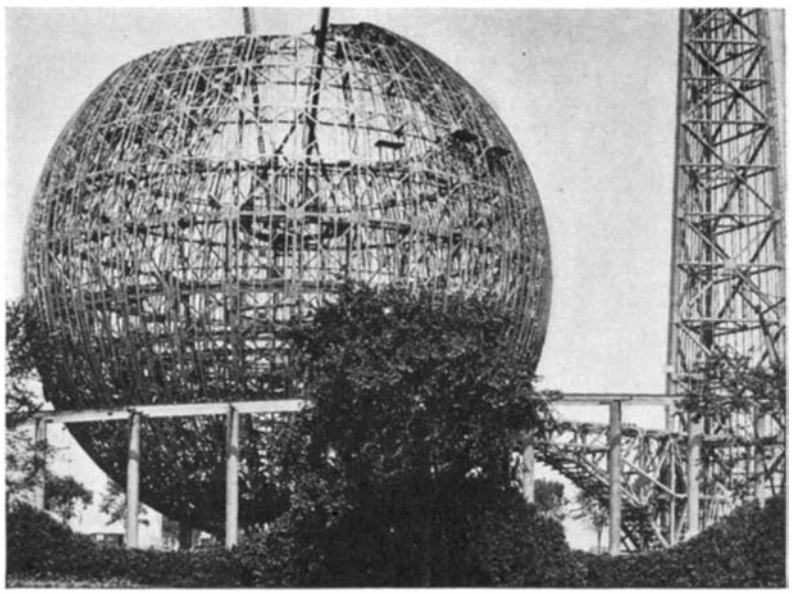
In order to support the extreme load of the finished Perisphere, including the thousands of people who will visit it hourly, the eight columns holding it up rest on mats of reinforced concrete 12 feet below the ground, and these mats are themselves in turn supported by 528 creosoted, 90-foot, wooden piles, driven down into the swampy soil.



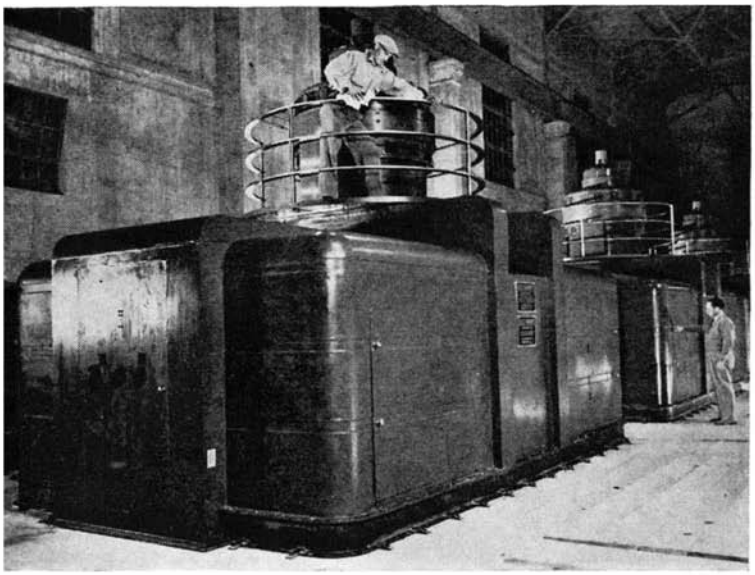
Upper right: The three-sided tower known as the Trylon had to be strongly constructed to withstand high winds

Right: Pointing high into the air, the Trylon steel receives the first of its covering, or outside wall, from the top down

Below: Still unfinished—the two theme structures, the bridge that connects them, and the spiral ramp, or helicline. All these will be covered

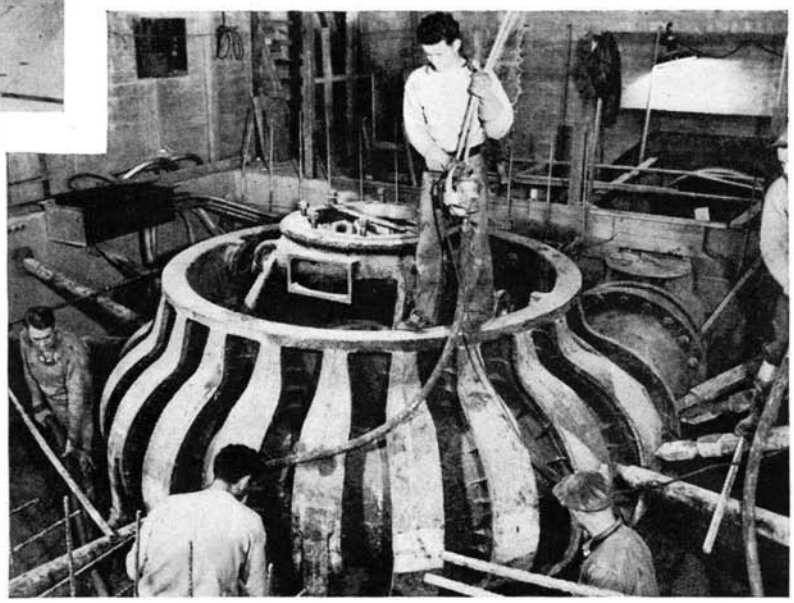


A Billion Gallons a Day



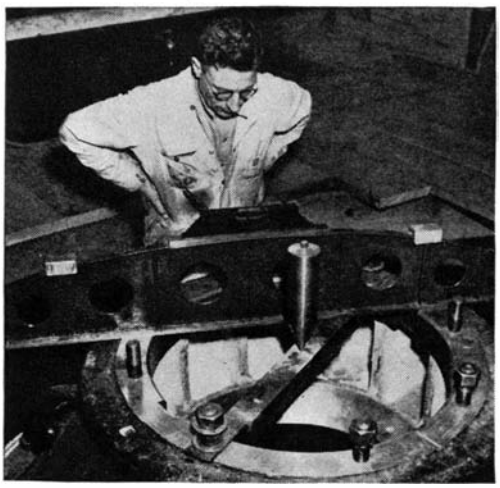
Left: One of the electric motor installations of the Colorado River Aqueduct pumping system, by means of which water will be delivered from the Colorado River through 242 miles of canals, tunnels, conduits, and siphons to Los Angeles

WHEN the Colorado River Aqueduct is completed a few years hence, 45 huge electric motors will drive pumps to lift 8,300,000,000 pounds of water daily and deliver it from the settling basin above Parker Dam to Southern California. The total height through which this water will be lifted is 1616 feet, to be accomplished in five steps, nine pumps working at each pumping plant. The pumps, set below water level to be self priming, will be connected to the motors through 40-foot-long steel shafts. Details of this engineering feat are shown in the accompanying photographs.—*Andrew R. Boone.*



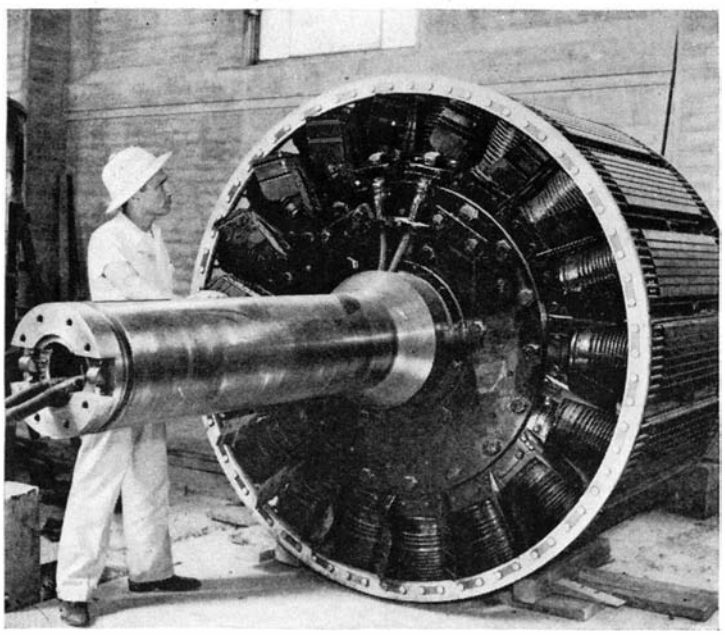
One of the scroll cases within which the impeller of one of the huge pumps will rotate. These cases, placed below water level, will be set in concrete. The impellers will throw water outward and force it upward through pipes

Below: Since the pumps are connected to the motors through long shafts, the scroll cases of the pump units are accurately leveled by a plumb bob and a spirit level on horizontal beam

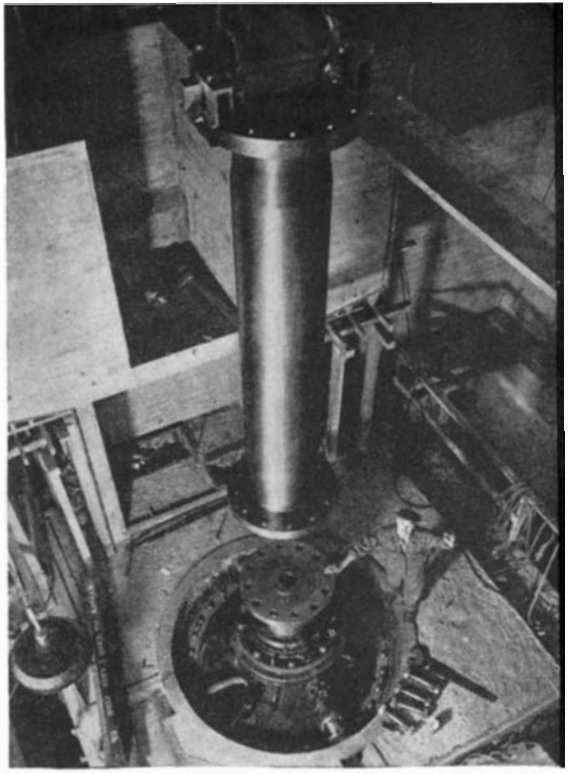


Below: Pump replacements and repairs will be difficult and expensive, so the greatest care is taken to insure proper running fit between bearing surfaces. Here two engineers are "miking up" one of the large bearing rings used in the pumps

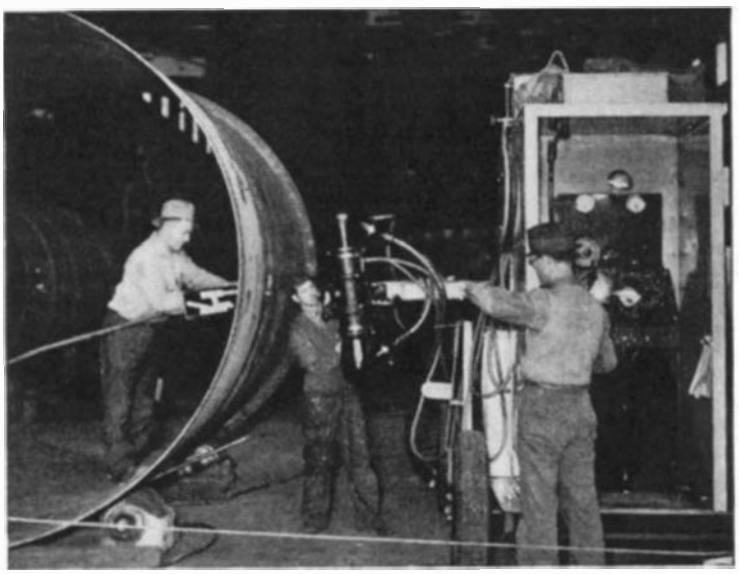
Below: The 35-ton rotor of one of the electric motors which are capable of developing 12,500 horsepower each. When these motors are in operation they will be cooled by air moving in a closed circuit and kept at the proper temperature for best efficiency by water circulation



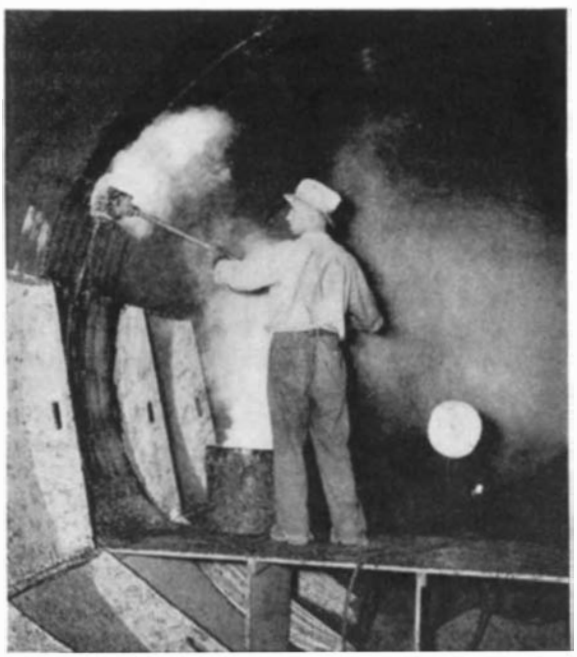
Left: Throughout the entire installation of the pumping equipment for the Aqueduct, the most modern testing instruments are in constant use to guard against imperfections. Here a technician is using an electrical micrometer to true up one of the motor shafts



Right: Looking down on one of the pumps from above the level where its driving motor will be installed. The long steel shaft is being lowered into position on pump rotor, prior to being trued up



Large steel pipes used in the Aqueduct are X rayed to be sure that no flaws are present which might later develop disastrous leaks. A close-up view of the X-ray tube is shown in the circle at the left



Welded and riveted joints in the steel pipe are further sealed against leakage by an application of hot tar

Below: From the intake in the settling basin, water is delivered through three lines to a transition chamber, from which a single pipe leads toward California

SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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

D. H. KILLEFFER
Chemical Engineer

Danger in Low Voltage Electric Shock

LOW voltage shocks of even 12 volts can be dangerous, H. W. Arlin of the Westinghouse Electric and Manufacturing Company told a meeting of the Safety Congress.

Despite the general belief among workmen that voltages up to 110 to 220 volts cannot produce fatal shock unless a man has a weak heart, Mr. Arlin cited reports on tests conducted by various organizations which show that when an electrical circuit is completed through a wet contact, any voltage in excess of 12 volts is dangerous.—*Science Service.*

New Building Material

BY treating with lime the waste liquors from the pickling of steel, a new type of building block having valuable properties is being produced. Steel mills have had difficulty in the past in disposing of the waste acid from the pickling of steel since this cannot be dumped into streams. The preparation from this waste of a satisfactory building block is expected to convert this liability into an asset. The blocks, marketed under the trade name of Ferron, consist principally of calcium sulfate with an admixture of oxide of iron. They are light in weight and possess some advantages over customary gypsum blocks although they have a brown color.—*D. H. K.*

Microscope Lens: Planachromat

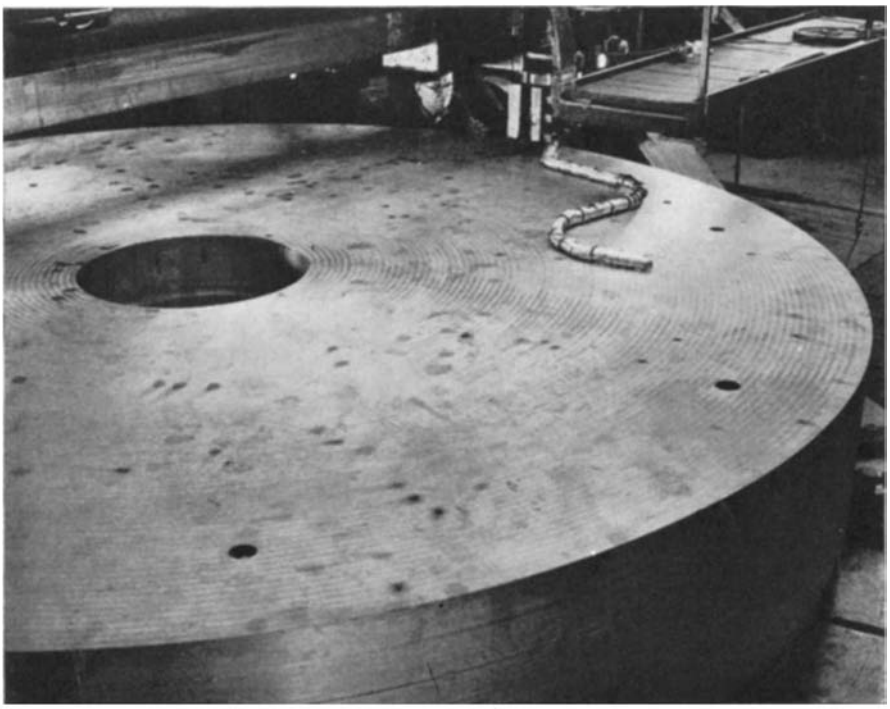
AN important forward step in lens-making and the end of a long period of research is marked by the announcement, from Carl Zeiss, of the Planachromat, a new microscope objective which gives equal sharpness in definition throughout the whole field of vision. Lenses just received from the laboratories in Jena are considered to be a definite improvement on microscope objectives available up to now.

Heretofore the field of magnification could be made flat only at the cost of lessening definition at the center. While the spot at the center of the field was sharply in focus, the field became increasingly blurred toward the edges. Scientists had to be satisfied with having the utmost clarity at the center of the field at the expense of the surrounding area, rather than equalized but lessened definition.

At present the new lenses are available in two magnifications, 9x and 40x, or the low and the medium members of the usual battery of dry lenses.

Shock Absorber for Steel

THE 190,000-pound flywheel shown in our illustration is being "faced" to a perfect circle in the East Pittsburgh works of the Westinghouse Electric & Manufacturing Company before it goes to work as a cushion of power in a steel company's blooming mill. Part of a 6000-kilowatt motor-generator unit built by Westinghouse for the steel concern, the flywheel will maintain the generator at a steady power output despite peaks and recessions in load requirements as steel billets are pressed between the mill rolls.



This huge flywheel will absorb shocks in a steel mill

Rifle Shell Fire Alarm

LONG-rifle shells of .22 caliber and made by Remington, primed, but with no lead bullet or powder charge, are now being used on airplanes in connection with a fire-alarm system. The shells are mounted at strategic points about the engine, and from them tubes lead to the instrument panel. Flame or heat of 250 degrees explodes a shell, flashes a signal, sounds an electric alarm.

When the force of the explosion flicks the red signal light, the pilot releases, through distribution pipes, carbon dioxide gas which

envelops the engine and snuffs out the fire.

The alarm system is valuable on planes with outboard motors on the wings where a flare in a motor housing could not easily be seen.

This new device has also been constructed to operate an automatic fire-extinguisher, from which the carbon dioxide gas is released at the instant of the explosion.

Many American-built transport planes are equipped with this device. The Argentine Government recently purchased 100 planes for its army and navy, 60 of which are equipped with the Lux Fire Detector System, which is manufactured by Walter Kidde and Company.

SWEET SMELLS

A HUGE outlet for sweet smells is the cigarette industry. Although frankly perfumed cigarettes have only a small market, every widely used cigarette is flavored; that is, it contains some spice, extract, essential oil, or sugar that will modify the taste and odor of the tobacco. In 1929, for instance, a favorite was coumarin; one manufacturer found that maple sugar gave somewhat the same smell and used 4,000,000 pounds of it in a year.—*Technology Review.*

Steel trusses, usually hidden from sight in ordinary building construction, will remain exposed in the "inside out" exhibit building of U. S. Steel at the New York World's Fair. Here is shown the skeleton taking shape, ready to support a stainless-steel dome 66 feet high and 132 feet in diameter. The shape of the building carries out the motif of the Fair's Theme Center which is described in some detail on page 24 and illustrated on the front cover of this number

ONE-MAN SUBMARINE

EARLY rising residents of Michigan City on a recent Sunday morning gaped in astonishment at a strange object that was passing through the streets as they stepped out to gather in the morning milk. The contrivance looked for all the world like a huge speckled trout mounted on an automobile trailer—a trout with adenoids, for its mouth appeared to be open; a trout with two baleful-looking eyes, no fins and a queer kind of tail.

Some of the curious threw on a few clothes and set off in hot pursuit. Down at the water front they got a better look at the contraption which turned out to be a one-man submarine. It was about eleven feet long, three feet high, and about two feet through the middle.

According to Barney Connett, a garage mechanic by trade, the body was made of steel and weighed just over a thousand pounds. The power plant, he said, consisted of five regular Kathanode automobile batteries, four of which furnished the power for the 38-mile crossing of Lake Michigan.

When everything was ready, Barney lowered himself into the cramped interior and pulled down the hatch cover which looked like an over-size pith helmet with a flag pole on it. The flag pole, of course, was Barney's periscope.

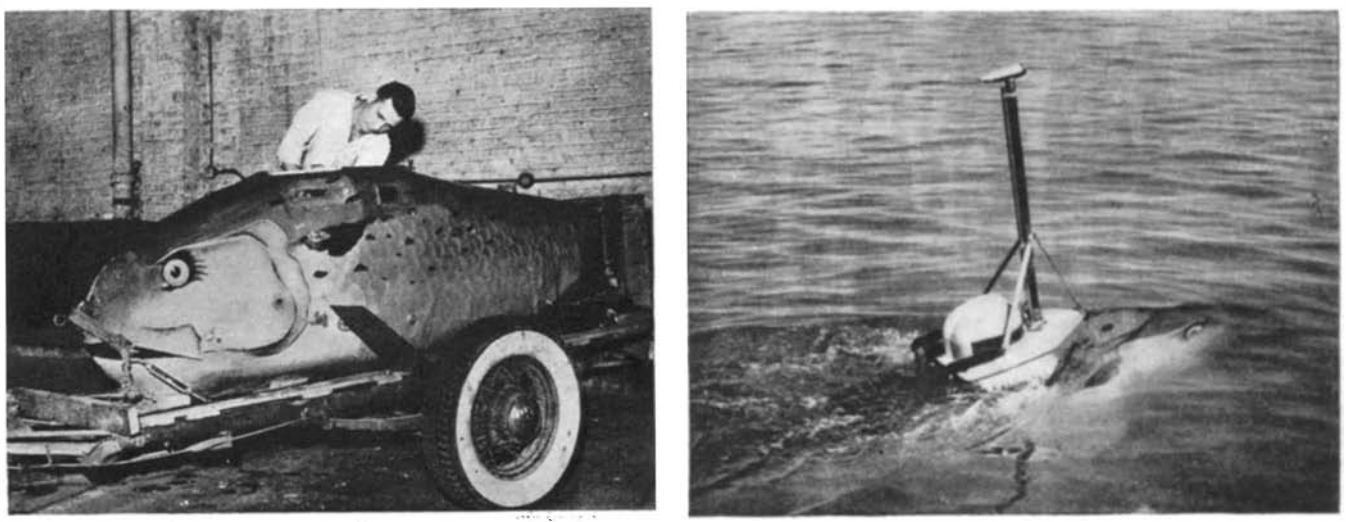
The little craft began moving silently out into the lake and Barney submerged until only the periscope was visible from shore. The inventor claims his sub will go to a depth of 31 feet, but you can't go down that far with a four-foot periscope—not and still see where you're going. So Barney stayed within about three feet of the surface. Behind him came the *Idler*, a 65-foot sloop carrying two professional divers—just in case.

About eight miles out from Michigan City the under-water craft ran into a storm, but her batteries pushed the boat steadily through the rough water.

When the submarine purred into Navy Pier, Chicago, and Barney climbed out, the sub was still going strong, he said, but he was exhausted—and happy. He had done what he set out to do.

FINGERPRINTING CHEMICAL COMPOUNDS

X-RAY diffraction patterns produced by crystalline compounds have long been used in chemical investigations. Full usefulness of these patterns, which are characteristic of the material investigated, has been impossible in the past because no sure method of indexing multitudes of patterns existed. Recently such a system has been devised by chemists at the Dow Chemical Company and applied to the patterns produced by a thousand different chemical compounds.



The one-man sub ready to be towed to the water, and, right, under its own power

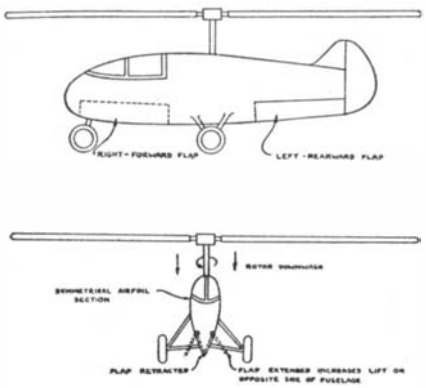
This system of classification, which is capable of extension to other compounds, provides a method of identifying chemical compounds as sure and accurate as fingerprinting identifies persons.

Diffraction patterns are made by placing a small specimen of powder of the unknown material in a narrow beam of X rays which are thereby refracted to make a record on a photographic film. This record consists of lines in different positions, characteristic of the arrangements of atoms in the material investigated. The important value of the method lies in the fact that it will detect and make a permanent record of the various materials present in a mixture without destroying the sample or otherwise affecting it.—*D. H. K.*

The Helicopter Triumphant

At the Franklin Institute, under the auspices of the Philadelphia Chapter of the Institute of the Aeronautical Sciences, there was recently held the first meeting ever devoted exclusively to Rotary Aircraft. Beginning with an introductory paper intended to give a comprehensive view of the entire art by the Aeronautical Editor of Scientific American, papers were delivered by almost all the outstanding exponents of the Autogiro, the Gyroplane, the Convertaplane, and the helicopter. Space will permit us to cover only the most significant features of this highly successful gathering.

The honors of the meeting went to the helicopter. W. Laurence Le Page showed a film of the Focke Helicopter which we have described in these columns. The film was positively astounding. The machine performed the most marvelous evolutions inside a hall; flew forward at 75 miles an hour, backward at 18 miles an hour, hovered, turned around its own axis, all under perfect control. That highly distinguished aeronautical engineer Grover Loening confirmed the astounding characteristics of the machine. On one occasion he stood beside Professor Focke, when an inexperienced pilot was in the cockpit. Not knowing what to do, he brought his machine completely to rest some ten feet from the ground, and called out *"Was Soll Ich Thun?"!*



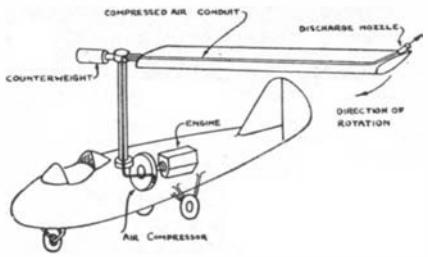
Side and front views of Hafner's rotor plane employing side flaps

But although the Focke-Wulf helicopter has broken all records, and constitutes a remarkable achievement, the helicopter is still in the rapidly evolving stage and many other forms will doubtless present themselves.

As we had occasion to state previously, it is highly desirable to have a helicopter with the lifting qualities and the simplicity of a single large lifting airscrew. But since the large airscrew turns slowly its reaction torque is high. This is how two excellent engineers propose to meet the reaction torque while using one rotor:

Raoul Hafner (of Hafner Gyroplane fame, a windmill type which has been most successful in England) is about to construct a craft in which a relatively small rotor will be used, turning rapidly so as to give efficiency in forward flight and a relatively small reaction torque. Combined with this Mr. Hafner will use a long, slender fuselage, provided with two side flaps front and rear. These flaps, displaced in the downwash of the rotor, will produce lateral forces, which will take up the reaction torque with a minimum of air drag. This ingenious idea was very well received.

Professor Montgomery Knight suggests a different plan. He will employ a single bladed airscrew (suitably counterbalanced) and instead of using a mechanical transmission will supply compressed air to the tip of the blade. The air ejected from the blade will drive it around, so again reaction torque will be eliminated in a highly novel form of direct lift machine. This idea was subjected to many criticisms such as the difficulty of balancing a single rotor and the fact that another conversion of energy is introduced (instead of the efficient tilting forward of the rotor to produce propulsion) and a very inefficient one at that.



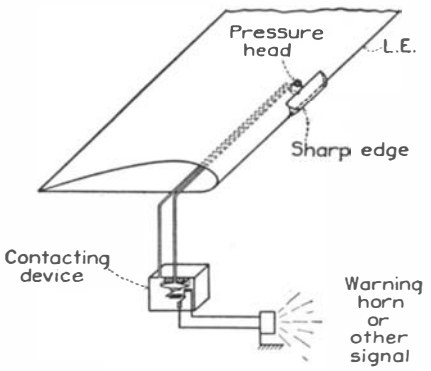
Knight's single-blade rotor plane

Indicative of the wide interest existing in this art is the fact that Edward Noble, chairman of the Civil Aeronautics Authority, addressed the gathering at a banquet which took place during the highly successful and interesting symposium.—*A. K.*

A Stall Warning Indicator

The "stalling" of an airplane wing, which occurs when the nose is raised too much, is highly undesirable, since it may lead to loss of control, falling off on one wing, and sometimes to an unpleasant spin. With stalling of the wing, the airspeed drops and in horizontal flight the airspeed meter is in itself a stall indicator. But in making a turn, the lift is greater than the weight of the airplane, because centrifugal forces have to be met, and the stalling speed is in turn higher than the stalling speed in ordinary, straight flying. Thus the airspeed meter becomes a very poor guide to safety in maneuvers.

To meet the difficulty the N.A.C.A. has developed a special stall indicator. Near the tip of the wing, close to the leading edge and just above its surface, there is placed a Pitot or pressure head. At the leading edge of the wing, ahead of the Pitot, a sharp edge is fitted. With this introduction of the sharp edge, a local stall and loss of pressure at the Pitot tube occur well ahead of the general stall of the wing. When this local loss of pressure occurs, a contacting device automatically closes an electric circuit, and an electric horn in the cockpit gives a warning blast.



Airplane stall indicator

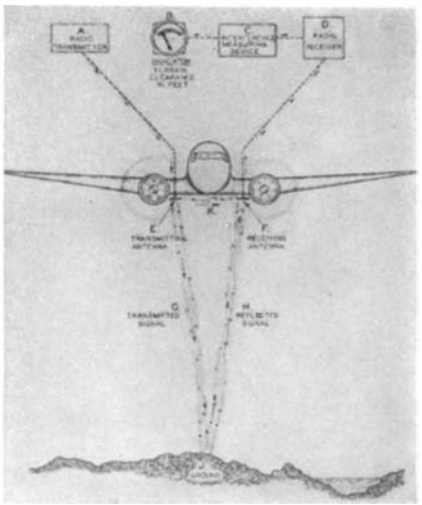
Full flight experiments at Langley Field, in a small Fairchild airplane, have shown that while this machine stalls at 42 miles an hour, the horn blows at 59 miles an hour. The pilot thus receives a warning well ahead of the danger zone.

There are minor difficulties to overcome. The pressure tube must be heated to prevent ice formation, and the device must be so arranged as not to increase air drag —the perpetual enemy of the airplane constructor. Nevertheless, it is clear that this ingenious and simple device is a valuable safety measure.—*A. K.*

Absolute Altimeter and Collision Indicator

In our opinion the development and successful testing in a Boeing transport plane of an absolute altimeter and collison indicator is one of the epoch-making advances in aviation. The absolute altimeter was developed jointly by Bell Telephone Laboratories, Western Electric, and P. C. Sandretto, Superintendent of the Communications Laboratory of United Air Lines.

The basic principle of the device can be



Simplified diagram of operation of the newest radio absolute altimeter

simply stated. A short-wave radio signal is transmitted from the airplane to the earth. The signal is reflected back from the earth, the time elapsed in the reflection of the signal is measured, and this time is translated into a direct and accurate meter reading of the plane's altitude in feet. Due to the use of an ultra-high frequency the altimeter is entirely free from static interference. Despite any weather conditions, or irregularity of terrain, the pilot can read his height directly above the earth whether it is only a few feet or is thousands of feet. A warning signal can be incorporated in the apparatus. Also, the altimeter can be directed forward at any desired angle, serving then as a collision indicator against mountains or other obstructions. The weight of the apparatus is only 40 pounds.

This sounds very simple, but our readers will agree that an enormous amount of research work must have gone into the invention.

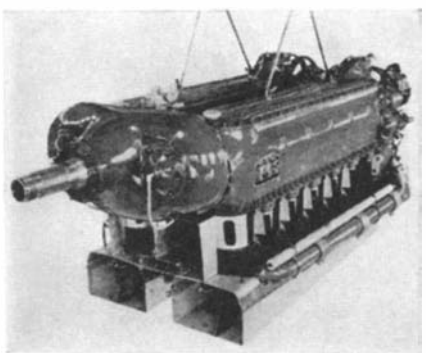
A really technical explanation is not yet available. No doubt it will find its way eventually into the technical journals. But the accompanying diagram will serve to give a general understanding of its functioning. (See lower right drawing, opposite page.)

In this diagram, *A* is the radio transmitter operating on a frequency of 500 megacycles, the highest frequency ever used for practical purposes in short-wave radio. The transmitter is connected to the transmitting antenna *E* only 12 inches long, located below the wing of the plane and about eight feet from its center. This transmitting antenna sends a signal *G* to the ground *J*, not in the form of a pencil or beam of radio waves, but in a large hemispherical pattern. The ground *J* reflects this radio energy back to the plane where it is received by the receiving antenna *F*. The radio receiver *D*, connected to the antenna *F*, receives a wave *K* from *both* the transmitted wave and the reflected wave. The interference thus created is measured by the device *C*, and by suitable calibration the measuring meter gives a reading on the "Terrain Clearance Indicator" *B*.

We hope that the instrument proves just as satisfactory in actual service as it has in the laboratory and in the experimental flights.—*A. K.*

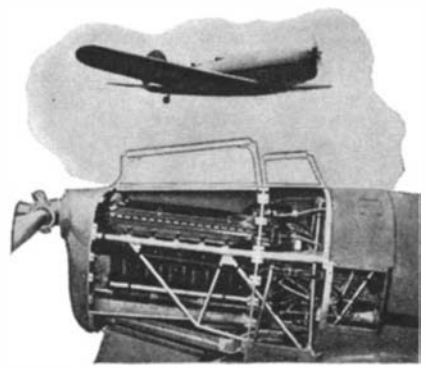
Unitwin Power Plant

DETAILS are now available of the Unitwin power plant in which two Menasco Buccaneer engines will be coupled to a single propeller in such fashion that when one engine fails the other will still keep the airscrew going. The advantages of such an arrangement are obvious. With the ordinary twin-engine power plant, with each engine mounted out on a wing, the failure of one engine sets up a turning moment which has to be rapidly counteracted by the pilot. Also, long leads have to be provided from the pilot's cockpit to the engines. With the Unitwin, all the safeguards against failure of one engine are provided, yet the turning moment is completely eliminated. Flight on one engine is thus much more of a certainty.



Unitwin

The Unitwin engine is shown in one of our photographs. Two six-cylinder, air-cooled, inverted engines are placed side by side, with the propeller shaft exactly between them. The two engines are geared together to the common propeller by means of an over-running clutch (which has been used in many lines of industry, as well as in free-wheeling and over-drive units in automobiles). When the engine on either side quits, the over-running clutch immediately brings it out of engagement. Each engine has a flywheel incorporated in the gearing unit in order to prevent the motor from stopping when idling.



Installation of a Unitwin power plant in a low-wing Vega monoplane

Another of our photographs shows the installation of the new power system in the nose of the low-wing Vega monoplane, which is being rushed to completion by Vega Airplane Company, a subsidiary of Lockheed. The neat looking Vega will carry five or six passengers in all the comfort of the largest airliner and will be particularly useful on feeder airlines. The Vega should also be very interesting to private plane owners seeking the maximum of twin-engine safety. With a useful load of 1729 pounds, and a gross weight of 5400 pounds, the new Vega will have a maximum speed of 210 miles per hour at 7500 feet altitude, and a cruising range of 600 miles.—*A. K.*

A mobile airport provides mechanical servicing facilities in the field

A Mobile Airport

THE wars in Spain and China and the records of other military operations indicate that in air warfare the provision of a limited number of airports and landing fields may not be enough. It appears desirable to provide a mobile airport or flying base which can be set up anywhere, travel over almost any terrain, and provide ample facilities for the repair or maintenance of aircraft. Mr. K. W. Couse, of New Mexico, has in very logical and thoroughly engineering fashion developed a traveling or mobile airport which has been exceedingly well received by all the authorities who have examined it.

Mr. Couse has made no startling inventions or evolved intricate gadgets. He has merely used a high degree of common sense. A glance at the photograph of the mobile airport will indicate its general character. Here are its specific features and accomplishments:

With two driving rear axles, powerful gear reduction, and removable steel tractor treads, the Couse mobile airport can climb, continuously, up a grade of 35 percent. The wheel base is shorter than in standard truck designs, which makes for roadability and the ability to make very sharp turns. The short wheel base also allows an irregular road surface to be followed. The special design of the chassis brings the center of gravity down quite low, which means more steadiness on the road. As the Couse unit is specially designed to house heavy equipment and machinery, it can carry large weights without the over-all weight of the unit becoming excessive. The two spare wheels in front also serve as a fine bumper.

So much for the automotive side of the picture. From an aviation point of view

there are many desirable features. The neatly installed shop equipment includes a lathe convertible into a milling machine; welding equipment; other machine tools; a generator with ample capacity for operating the various tools; drill presses; hand tools, and so on—everything needed for field repair of aircraft. The sides of the vehicle swing out and up to provide shelter in inclement weather, with the addition of a tarpaulin at the end of the hinged roof. There is a crane and an engine workstand, as well as radio equipment for both transmitting and receiving. A searchlight at the front of the vehicle can be made to indicate the direction of the wind. There are also two other searchlights, so that three vertical beams can be set up to mark out the boundaries of an emergency field. —*A. K.*

Improved Streamlined Wheels

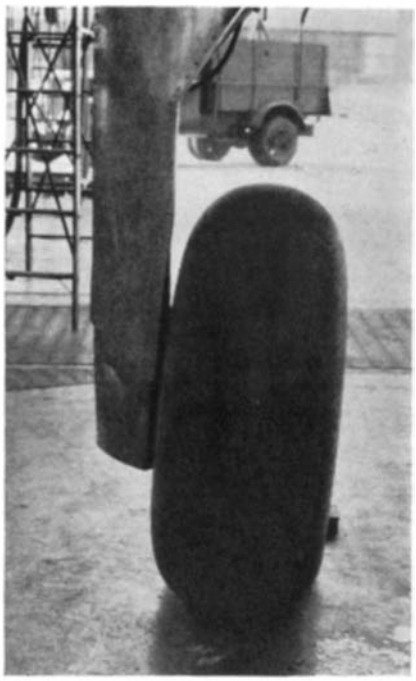
THANKS are due to the Army Air Corps for the accompanying photographs of a streamlined airplane wheel and tire, with smooth contour. For a non-retractable chassis, the advantage of a streamlined wheel is

so obvious as to need no comment. To improve operation on soft ground the Air Corps engineers have widened the tire contour at the tip of the tread as the picture indicates. To reduce the opening in the wing with a retractable chassis, the designers are making the wheels smaller and smaller, and quite recently the standard 60-inch size (employed on large bombers) has been reduced to 56 inches diameter. For a craft weighing something like 70,000 pounds, the utmost efficiency and greatest reduction in size are absolutely essential.—*A. K.*

Civil Aeronautics Authority

POLICIES of the Civil Aeronautics Authority are not yet clarified, but its members have made an impression of earnest good will and willingness to work hard. The addresses delivered by members of the Authority during National Air Travel Week were well informed, sensible, and to the point. In particular the remarks of the Chairman, Edward J. Noble, broadcast from Annapolis, Maryland, during Air Week, brought out the progress in air transport in striking fashion. Mr. Noble compared air transport of ten years ago with that of today.

Ten years ago, there was no information on the upper atmosphere. Now we talk about flying in the stratosphere and the substratosphere, in pressure cabins, and think nothing of it. Ten years ago there was little or nothing available in radio, instruments,



Above and left: **Views of the improved streamlined airplane wheel**

sound-proofing, aviation medicine. Other contrasts are equally marked.

Yet in a country of 130,000,000 people only 2,500,000 fly for any reason whatsoever. The airlines check in a million passengers a year, but they know that the same people are flying frequently and they actually get only a quarter of a million passengers.

Fear still remains. As fear is vanquished, further progress will be stupendous or colossal, or any other Hollywood adjective. Citing the various well developed aids to navigation, Mr. Noble summarized the safety situation in the following words: "It is 300 percent safer to fly now than in 1930. The airline ratio is one fatal accident to each twelve million miles of flying. At that rate you can fly *around* the world *four hundred and eighty times* before you need to be afraid of flying into it! That figure is absolutely correct and it is something for timid souls to think about."—*A. K.*

Glassy Landings

WRITING in Aero Insurance News Letter, Jerome Lederer states that judging height accurately when alighting on perfectly calm water is practically impossible. Within the last year, about 50 pilots and passengers have lost their lives in various parts of the world because of "glassy landings." Under glassy conditions, the pilot should not guess at height and follow the conventional maneuver of gliding down and then flattening out a few feet from the surface. He may flatten out too late, and nose into the water with possibly disastrous consequences. What he should carry out is a "power stall." At about 50 feet from the surface of the water, he should open up the throttle of the engine a trifle, and pull the nose slightly above the horizon. The plane will then lose altitude slowly in an almost stalled attitude. The subsequent contact with the water will be harmless, although to land in a power stall on the much harder ground might not be so judicious.

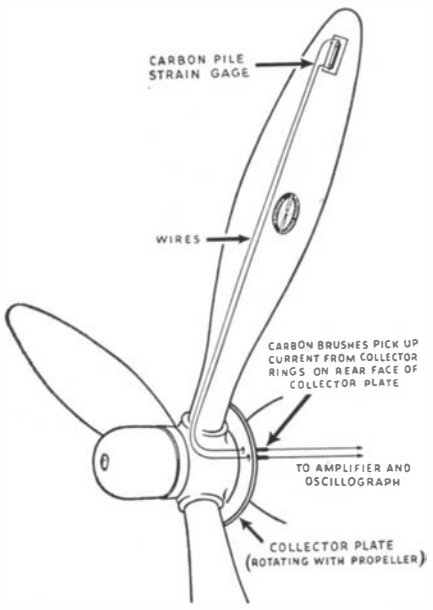
Incidentally Mr. Lederer argues that land airports should never be located on islands or terrain largely surrounded by water because of this same difficulty of judging height while still over the water and making the approach to the field.—*A. K.*

Propeller Stresses Measured in Flight

IT is not the steady load which causes failure of a metal propeller, but vibratory stresses due to the uneven torque cycle of the engine or its dynamic unbalance. The reliability and safety of the propeller have therefore been increased by intensive study of its vibration. Hamilton Standard have advanced this study of propeller vibration to such a degree that in the 20,000 controllable pitch propellers built in recent years not a single failure at the hub has been reported, and the less serious blade-tip failures are very few in number.

Now Hamilton Standard announces an ingenious and simple method of measuring the stress at any point of the propeller blade during flight, which should advance knowledge and hence safety still further.

The device is illustrated diagrammatically in one of our drawings. It depends upon the phenomenon that certain materials increase and decrease their electrical resistance in direct proportion to the loads or



For measuring propeller stresses

stresses imposed upon them. The resistor or strain gage used in this case consists of a "carbon-pile" strip approximately two inches long, a quarter of an inch wide, and one sixteenth of an inch thick. This carbon pile, cemented lengthwise to the propeller blade but insulated from it electrically, is attached at its ends to two fine wires which carry direct electrical current. As the propeller blade stretches under load, the resistor stretches with it, and increases in

electrical resistance so that the current flowing through the system varies. This varying current is used to operate an oscillograph which consists essentially of a coil between the poles of a magnet. The coil moves in the magnetic field, following the change of the electric current in the resistor. A tiny mirror is mounted on the moving coil, and a fixed beam of light is focused upon the mirror. As the coil moves, the mirror picks up the beam of light and flashes it up and down on a strip of light-sensitive paper. If the sensitive paper is moved at a given speed a wavy line appears, with the height of the waves directly proportional to the stress in the propeller. The permanent record thus obtained can be studied at leisure and gives the engineer an exact idea of what is happening in the blade. An advantage of the instrument is that it lends itself to remote control and is portable. —*A. K.*

PALLADIUM PRINTS

PALLADIUM is being used in solution for hand-sensitizing photographic papers in order to print high-quality photographs of the sort formerly obtainable only by using platinum.

GLARE-FREE DESK LIGHT

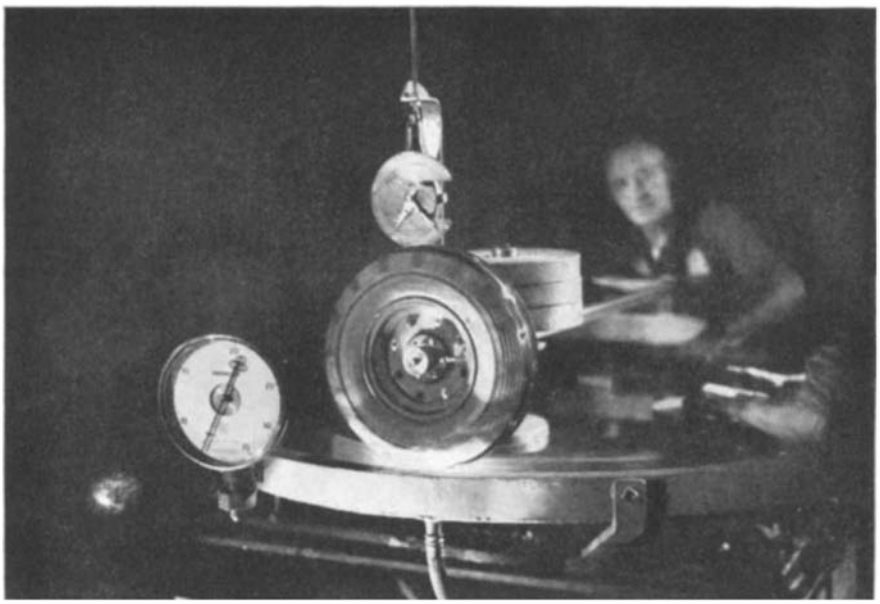
VISION without glare, bright illumination with no eye fatigue, greatly improved contrasts in viewing black and white illustrations, and truer, richer perception of colored objects; all this is accomplished by a new polarized-light lamp which can be used on desk or table. It is of moderate

Polarized light—no glare

height and has a circular metal shade with an internal reflecting surface. All light is thrown downward so that no direct light reaches the eye.

A new transparent plastic material polarizes the light as it is reflected downward by the metal shade. This new plastic polarizer, known as "Pola-Ply," was especially devised for this light by Alvin M. Marks of Polarized Products Corp. It is a composite plastic sheet containing no polarized crystals and which polarizes by virtue of the transmission of light through many layers of extremely thin isotropic plastic sheets. These sheets are sealed tightly during manufacture.

This unique material can be produced in unlimited quantities for a small cost per square foot, and it promises to have many uses in the lighting industry.



A glass-topped turn-table was devised by Goodrich engineers to make possible direct photography of the action of an automobile tire tread on a film of water. The turn-table is revolved while a camera placed beneath it takes photographs of tread action, showing in the laboratory the results of braking and other factors to which the automobile tire will be subjected as it rolls along the pavement

SULFUR AIR POLLUTION

RECENT studies of the concentration of sulfur dioxide in the air in five important industrial areas of the United States show that this is a negligible factor in its physiological effect. As a result of some 50,000 separate analyses covering a period of 15 months, with samples taken within a 15 mile radius of the center of the area, the following figures were obtained:

St. Louis—East St. Louis—
Average 0.128 parts per million (maximum 2.266).
Pittsburgh—Average 0.037 parts per million (maximum 0.897).
Detroit— Average 0.028 parts per million (maximum 0.396).
Philadelphia-Camden—
Average 0.027 parts per million (maximum 0.424).
Washington—
Average 0.009 parts per million (maximum 0.290).

Apparently Pittsburgh, in spite of its reputation, is not the leader in this type of air pollution.—*D. H. K.*

HEAT LAMP PROVES EFFECTIVE

FOR the relief of various deep-seated congestions, the 10-watt heat lamp recently made available by General Electric has proved particularly effective and convenient in use. The lamp utilizes a lamp constructed of infra-red transmitting black glass with a reflector, and has been designed to concentrate infra-red rays directly at the point of application. These penetrating rays augment the normal blood processes, thereby relieving congestion.

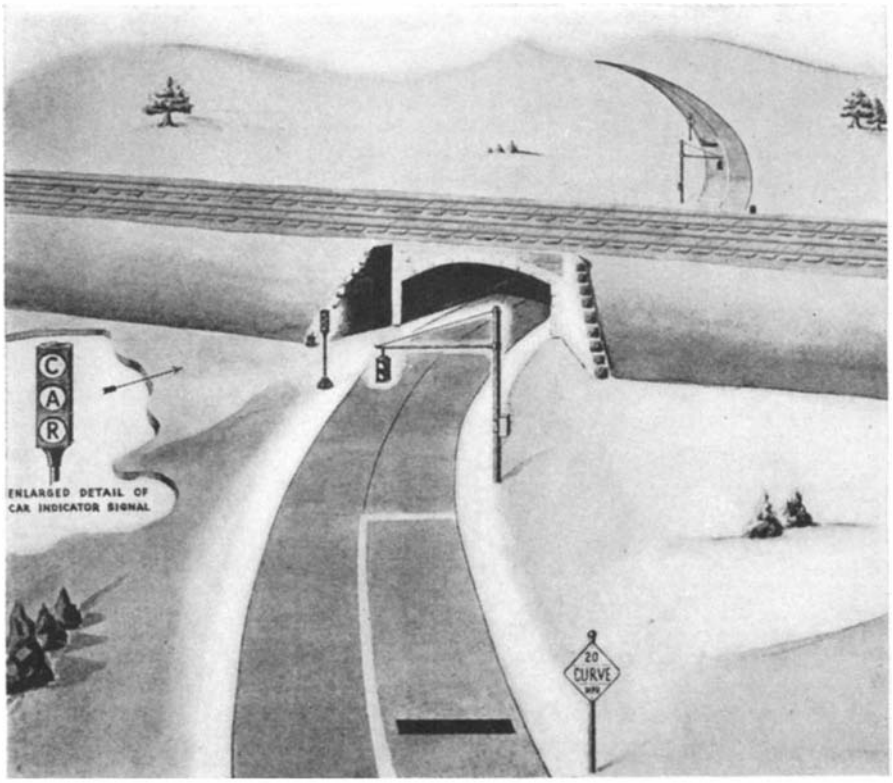
New, compact heat lamp in use for the local treatment of congestion

Simple and safe to operate, the lamp is of light-weight aluminum with an ivory baked-enamel finish. It has a handy switch and permanently connected all-rubber cord. The lamp draws 10 watts at 110 volts, and may be used with either alternating or direct current. Its compactness makes it convenient to carry for travelers who may desire relief from sinus afflictions at short notice.

STATE BIRTH CONTROL PROGRAM

NORTH CAROLINA is the first state in the nation to have a birth control program sponsored by the state health department.

Nearly half the counties of the state now have birth control clinics. There has been no local opposition to the service or the method



Highway safety may be increased by installations such as this one

adopted for rendering it. Social, religious, and other civic leaders have given their full endorsement and co-operation.

The patients have been selected from poor married women who need to limit the size of their families or space their children for the sake of their own and the children's health. Women who are able to pay a private physician are encouraged to do so. Practicing physicians in the communities served have been glad to find that they may legally give this service to their private patients.

A total of 1141 patients have been served, with only six failures reported. In three of these the mentality of the women was very low.—*Science Service.*

Speed Control System

FOR dangerous curves, highway bottlenecks, underpasses, and the like, the Automatic Signal Corporation has developed an ingenious speed control system called the Electromatic. Our illustration shows an installation at an S-curve underpass.

In the foreground near the speed limit sign is a vehicle detector inset into the pavement. On the right near the railroad bridge is a traffic light, with one red and one green or orange light, controlled by the detector. To the left, nearer the bridge, is a car indicator signal which, despite its position at the left, is intended as a guide for the car in the right lane. Beyond the railroad is a duplicate set of detectors and signals to guide the oncoming left-lane traffic.

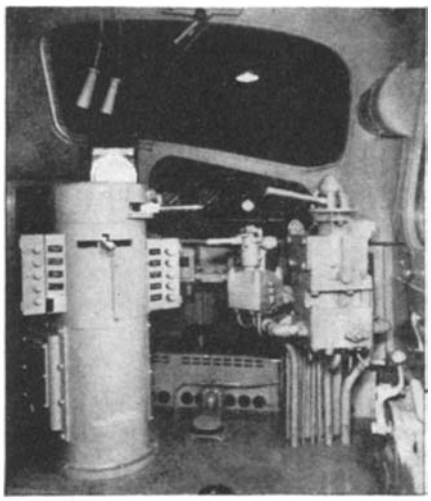
The traffic light is normally red. As a car passes over the near detector, it must slow down and wait a given number of seconds until a "proceed" indication, governed by local preferences, is flashed by the traffic light. The car then proceeds into the curve and under the underpass at a necessarily reduced rate of speed. After this car passes, the traffic light automatically returns to the red, or stop, light. Adjustment is made to take care of a number of cars travelling in the same direction at rather close intervals.

When a car has gotten the "proceed" signal from the traffic light, the car indicator signal on the opposite side of the blind spot flashes on, spelling out "c-a-r," to warn approaching drivers.

Diesel Control Cabs

THE control cabs of the new streamlined 6000 horsepower, Seaboard, Diesel-electric locomotives, the most powerful and longest in the world, look very different from the cabs of steam locomotives, as our illustration shows. Safety in operation is an important factor, essential controls of the Seaboard Air Line Railway's Diesels consisting of a dead-man control pedal which would automatically stop the train if the engineer's foot should leave the pedal, a throttle lever controlling the speed, a reverse lever, and an air-brake lever.

The engineer is always given immediate information as to the condition of his operating equipment. An eight-inch electric gong and illuminated annunciator box is also placed both in the cab and in each engine room to inform the engineer of any abnormal condition in the power plant or chassis. The annunciator boxes have three differently colored lenses which show if there is a hot engine, low oil pressure, or heating plant boiler failure. The alarm gong starts ringing the instant a warning light comes on and continues to ring until the engineer closes the throttle to stop the train. Windshield wipers, defrosters and visors, electric horns, safety glass, and speedometers all contribute to safety.



In a Diesel-electric locomotive cab

SWIMMING POOLS

GROWTH of algae in swimming pools is prevented by a grayish, white powder dissolved in the water. The treated water is not colored, does not stain suits, and is not objectionable to bathers.

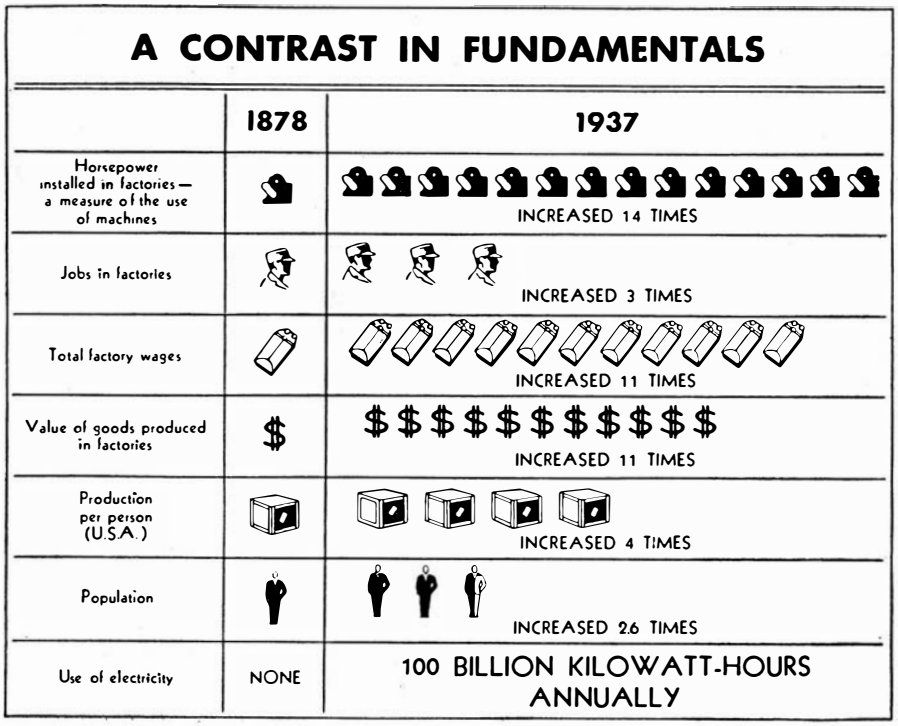
Death Ray For Insects

COLD-BLOODED inhabitants of the fur of dogs and cats, of birds and their cages, lofts, and coops—fleas, ticks, lice, red mites—now have their own private death ray. A new infra-red lamp, developed by the Leray Corporation, kills all such vermin and others which infest seeds, cloth, wood, and other materials. Fungus is also said to be susceptible to its killing rays, so that plants may be freed of disease fungi.

"Flea killer" in use

At present most of the emphasis on the killing power of this light is being placed on its use to rid household pets of vermin. Abercrombie and Fitch Company, New York sporting goods store, through whose courtesy we show the accompanying picture, advise that they are daily making very satisfactory demonstrations on dogs that are brought into the store. One treatment, naturally, is not sufficient to eradicate all vermin on an animal. The reason for this is not that all pests on the pet do not succumb at once but because the vermin often leave their "hosts" for short periods, especially after they have eaten well and are sleepy. The pet is therefore used as a lure or trap to facilitate cleaning of its quarters.

The Leray lamp is as easy to operate as a flashlight. It is held close to the animal's body, as shown in the photograph, while the operator's other hand ruffles the fur so that the light will penetrate to the skin. That is all there is to it except that often it is necessary to accustom the animal to its presence



by flashing it on for several short periods. Death to vermin at any particular spot comes in from a fraction of a second to four or five seconds.

Synthetic Glycerol

GLYCEROL, produced as a by-product of the manufacture of soap from fats, has become so important in the manufacture of synthetic resins, particularly those used in paints and enamels, that its synthesis is being undertaken to amplify the supply. The process of synthesis consists in chlorinating propylene, a by-product of cracking of petroleum, and hydrolysing with alkali the trichloropropane thus formed. One of the large oil-refining companies has already installed equipment for this purpose and expects to be able to produce glycerol at a fraction of its present price.—*D. H. K.*

MAJOR INDUSTRY

OUT of every $100 of sales of organic chemicals in 1937, $4.30 was spent for research, for which chemical manufacturers spent during the year, according to conservative estimates, $20,000,000.

Sixty Years

THE accompanying graph, prepared recently by, and used through the courtesy of the General Electric Company, presents some interesting contrasts. It shows clearly, by verifiable figures, that we are not yet quite licked by the machine of man's own making. In fact, at the very point where the machine should have done the greatest part of its dastardly work, the evidence indicates that man is still the boss.

In approximately 60 years, the population of the United States increased 2.6 times. Had our machines of 1878 been left alone and had all other things been equal, jobs in factories should have increased a like number of times, or 2.6 times. But jobs actually increased 3 times. That means more jobs per capita, with the machine than without. Study of the graph will indicate other illuminating improvements in standard of living, money to buy the things for the better life, and so on.

Fluorides in Water Prevents Tooth Decay

DRINKING water containing fluoride, a worry to residents of certain localities because it causes a permanent discoloration of the teeth of children, known as mottled teeth, may actually be a blessing in disguise.

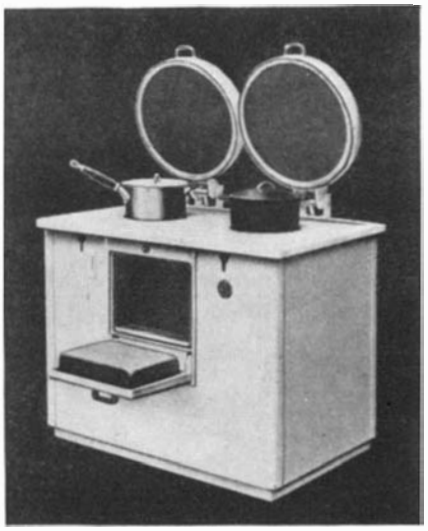
Children drinking this water are relatively immune to tooth decay, it is revealed by a four-year study described in *Public Health Reports* by Dr. H. Trendley Dean, dental surgeon of the United States Public Health Service.

Examination of thousands of school children in South Dakota, Colorado, and Wisconsin showed that the severity of dental caries is lower in localities where the mottled enamel occurs. In fact, the severity of tooth decay is inversely proportional to the prevalence of mottled enamel.

A special study of nine-year-old children showed that the number of children completely free from tooth decay is over five times as high where the drinking water contains appreciable amounts of fluorides as where the water is relatively free from the mottling substance.

Dentists are not ready to advise drinking of the fluoride water to prevent tooth decay, but the research raises some interesting questions, Dr. Dean points out. "What rôle, if any, does the physical structure of a tooth play in either susceptibility to or immunity from dental caries?" he asks on the basis of these findings. Is the higher fluoride content of the enamel of a mottled-enamel tooth the immunity-producing factor? Is the limited immunity due, directly or indirectly, to the well-known inhibitory action of fluorine on enzymatic processes?"

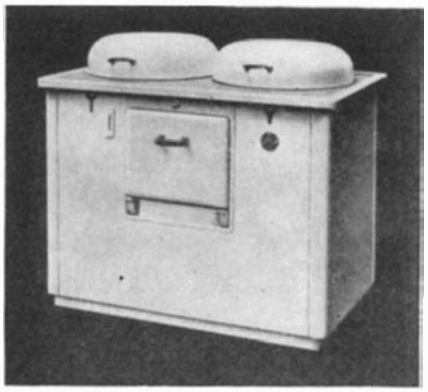
Perhaps it is not the fluoride that causes the immunity, after all, Dr. Dean points out, but some unknown constituent in water that either appears only where fluoride is present, or is in greater concentrations in water containing fluoride, or that acts to produce immunity only when associated with fluoride. —*Science Service.*



For the Kitchen

SOME years ago we pointed out that invention per capita was higher in Switzerland than in this country. It seems that the Swiss are as ingenious as they are prolific inventors—if we are to judge by two new patented inventions recently described to us by Mr. J. Basler, who is in this country to interest American manufacturers in their production.

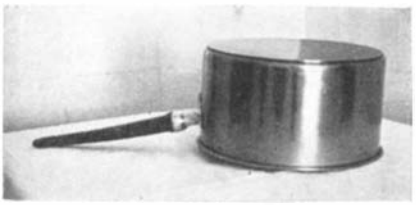
Electrical ranges have the disadvantage that, when starting to cook, the housewife must wait until hot plates and oven are up to temperature. The result is that cooking is very slowly done. This delay is unnecessary with the Swiss range illustrated on this page. It operates like an electric refrigerator—the current is on all the time. The body, the oven door, and covers over the hot plates are well insulated so that the exterior is comfortable to the touch. However, the housewife has only to lift one of the covers to find the hot plate heated to 270 degrees, Centigrade. Speedy cooking results.



Above and left: **Two views of the electric kitchen range in which current is left on all the time**

Inside this unit is a strong, sealed tank of water which acts as an accumulator of heat. A heating element which consumes 600

watts and is turned on 24 hours of the day keeps a constant head of steam under pressure circulating under the hot plates and in the oven. An automatic regulator keeps the heat constant, turning the current on and off, as needed, exactly as does the control mechanism of an electric refrigerator. Inside the



The bottom is thicker than the sides in this latest one-piece saucepan

body of the range is also a coil connected with the water system to supply running hot water at all times.

Besides faster cooking, the advantages of this range lie in lower rates for current; the use of off-peak-load, or night current; prevention of burned food because of the even, controlled heat; and other features.

The other invention consists of a stainless saucepan, the bottom of which is of heavier "plate" than the side walls, but cast as one unit. Besides the well-known advantages of stainless ware, this pan will not buckle or warp. It is particularly useful on all perfectly flat hot plates of electric ranges.

FOREST FIRES

A FOREST fire every three minutes was last year's count in the United States, according to summaries compiled by the Forest Service, U. S. Department of Agriculture. The total for the year was 185,000.

Castor Oil Off the Medicine Shelf

YOUNG America's acquaintance with castor oil does not include knowledge of the important fact that it is the only known lubricant which does not affect rubber. That makes it invaluable in hydraulic brake fluids widely used in modern automobiles. Brake fluids consist, with a few exceptions, of castor oil mixed with a solvent, such as alcohol, to make it thinner and to prevent it from thickening in cold weather.—*D. H. K.*

British Praise New American Cruisers

IN the new cruisers of the *Brooklyn* class, the U. S. Navy possesses the best ships of their type in the world. Such is the general tenor of an article in a recent issue of *The United Services Review,* leading British military periodical.

In armament, protection, speed, seaworthiness, plane-carrying capacity, the new American craft are given a long lead over the *Mogami* class in the Japanese Navy, and even admitted to have the edge over the comparable British cruisers, the *Southampton* class.

The main armament of the *Brooklyn* class,

15 6-inch guns, is the same as that of the *Mogamis,* but the latter ships have a displacement of only 8500 tons as against the Americans' 10,000, and are therefore rated as over-gunned by the British journal. They have purchased their heavy battery probably at the cost of other desirable qualities, such as armor and internal protection against damage by torpedo and mine explosions.

The *Brooklyns* carry four planes, and can accommodate as many as eight. This capacity, the *Review* comments, is far superior to that of any foreign cruiser save one in the Swedish Navy, which is a hybrid ship that has sacrificed everything to carry from six to eleven planes.

The British observers are favorably impressed with the anti-aircraft armament of eight 5-inch guns carried by the American cruisers, which is "very similar to that carried in the *Mogamis* and is slightly superior, at least in theory, to that in the *Southamptons.*"

Unlike the comparable British and Japanese cruisers, the *Brooklyn* class carries no torpedo tubes. These weapons have been given up in all American ships larger than destroyers. The feeling of the *Review* seems to be that this is no particular disadvantage, since the new cruisers are designed to act in conjunction with the destroyer flotillas, and American destroyers now building carry the exceptionally heavy torpedo armament of 16 tubes.—*Science Service.*

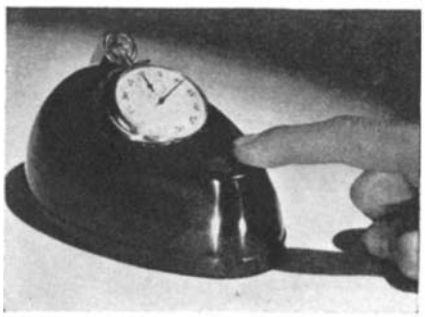
PEACE

RINGING in the first one hundred years of peace between the United States and Canada, a large nickel bell known as the International Peace Bell has been installed on the lower ramparts of Fort Wellington overlooking the St. Lawrence River at Prescott, Ontario, where the "Battle of the Windmill" was fought in 1838. Over 15 inches high and weighing more than 200 pounds, the bell is made of a special nickel alloy.

STOP-WATCH-MAN

IN presenting an honorable mention award in the Scientific Group of its Third Annual Modern Plastics Competition to the Precision Scientific Company of Chicago for its Stop-Watch-Man, *Modern Plastics Magazine* recognizes the design achievement made possible with plastic materials.

The Stop-Watch-Man is a tear-drop shaped holder or base for a stop watch, for use in the laboratory where workers' hands are very

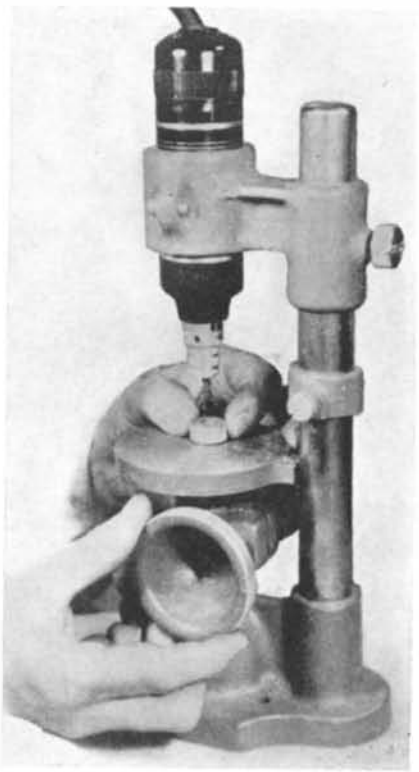


Stop-watch holder, made of molded plastic, for use in the laboratory

busy and often wet with oils or chemicals. A regular stop-watch is recessed into a Bakelite molded plastic base, so constructed as to permit control mechanism to be set into the base and the watch operated by merely pressing a button. Designers Barnes & Reinecke of Chicago achieved not only a better-looking, better-functioning unit utilizing plastics, but also were able to reduce manufacturing and, consequently, selling costs, compared with an older cast metal model. The Chicago Molded Products Corp., Chicago, did the molding job, using Bakelite.

Grinder Becomes Versatile

HOBBYISTS and lovers of fine tools who are fortunate enough to own a DeLuxe Handee, made by Chicago Wheel and Manufacturing Company and described in these pages some months ago, may now purchase a number of accessories to make it into a



Hand grinder in a drill press

far more versatile tool. An accompanying photograph shows a simple mounting which turns it into a drill press. Other simple attachments, or rather, holders, convert it into a router and shaper. The Handee Workshop is a kit which makes possible its use as anyone of 12 machines: lathe, drill press, router, grinder, polisher, sander, saw, shaper, and so on.

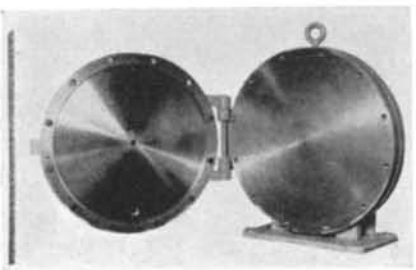
Sonic Soft Curd Milk

THE Submarine Signal Company has specialized for years in the development of electro-mechanical vibrational apparatus of all sorts. One interesting product of this work has been the development of a method and equipment for introducing soft curd characteristics into milk by the application of sonic energy. Sonic energy—high frequency vibrations—and its effect on the curding properties of milk have been the

subject of considerable research by Dr. Leslie W. Chambers.

Ordinary cow's milk is assimilated with difficulty by many adults as well as children, due to the large, tough curds formed in the stomach by the initial reaction between the ingested milk and the stomach juices. The necessity for some effective and inexpensive treatment by which the curd formation can be altered to a more easily digested form is shown by the universal practice of modifying cow's milk by various expedients, before feeding it to infants, so as to give a more readily digested curd.

The apparatus used to apply the present process to milk consists of a stainless-steel



Two-foot stainless-steel diaphragm set-up for the sonic treatment of milk

diaphragm approximately two feet in diameter which is vibrated electromagnetically at a frequency of 360 vibrations per second. A stainless-steel cover is provided, as shown in the photograph, which can be bolted against the diaphragm, thus forming a chamber. The milk to be treated is introduced into this chamber through the inlet opening at the outer edge of the cover and in order to pass out of this chamber must of necessity flow over the center of the diaphragm where it is subjected to intense vibration before passing out through the centrally located outlet opening in the cover. The unit shown is capable of handling milk at the rate of 250 gallons per hour with a power consumption of approximately five horsepower.

Curd formation in the stomach as a result of this process is uniformly small and readily digested. During the process the cream in the milk is distributed through it so that no cream line forms on the top of the bottle. It is interesting to note in this connection, however, that although the butter fat particles are distributed through the milk by the process the particles are nevertheless large enough so that subsequent recovery of the cream from returned milk is readily possible by passing it through the ordinary type of separator.

Feeding tests on children and invalids who previously had difficulty in assimilating ordinary milk have demonstrated that the process definitely increases the digestibility of the milk without addition to or subtraction from the ordinary constituents of normal whole milk.

Rubber Trolley Guard —Safety for Mines

THE exposed trolley wire has long been a danger to workmen in those mines where electric transportation is used in the main entries. Even when the greatest care is taken to prevent body contact with the wire, there is always the possibility of serious injury or death occurring to a miner due to

his touching it with the tools which he is carrying.

Trolley wire guards of wood or old fire hose have been used, but both offer disadvantages. Too often the wood guards are made from old or inferior grades of lumber and are easily broken. Use of old fire hose as a wire guard offers an advantage in that it is flexible. However, it does not offer perfect protection due to the fact that the yarn in such hose acts as a conductor of electricity.

A solution to this problem is offered by The B. F. Goodrich Company, in the development of a new rubber trolley wire guard de-

No more shocks from mine wires

signed especially for mine service. This guard is made of cloth-inserted sheet rubber, 3/32 of an inch thick by 9 inches wide, which is folded double and cured in a permanent "U" shape. It provides complete protection for the workmen because the material flexes or bends in either direction. Installation is simple and economical. All that is necessary is to notch the rubber guard to fit around the trolley wire support and place it over the wire like a saddle.

MAN STILL CHAMPION OF THE AIR

DIGRESSING for the moment from the usual types of scientific investigations which ordinarily occupy his time, an industrial research scientist has exploded—with proofs aplenty in different ways—a fantastic yarn about an insect that flies so fast that it arrives before you hear it leave—a fly with a speed of 818 miles an hour (sound travels only 740 miles an hour).

The scientist is Dr. Irving Langmuir, associate director of General Electric's research laboratory and Nobel prize winner; the fly whose reputation he has smashed is the deer bot-fly, which repeatedly in recent years—and more and more as time has progressed—has been held up as something which has far outstripped man's puny efforts to become flight-speed champion of the living world. Man's fastest planes hurl themselves through the heavens at a mere rate of hardly more than 400 miles per hour.

Particularly in recent months have there been cartoons and news items referring to the speedy deer bot-fly or again simply to the deer fly.

Now Dr. Langmuir has shown:

1. The non-streamlined—and really flat-headed—fly at such a speed would encounter a wind pressure against his head of about eight pounds per square inch, probably enough to crush him. $R=pd^2v^2f$ is his proof.

2. Power consumption for maintaining a

velocity of 818 miles per hour would be about one half horsepower which, for a fly, would be a good deal.

3. If the fly equals man in efficiency—and it doesn't seem as though the fly can be more efficient than man who as an organism himself has a high thermodynamic efficiency—the fly must consume 1.5 times his own weight of food each second to deliver the 370 watts, or nearly half horsepower of energy, which such speed requires.

4. A piece of solder of roughly the dimensions of the fly can be seen only as a blur if, in a brightly-lighted, white-ceilinged room it is attached to a silk thread and swung so that its speed is 13 miles per hour; at 26 miles per hour it is barely visible; at 43 miles per hour it appears only as a faint line and its direction of flight cannot be told; and at 64 miles per hour the solder "fly" is invisible. (The higher speed attributed to the fly was based on a published report of an entomologist that he had seen the insects fly past him so fast that they could be seen as a blur, and that he estimated their speed as 400 yards a second, or 818 miles per hour.)

5. Laboratory light intensity measurements and calculations also prove that an object the size of the deer fly is invisible at speeds of 64 miles per hour and above.

6. A fly striking a person at such a speed would exert a force of 310 pounds, or about four tons per square inch, and would penetrate deeply into human flesh—and the first such instance is yet to be reported; and finally,

7. Dr. Langmuir concludes a speed of 25 miles per hour is a reasonable one for the deer fly, while 800 miles per hour is utterly impossible.

Aviators, then, do not have to hang their heads in shame because they can hardly surpass 400 miles per hour with today's airplanes. Nor will they ever have to move over in their courses to give the right-of-way to deer-fly speedsters.

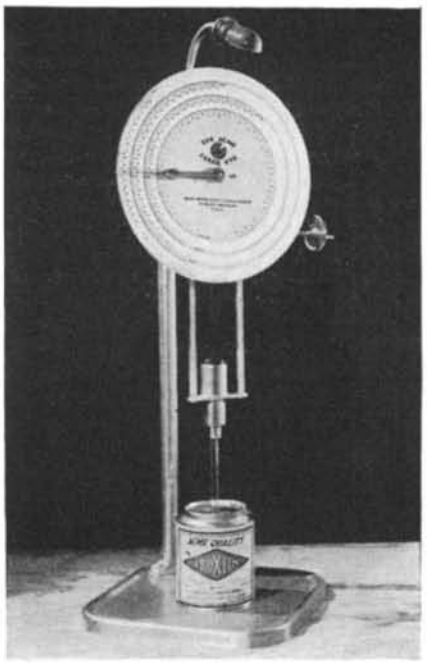
LARGEST

THE largest steam locomotives in the world are in operation in the United States. The boiler barrel of one of these locomotives, if all tubes and other obstructions were removed, is large enough to permit any standard automobile to be driven through with room to spare.

LIGHT BEAM USED IN COLOR MIXING

THE principle of interrupting a beam of light to make precision measurements has been put to a new use, according to J. W. Strain, of the Acme White Lead and Color Works.

Taking a leaf from the experience of other branches of industry and science which have been utilizing light-beam measurements for a number of years, the Acme Color Eye measures the exact level of color poured into a container by interrupting the light beam when the color has reached the desired level. The operation of the device is very simple: required proportions of basic tinting colors are indicated on the large lighted dial. This automatically establishes the level of a trans-



Light beam makes possible automatic measurement of paint colors

parent rod which extends into the mixing can. A light beam travels down this rod of special transparent composition and is reflected in the surface of the color in the can. The instant the color reaches the correct level and touches the end of the illuminated rod, the reflection automatically disappears, giving an instantaneous stop-pour signal.

Experience has proven that this type of signal is so quickly telegraphed to the hand that pouring stops instantly.

NEW WOOD PRESERVATIVE

PENTACHLOROPHENOL, now produced on a commercial scale, has been found to be a particularly effective material for the treatment of wood for preserving it against decay, termites, and other destructive forces. It may be applied as a 5 percent solution in a petroleum solvent, preferably by pressure impregnation or by brush treatment. The advantage of the new chemical as compared with creosote and other familiar materials is that it does not change the texture or painting properties of the wood and possesses practically no odor. It can be used for treating heavy timbers or for the preservation of finished mill work. Although it is difficultly soluble in water, it forms a compound of sodium which is readily soluble and can be used for controlling slime and algae in industrial water supplies and as a preservative for glue and other similar materials subject to decomposition by bacteria or fungi.—*D. H. K.*

DEW PONDS AGAIN

PREHISTORIC Britons, confined to waterless hillsides by wolves on the plains, obtained water for their cattle by constructing mysterious dew ponds. Slightly below the crest of a hill, a shallow pit was dug and lined with straw; a layer of puddled clay was added, and gradually a pond appeared, filled with water from an invisible source. Day after day the herds drank, yet

the ponds remained filled, fed by moisture condensed from the air.

Modern scientists are not yet certain why dew ponds work so well, nor do engineers know the conditions necessary for duplication elsewhere. Natives say that the only known successful builders today are from a single English family who use inherited methods, except that concrete replaces clay. The bed of chalk running from the Weald of Kent through the Sussex Downs to Wiltshire is the only subsoil known to support these ponds. Whether the chalk is essential no one knows. George and A. J. Hubbard. British scientists, once wrote an able and fascinating treatise on the subject, but they were unable to duplicate the results.

Obviously a dew pond must condense more water than it evaporates, which means that it must keep cool. It must lose heat otherwise than by evaporation, and must not absorb heat unnecessarily from the earth. Recent research has shown that water is nearly perfect as a "black body" or a body that easily gives off heat by radiation, and this discovery may furnish one key to the dew pond's efficiency. The balance is delicate and the straw which keeps away the heat of the earth must be kept dry. The flint men protected their straw insulation carefully against moisture, and 20th Century man suffers by comparison when he finds ice between clapboard and plaster in his insulated home. To the men of the hills, such ignorance of nature's ways meant victory for the wolf pack.

Nearly 3000 years have passed since the Neolithic hill-man fought off wolves with organized trench warfare, defending his herds and his temples of the sun. "Trolls, kelpies . . . pixies, gnomes and the rest—gone, all gone!" But dew ponds remain to intrigue and mystify the sages of a modern day.—*The Industrial Bulletin* of Arthur D. Little, Inc.

THE CHINESE ARE NOT RACIALLY ALIKE

MR. Chungsee H. Liu has attempted a classification of the races of China in which he points out that the Chinese people are by no means a homogeneous unit, as commonly supposed, and examines critically the classifications of those anthropologists who have recognized this fact. Mongol, Mongoloid, and Mongolian, are loose and unsatisfactory terms, and *Homo sinicus* is suggested to replace them.

In the Chinese population as a whole, the physical characters are, in general terms: hair universally black, lank or coarse, straight, with almost circular cross-section: body and face hair very scanty; skin varying from yellowish to yellow-brown; eye color light-brown; setting of eyes horizontal or oblique with epicanthic fold; cheek bones prominent; medium to broad-headed; nose relatively flat with depressed nasal bones; medium stature; slender or thick-set; hands and feet small.

Within this general description, three types are recognized, which are distributed in accordance with the three great river-systems of China: (1) The Huangho type in the north, mainly found in the valleys of the Huangho, the Liao Ho, and the Sungari Rivers in Manchuria. This type is of high stature, long-headed, slender-nosed, and of

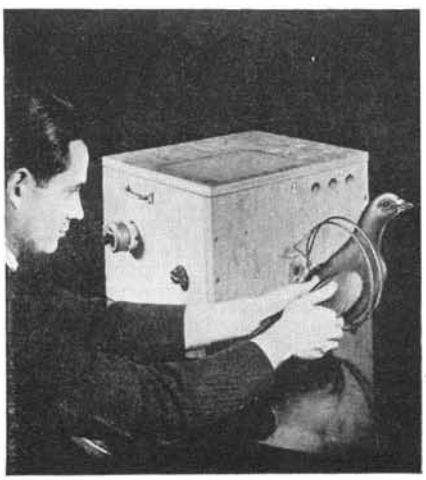
vigorous physique and robust feature. It is honest and frugal, slow but sure, chivalrous and conservative. The people speak the northern Chinese mandarin, and may be regarded as the archaic type of Chinese. (2) The Changkiang type, mostly confined to the Chang Kiang or Yangtze River valley in a favorable natural environment. This type is of medium stature, of medium head width and medium nose height, with light yellowish complexion. The people exhibit great iterary power and ability. They speak southern Chinese mandarin with local dialects—the progressive type of the Chinese nation. (3) The Chukiang type in the Chu Kiang or Pearl River valley of southern China, with Fukien as an eastern corridor and Hainan Island beyond the sea. They are of shorter stature, broad-headed, low-nosed, of darker skin color. Mentally this type is vivacious, and adventurous, quick in action and radical in thought. They speak various dialects of southern China.—Adapted from *Nature* (London).

New Insecticides

BRITISH research on chemicals for the control of pests has recently revealed the fact that several unusual compounds ordinarily used for other purposes possess merit for controlling insects. Tetramethylthiuram sulfide, a valuable accelerator in rubber vulcanization, repels the Japanese beetle. Methyl bromide has been found to be even more toxic than hydrocyanic acid for several types of moths and larvae and is being used effectively against granary weevils. Phenol thiazine is being studied as a substitute for lead arsenate. Dichloroethyl ether, used as a solvent in refining petroleum, has been found effective in killing the wire worm.—*D. H. K.*

Homing Pigeons Exposed to Radio Frequency Waves

OCCASIONAL reports have appeared from time to time to the effect that radio waves disturb the homing instinct of homing pigeons. One of these reports covers tests conducted by the Navy Department at Lakehurst, New Jersey, and shows quite conclusively that the pigeons were affected. Those exposed to radio waves at the antenna of the A. T. & T. transmitter at Ocean Gate, New Jersey, took much longer to return



Exposing a pigeon to radio waves

Gardening in Chemical Solutions

home than did those birds released at the same location but not exposed.

In order to find out, if possible, what were the effects of radio waves on pigeons, a 100-watt oscillator was constructed in the laboratories of the Zenith Radio Corporation under the supervision of Commander E. F. McDonald, Jr., the organization's president, and a series of experiments were conducted at many different wavelengths on homing pigeons. The oscillator was arranged to have large tank coils so that the pigeons could be placed in a strong field. The oscillator was adjustable over a range of five to 50 meters.

The pigeons were released one at a time at suitable intervals. The tests were carefully arranged so that only certain pigeons were exposed to radio frequencies. The remainder were kept ½ mile away from the oscillator, inside a steel bodied truck.

Tests were conducted under these conditions at Mount Prospect, Illinois, beginning October 13 and continuing through October 27, with the following results:

EXPOSED TO RADIO FREQUENCY

Wavelength	*No. of Pigeons*	*Flying Time Minutes*
5 Meters	1	35
11.5 "	3	29
15 "	4	27
20 "	5	27
30 "	3	31
40 "	4	32
50 "	3	28

Average Time.....29½ Minutes

NOT EXPOSED TO RADIO FREQUENCY

No. of Pigeons	*Flying Time Minutes*
2	24½
2	24½
3	30
2	23
3	37
2	24
3	21

Average Time.....26½ Minutes

Flight course.....25.6 Miles
About 125 pigeons flown during entire tests.
Above compilation covers 40 pigeons.

It appears from these figures that homing pigeons exposed to radio frequencies are affected by the exposure and that in some way their ability to return home does slow up. The difference in time used to return home between the exposed and the unexposed birds is not very great; however, it must be borne in mind that the power of the oscillator is not great. Considering this, the results obtained become significant.

During the course of these experiments many other tests were conducted. In some cases fixed permanent magnets were hung around the necks of pigeons. This was done to determine whether or not the pigeon's homing instinct might not result from some ability on its part to be guided by the earth's magnetic lines of force or, as has been suggested, since there exist no two places on the earth's surface having the same magnetic field strength, these birds might seek that field strength which exists at the home lofts. It was found that the magnet on the pigeon's neck did not seem to affect his homing ability at all. Further tests of this type might produce more conclusive evidence. However, the present tests indicate that the flying time is the same both with and without the magnet.

It has been reported that homing pigeons having their ears blocked up fail to return to the home loft. The use of wax in the ears seems greatly to irritate the pigeon. In order to make this test under conditions where the pigeon would not be irritated in any

way and would be normal in every respect, except that his hearing would be stopped, the ears were completely filled with Vaseline. The feathers all around and over the ears were also smeared with Vaseline. The temperature on the day of the tests was around 45 degrees and the Vaseline quite solid at this temperature. The pigeon so treated returned home faster than it had ever been known to do so before, and with the Vaseline still in its ears. It is possible that further tests might develop additional information; the fact that the pigeon returned home in very much faster time is at variance with other reports which indicate that the pigeon loses his homing instinct entirely when his ability to hear is removed.

Several tests were also conducted where an antenna was coupled to the oscillator and a half-wave antenna, of very small wire, tuned to the transmitter frequency, was tied to the pigeon's leg so that there was actual contact to the leg. This seemed to slow the bird's flight up somewhat and it is difficult to say whether the slowing up was due to the drag of the antenna or the resultant application of more radio frequency to the pigeon through the medium of the antenna.

This test would be of real merit in the vicinity of a regular transmitter having considerable power.

The facts produced from the experiments would indicate that the pigeon's organs of hearing apparently are not connected with the homing instinct, that the homing instinct is not affected by magnetic fields such as the earth's field, that radio radiations do affect the homing instinct, and that the homing instinct is not appreciably affected by any particular wavelength in the short wavelength ranges, any wavelength producing about the same results.

It is of interest to note that exposure to radio frequencies in the ranges tested, often seemed to make the pigeon restless and that at 20 meters the respiration and heartbeat seemed to increase a noticeable degree and to an extent much more noticeable than at any other wavelength in the range used. —*C. E. Brown, Zenith Radio Corporation.*

RADIUM HOUNDS

(*Continued from page 8*)

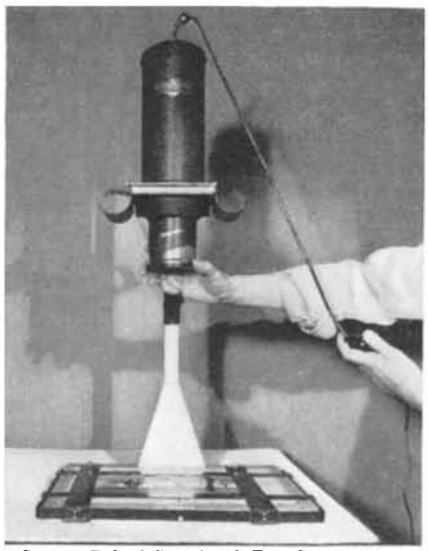
suspected thief, as well as all likely caches, could be searched entirely without his knowledge. Even his home could be thoroughly "ransacked" by the unobtrusive method of parking a car carrying a Geiger-Müller counter in front of it.

With the increasing use of radium in medicine, the manufacture of "radium hounds" is on the rise. About 20 of these devices are now being used in the United States. Some of them are home-made affairs, but at least two companies manufacture them for the trade, at an approximate cost of $125. Are the machines effective? Of the 107 radium losses mentioned above, 59 complete recoveries and 11 partial recoveries were made by "radium hounds." The radium thus recovered represents several hundred thousand dollars in cash, also the removal of a grave potential hazard to any human being who might unconsciously come in contact with this burning element. Since the advent of the "radium hound," I know of no instance in which anyone has been seriously injured by lost or misplaced radium.

Conducted by JACOB DESCHIN

Picture-Making by Enlargement

TIME was when the contact print was taken for granted and only the so-called "advanced" amateur and professional went in for enlarging his pictures. But with the advent of the miniature negative, the enlarging camera became essential equipment. A great many amateurs today use an enlarger as a matter of course not only because the miniature negatives most of them make cannot be seen properly in a contact print but chiefly because of the many opportunities afforded by the enlarging medium for improving the final result.



Courtesy Federal Stamping & Eng. Corp.

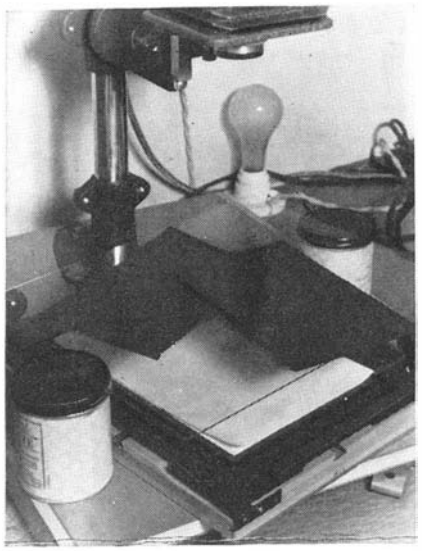
Focusing the enlarger

Undoubtedly the chief attraction of the enlarging medium in photography is the large print. The mere comparison of a small contact print with a 5 by 7 or 8 by 10 enlargement of the same negative image is enough to sell the enlarging idea to practically any photographic worker. But more wonderful even than this is the remarkable fact that by the same token and in the same way that the negative is enlarged to greater proportions, a mere portion of the negative may be selected and magnified to occupy the full format of a good-size print. The opportunities thus afforded for recomposing the arrangement of the negative image, for altering the emphasis of certain details, for introducing a special meaning that may not have been perceived in the original subject as recorded on the negative, are all too obvious to require more than mention. Moreover, it is no mean advantage thus to be able to delete extraneous matter, particularly when the focal length of the lens or an enforced vantage point made it necessary to include more than was actually wanted.

Control in printing, more familiarly known as "dodging," is practised most effectively during enlargement. Suppose, for example, you project on the easel a negative image in which the shadow detail is abnormally lower in the tonal scale than the detail in the brightest highlights. For the best possible enlargement from this negative, you will want to show detail in both highlights and shadows. If you were to expose for the highlights, you would lose or badly damage your shadow detail, and if you exposed for the latter, your highlights would very likely show little more than white paper. In order to get both shadow and highlight detail in an enlargement from the negative mentioned, you will have to resort to the procedure known as dodging. This is done by attaching a piece of cardboard or wad of cotton to the end of a wire which is held in suspension for the required time between lens and easel. The dodger is cut or shaped to the required size and form and agitated during the exposure. In this manner, relatively transparent or thin areas are held back; relatively dark or dense areas are permitted a longer printing time by the use of a cardboard large enough to more than cover the size of the paper on which the print is being made and with a hole cut in it so positioned and of such a size as to permit the dense area to pass through while the rest of the negative is completely shaded.

Another interesting printing method is that of the photomontage made by projecting a number of different negative images

Dodging



For photomontage work

on the same sheet of paper. As each image is projected in its allotted space on the paper, the rest of the paper is shaded, as shown in the illustration or by some similar method. Before actual operations are begun, a plan must, of course, be laid, and the individual negatives projected and spaced off on a plain sheet of paper which, thereafter, becomes the guide for the projected images. Adjoining areas are made to merge into one another and should not show sharp, delimiting lines.

Distortion of the negative image is accomplished during projection by tilting the paper easel in relation to the enlarging camera lens so that the image is either elongated or broadened, depending on the position of the easel with relation to the projected image. Tilted buildings caused by an upward tilt of the camera in making the exposure may be corrected under the enlarging lens by a contrary tilt of the easel, thus bringing the building upright again.

These are the principal uses of the enlarging process and many workers see in them more than their money's worth in the purchase of an enlarging camera.

World's Fair Pictures

THE ability to "see" pictures is rarely so well demonstrated as in the work of Richard Wurts, of New York City, a widely known photographer, who recently exhibited more than 50 pictures of the New York World's Fair in the making. Held at the Museum of the City of New York, the display marked Mr. Wurts' first one-man show and well deserved the wide attention it received. Those photographically minded were impressed with the implied proof so graphically displayed that picture materials may be found in relatively unpromising surroundings provided the photographer has "what it takes" to pick them out.

When asked why he had taken the trouble to make pictures of subject-matter that was merely preliminary to the real and completed thing, Mr. Wurts explained that primarily what he was interested in was not so much the identity of the subject-matter itself as the opportunity it afforded for obtaining striking pictorial effects. Incidental to this but none the less worthy of the efforts he had expended in shooting the pictures was the documentary or historical aspect of the pictures which, once the Fair construction was completed, could never be made again. One of Mr. Wurts' World's Fair photographs appears on the front cover of this issue and another on page 24.

New Scheiner Ratings

THE announcement that Kodak Super XX, introduced in the 35-mm size, is now available in all the popular roll-film sizes and in film packs, is accompanied by Scheiner or Photoscop ratings for the new Eastman films. These ratings, which supplement those for the Weston and General Electric systems announced in a recent issue of this department, are as follows:

	Daylight	Mazda light
Panatomic X	25	23
Plus X	26	24
Super XX	29	27

These ratings are intended for average exposures and are not intended to be the maximum speeds. Negatives made with half the exposures called for will be quite satisfactory under ordinary conditions, but where the subject includes much shadow detail, for example, it is not always wise to attempt the shorter exposures. As a general, practical guide, the speeds indicated will result in fully exposed negatives.

Y.M.C.A. Camera Contest

YOUTH holds the limelight in an international photographic contest under the auspices of the National Council of the Young Men's Christian Association of the United States. The contest, which closes February 15, 1939, is open to amateur photographers throughout the world. Winning photographs will be used in the decorative scheme of the Young Men's Christian Association Building now being erected on the World's Fair Grounds in New York City.

Submitted photographs must picture the life and activities of present-day youth in the five following classifications: Youth at home; Youth at work; Youth at play; Youth and citizenship; and Youth at worship. There is a first prize of $25 and a second prize of $15 in each group, with an additional grand prize of $50 for the best photograph in the entire contest.

Contest rules limit entries to work of amateurs, require that pictures must fit one of the given classifications, and that prints must not be smaller than 8 by 10 inches, black and white. All entries must be in the hands of the Photograph Contest

LAST CALL

For Entries in the
Third Annual
SCIENTIFIC AMERICAN
Photography Contest

All entries must be in the hands of the judges by January 2, 1939

Complete Rules in October 1938 Scientific American

Editor, National Council Y.M.C.A., 347 Madison Avenue, New York City, not later than closing date. Contest rules are available at local Y.M.C.A. branches or from Contest Editor at the New York headquarters. Judges will include Harry B. Baker, editor of International News Photos; Emile Bruguiere, Dean, New York Institute of Photography; Morris Germain, A.R.P.S.; Wilson Hicks, Picture Editor of *Life*, and Herbert C. McKay, F.R.P.S.

From 1 by 1½ to 64 by 50

A PHOTOGRAPHIC enlargement 64 inches high and 50 inches wide made from a mere 35-mm negative and showing an Indian chief will soon become a familiar figure throughout the country as the Zeiss exhibits make their rounds. The negative is the work of Frank H. Shearer, of Bay City, Michigan, who writes that the negative shows "no perceptible grain" when blown up to these dimensions, "and every detail is perfect." He adds that no "step up" process was used, that is, no intermediate negative, and that the enlargement was made directly from the original 35-mm negative on paper 50 inches wide, not pieced together. Mr. Shearer gives the following data: Exposure in Contax III, equipped with Sonnar *f*/2, at *f*/4 and 1/125 second. Film used was Eastman Panatomic and development was in MPG.

Hunting with Flash Guns

THE Craighead brothers, Frank and John, who have been doing some notable work in the field of wild bird photography, pay tribute to the range finder and the flash gun for having made possible some unusual shots which they say could not otherwise have been obtained. Among the pictures which they have made are the two which they kindly permitted us to reproduce here. Concerning one of these they write:

"This represents an osprey or fish hawk leaving a fence post with a fish in his right talon. This picture illustrates how he uses one foot to shove off with and the other to grasp his prey. A few seconds later he will clutch the fish with both talons. Our Kalart

"Good Fishing"

"Annoyed"

focusing device made this picture possible, for quick focusing was essential.

"The other picture," they continue, "was taken with the aid of both the focusing device and the synchronized flash. It represents a young great horned owl in its nest. The nest was located in a small cave on the side of a cliff. The picture was taken as the young owl raised his wings in alarm. Even with the fastest film, it would have been impossible to get the picture without a synchronized flash. The great horned owl is one of the largest and fiercest of our owls, usually nesting in large wooded tracts far from the habitation of man."

CAMARADERIE OF THE CAMERA

THE camera has become the passport to impromptu friendships to such an extent that it needs no more than the display of one's camera in park or street or aboard ship to strike up an acquaintance with any other camera toter in sight. This has happened to this department on several occasions. We would be poking the camera up at some building or other and before we had finished, someone would come up and want to know what stop and shutter speed were used, what film, what filter, and so on. In no time at all the two would be talking on camera subjects in general with the freedom one usually employs with a friend of long standing. This unfailing "open sesame" to acquaintanceships that characterizes the camera fraternity led this department to invent a new term, namely, "cameramour," and the camera user as "cameramorist." Camera love and camera lover seem a bit far-fetched when heard for the first time. But how about bibliophile? Persons who collect first editions of books think this term to be quite proper and aptly descriptive of the book collector.

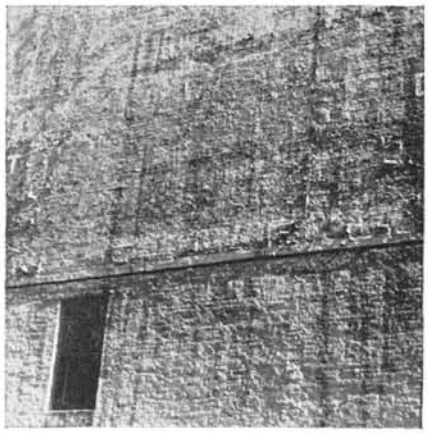
STANDARDIZING PHOTOGRAPHY

STANDARDIZATION in the field of photography took another step forward recently with the appointment of a new committee on standardization, according to an announcement by the American Standards Association, of New York City. Initiated at the request of the International Standards Association, the new committee will represent 40 different organizations, including Federal government departments, user groups, manufacturers of photographic

materials, distributors, and some 12 general-interest groups. The work of the committee will be the inauguration of a project on standardization in photography under the leadership of the Optical Society of America, as well as co-operation in the work of the project.

For Texture's Sake

COMPLETELY lacking in pictorial interest when the sun struck the wall head on—that is, with so-called front, flat lighting—the subject illustrating this piece



Texture

was made highly picture-worthy when the sun came glancing across the surface. Each little projection on the wall, edges of bricks, surfaces of flaking paint, threw its own particular shadow and the multiplicity of these added up to a general effect of gayety through a rich display of sheer texture.

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.

AGFA PD16 CLIPPER SPECIAL CAMERA ($17.25): Fitted with fully corrected focusing *f*/6.3 anastigmat lens and shutter with speeds 1/25 to 1/100, time and bulb. Gives fifteen 2½ by 2⅛ pictures to a roll. Uses PD16 film (same size as 616). Telescoping, metal, pull-out front. Solidly built with pressed-steel frame; finished with black-grained, waterproof covering, with exposed metal parts in polished metal and black lacquer. Other specifications: optical, direct-view finder; tripod socket; depth of focus table; hinged back; simple loading arrangement; special eyelets for attaching neckstrap.

HYDRAULIC AGITATOR ($5.95): Metal device for agitating fine-grain film solution during tank development. Tank is held firmly in place on metal platform, while water, running from a faucet, fills trough at other end, causing device to tilt. As water spills out,

platform returns to horizontal position again, this see-saw movement continuing throughout the development period. Water flow regulation adjusts speed of agitation. Adjustable platform takes all standard tanks.

5 by 7 TWO-PELLICLE ONE-SHOT ALUMINUM CASTING ($100): Intended to serve as body around which one-shot color camera may be built and assembled. Castings declared to be correct in design, rugged in shape and fully machined so that all important surfaces are accurately flat. Distributors say anyone with some shop experience can quickly build the rest of the camera. Those interested in building the camera may obtain photograph of the casting with further information from this department. Ask for "Photograph 10C and supplemental data."

PHOTO RINSER ($1): For washing prints. Changes water and moves prints in fresh water automatically, reducing washing time 30 to 50 percent, according to manufacturers' claims. Device is merely set under faucet and water turned on, allowing small stream to strike pan. When one side has been filled with water, it becomes heavy and tips, thus permitting other side to receive stream. Water continually runs out through slots. Thus rocking back and forth, several 5 by 7-inch (or smaller) prints may be washed at same time. Pan 1½ inches deep, made of heavy steel coated with special asphaltum paint to resist acid.

KODAK TABLE TOP TRIPOD ($7, complete with Pan-a-pod and Tilt-a-pod): Camera support for table-top photography, still-lifes, and so on. Used on table, chair, floor or other convenient support. Legs, sturdy and without joints, unscrew from solid metal head so outfit can be carried in pocket. Leg spread 9½ inches, height 7 inches. Each leg rubber-tipped, non-skid, will not scratch or mar polished surfaces. Pan-a-pod ($3) is revolving head for use on any tripod with standard screw. Insures smooth, easy swing in either direction when panoraming with still or movie camera. Degree markings help in making "panorama" pictures with still camera. Almost full circle may be pictured, locking screw holding center of Pan-a-pod head at any selected setting. Tilt-a-pod ($2.50) is adjustable camera support permitting tilting to any desired angle. Tripod alone $1.75.

LITE-MASTER ($9.75): Transforms any ordinary household electric-light bulb into flood light giving up to five times normal brilliancy. Lite-Master connection cord is plugged into any 110-volt A.C. outlet. Lights to be controlled are then plugged into outlets provided on the Lite-Master. Regular

house lamps, reflectors or spotlights may be used, and any bulb, including 100-watt size. Control switch has four positions: off, normal, half flood, full flood. Half flood gives two and a half times normal light value; full flood, five times normal. Up to four 100-watt bulbs or their equivalent in a larger number of lower powered bulbs may be used. In full flood position four 100-watt bulbs, or their equivalent, will give illumination equal to 2000 watts of standard lighting.

F-R ADJUSTABLE CUT FILM AND FILM PACK TANK ($10): All-Bakelite tank, with no metal parts, adjustable to take all sizes of negatives from vest pocket (1⅝ to 2½ inches) up to and including 4 by 5 inches. Fills and empties rapidly, this process being aided by novel light-trapped air vent. Loading guide insures proper insertion of individual films in curved grooves and retainer bar holds film down firmly and prevents buckling or dislodging during processing. Grooves are numbered for different sizes of films. Developer volume required varies with size of film, vest pocket size requiring 26 ounces; 2½ by 3¼ inches, 36 ounces, and all sizes above that calling for 52 ounces.

KODAK 35's, three new 35-mm cameras: With *f*/3.5 lens and Kodamatic shutter (five speeds to 1/200, plus self-timer), shutter set automatically for next picture as film is wound ($39.50). With *f*/4.5 lens and Kodak Diomatic shutter with four speeds to 1/150, built-in self-timer and fully automatic device for preventing double exposures ($29.50). With *f*/5.6 lens, Kodex shutter with three speeds to 1/100, automatic film centering and winding control ($18.50). Lenses corrected for full color as well as monochrome. Equipment includes folding optical eye-level view finder; one-piece bottom and back which may be unlocked and slid off for full access to camera interior; finger-tip focusing from four feet to infinity by revolving lens mount; camera bodies finished in black pin-seal grain molded into newly developed damage-resistant material, with bright metal and black lacquer trim and fittings.

SPEED GRAPHIC 2¼ by 3¼ ($111 to $141, depending on lens equipment): News photographer's standard brought into miniature camera class. Dimensions, 5½ inches high, 4⅞ inches wide, 3½ inches deep. Has all features of larger Speed Graphics, plus built-in shutter-flash synchronization, all-metal bed, helical racks and pinions, precision vernier footage scales, dual focusing controls, interchangeable molded lens-boards, satin chrome trim, accessory internally coupled range finder. These features are added to regular Speed Graphic features including interchangeability of lenses, two view finders, generous bellows extension (9 inches) permitting 1-to-1 copying, drop bed to permit use of wide-angle lenses, ground glass focusing, focal plane shutter in combination with between-the-lens shutter affording exposures of 1 second to 1/1000, rising and falling front, choice of either Graflex or Graphic back.

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. I am interested in making my miniature films into positives for projection. I understand there is a special formula used. There is a way to make lantern slides, but I wish to develop the film as motion picture film is developed. Would you tell me the formula and process of development?—W. R.

A. The better method of obtaining positives from your miniature negatives is to print on positive film and use the latter for projection. However, here is one good reversal process that may be employed in this connection. Several others are given in the "Universal Photo Almanac and Market Guide."

Soak the film in water at 65 to 70 degrees, Fahrenheit, for one minute and follow this by development for three to five minutes until all highlights in the negative image are as dark on the back side of the film as on the emulsion side. This developer is made up of one part of the following stock solution and one part water, temperature in each case being 65 to 70 degrees:

Stock Solution

Water (at 125°)	1 gallon
Metol	180 grains
Hydroquinone	1¾ ounces
Sodium sulphite (desiccated)	7 ounces
Potassium bromide	¼ ounce

Add one dram of strong ammonia water to each 16 ounces of working solution.

After development, immerse for three minutes in combination stop and hardening bath made up of one ounce of chrome alum to each 32 ounces of water. For another three minutes bleach the negative image out completely in the following bleach bath:

Water	32 ounces
Potassium bichromate	64 grains
Sulfuric acid (concen. pure)	4 drams

(Note: add the acid to the water, not the reverse.)

Now wash for three minutes and then clear out stain of the bleach solution in the following clearing bath for 2 minutes:

Water	32 ounces
Sodium bisulphite	½ ounce

Turn on the white lights. A general service 100-watt lamp, five feet from the film, will be about right. Wash film for five minutes in running water, or six changes of water. Finally, redevelop film in the same developer used the first time, or any good non-staining M-Q formula, such as DK-50, D-16, or D-72, diluted 1 to 4.

Q. I have heard there is a way of drying glossy prints within a few minutes' time. Can you describe this method? —S. M.

A. Fill a tray with wood alcohol. Before placing on the ferrotype tin, immerse the thoroughly washed print in the alcohol for one minute. In less than five minutes the prints will peel off the tins, completely dry.

Q. Please list some of the advantages and disadvantages of the "vest pocket" (1⅝" by 2¼") *vs.* the square (2¼" by 2¼") negative sizes.—L. A. K.

A. The square negative has become very popular largely because of the fact that the camera does not have to be shifted to make vertical shots, as one has to do in the case of the rectangular shaped negatives. Many, however, avoid this shifting by making all shots in the normal position and enlarging to the desired composition. On the other hand, the square negative is disliked by some because most pictures are enlarged to a rectangle, whether vertical or horizontal, and one is inclined to forget and to compose the subject in the view finder or ground glass so that nothing looks right but the square composition. The main answer is, so what? Many pictures are made in the square format and look good that way. There is no law against square pictures and if your picture looks better square than rectangular, go ahead and print it that way.

Q. In comparing the readings afforded by my xxxxxx electric exposure meter with those given, under the same conditions, by an electric meter owned by a friend, I found that my meter called for exposures about twice those indicated by the other meter. Whose readings are correct, mine or his?—D. J. L.

A. Assuming that both meters are in good working order, we offer the opinion that it is not correct scientific procedure to take two meters and compare their readings, condemning any differences that may appear. This is due to the fact that different meters

are calibrated differently, all providing readings that will result in negatives of good density, though differing as to the depth of this density. That is, one will result in a negative of a certain density while another will have a somewhat greater degree of density. The printing results, however, will be about the same. As a matter of fact, due to the great latitude of modern emulsions, it is possible to over- or underexpose to a considerable extent without injuring the printing possibilities of negatives so exposed.

Therefore, it is possible that the readings of both your meter and that of your friend were correct for the subject in question. Also, it must not be overlooked that exposure meter readings are not intended to be the last word concerning exposure, but to perform the services of a guide. That is, if you do not like the density provided by the meter reading, all you need to do is to give particular films a higher or a lower rating than that indicated for the particular film.

***Q.* What is the proper height for an enlarging table?—M. S.**

A. The ordinary table height of 30 inches will do, but if you are constructing a table specifically for the purpose, we would suggest reducing this to about 26 or 27 inches. This height will be found more convenient for persons of average height. Taller persons, on the other hand, may find that a height greater even than 30 inches may be more suitable.

***Q.* Would you please explain the presence of bubbles in my lens, as well as their effect? There seem to be more bubbles in my lens than in other lenses I have seen.—D. L.**

A. These bubbles are common with all lenses and are unavoidable in the manufacture of lenses. Furthermore, it is of little consequence whether your lens has more bubbles in it than, perhaps, another lens you may compare with it. The bubbles are absolutely transparent and do not affect the clarity or sharpness of the image in the least. The light image passes these bubbles practically without alteration and with the same ease and directness as if the bubbles did not exist.

***Q.* How should the condensing lenses be mounted in an enlarger—flat surfaces together, or convex surfaces together? When I make enlargements of about 4 diameters magnification the prints show marks of air bubbles from the condenser lenses, and also a dim shadow from one side of the bulb I use for enlarging (a 75-watt frosted Mazda). With greater magnifications around 7 diameters, these defects are not noticeable in the prints.—K. L. R.**

A. Answering your first question, condensing lenses are mounted with convex surfaces facing each other but not in contact. The result of mounting these lenses in this fashion is to concentrate the light rays, make them converge, whereas the opposite would be the effect were the lenses mounted with flat surfaces against each other. It is not possible that the air bubbles will appear as marks on the prints for the reasons outlined in our reply to D. L. elsewhere in this department. More likely, the marks you refer to are caused by lint or dirt on the condenser. Clean your condenser lenses carefully, as well as the surfaces of the negatives, and observe the difference. The shadow you refer to is doubtless due to the fact that the enlarging light is not properly centered, an absolute essential for obtaining an even disk of illumination over the negative area.

***Q.* In focusing on the ground glass of my miniature single-lens reflex camera, the smaller the stop the more difficult the alignment becomes. I would appreciate it if you could help me with some suggestion.—D. W.**

A. Here is an idea that has been tried out with success by a man who uses one of these miniature reflex cameras in photographing architectural details on buildings. You know those transparent rulers they sell at the five-and-ten-cent store? This man cut a piece from one of these rulers about a half inch square and glued it in the center of the ground glass. The thin criss-cross lines are a great help in alignment, particularly when the lens diaphragm is stopped down or where the light is poor and focusing is difficult even at the larger stops.

***Q.* I wish to construct a depth-of-field table for my camera lens with the help of the instructions given by you in the July, 1938, issue. My camera is an Agfa Isolar, 9 by 12 cm size. Its lens is *f*/4.5 and is marked as equivalent to 13.5 cm in focal length. I think I should be able to prepare the required table by following your suggestions in the July issue provided I know the circle of confusion. I would like to know how this is determined.—C. R.**

A. In our reply to P. P. A. in the September, 1938, issue, we attempted to explain this subject and if you have not seen this, perhaps reference to it may help you to understand the matter a little better. Generally speaking, the diameter of the circle of confusion which one elects to employ in figuring out a depth-of-field table for a particular lens depends on two things: the distance from which the picture is to be viewed and the degree of enlargement to which the negative is to be subjected. The greater the distance from which the picture is to be viewed or the smaller the enlargement of the negative, the larger, relatively, is the permissible circle of confusion. The reverse, however, obtains when the viewing distance is relatively closer or the enlargement is relatively greater. In your particular case, a circle of confusion of 1/250 will be right since 8- by 10- or 11- by 14-inch enlargements are probably the largest you intend to make, if you intend to make any enlargements at all, and a viewing distance of about 10 or 12 inches will be the closest approach.

***Q.* Please advise what can be done to remove the film of moisture or dust that sometimes settles on the mirror of my miniature reflex camera when the lens is removed or changed.—W. P. M.**

A. It is our suggestion that when you remove the lens from the camera you take extra precautions against the possibility of dust or moisture entering the camera and settling on the mirror. Once dust has settled on the mirror, however, our best suggestion is that you attempt to remove this dust with a very soft brush or cloth, being careful not to press heavily on the mirror in doing so.

Books

SELECTED BY THE EDITORS

YOU CAN SLEEP WELL

By Edmund Jacobson, M.D.

YOU can take it from an editor who has tried many systems of overcoming sleeplessness: If you read this book through and follow the directions given, you will not only go off to sleep quickly, but you will sleep restfully. (269 pages, 6 by 8¼, well illustrated.)—$2.10 postpaid.—*F. D. M.*

LIGHTING IDEAS IN PHOTOGRAPHY

By William Herrschaft and Jacob Deschin

LIGHTING is the backbone of all photography. Without lighting, photography is impossible; without proper attention to the problem of lighting, *good* photography is impossible. In this compact book the authors have treated the entire subject of artificial lighting in photography and have given descriptions of various methods of achieving certain desirable lighting effects. Light sources and controls are discussed in detail and instructions are given for making lighting outfits. Here in one book is compressed all that the serious-minded amateur photographer needs to know about the art of artificial lighting. Co-author Deschin is the conductor of the "Camera Angles" department in Scientific American. (276 pages, 6 by 8½ inches, numerous photographs and line drawings.)—$2.85 postpaid.—*A. P. P.*

GIANT FISHES, WHALES & DOLPHINS

By J. R. Norman and F. C. Fraser, both of the Department of Zoology, British Museum

A SOUND, solid, scientific reference book on the many varieties of larger fishes (sharks, rays, barracudas, remoras, and so on) and the cetaceans such as right whales, fin whales, sperm whales, porpoises, and dolphins, which are likely to be seen on pleasure cruises and voyages, each discussed in form comprehensible to the layman. The illustrations, many of them in natural color on fine paper, are excellent. A handsomely produced volume of permanent value. (361 pages, 5½ by 8½ inches, 97 illustrations and eight color plates each showing several fishes.)—$4.10 postpaid.—*A. G. I.*

AUDELS NEW AUTOMOBILE GUIDE

By Frank D. Graham

PREPARED particularly for automobile owners, mechanics, and service men, this compact book gives a vast amount of information regarding the various parts of automobiles, their care and replacement. (1500 pages, flexible binding, 5¼ by 6¾, profusely illustrated with drawings and photographs.)—$4.10 postpaid.—*A. P. P.*

TRAINING YOUR DOG

By Carl Spitz

WHAT man has not wished for just such a concise, well-illustrated book which would tell him the best workable methods of training his "best friend"? This author has done an excellent job in the space of 234 pages and has supplied numerous illustrations to show habits to be broken and how they are broken. We can recommend this to any dog lover. (In an attractive paper binding.—5½ by 8¼ inches.)—$2.60 postpaid.—*F. D. M.*

THE LEICA BOOK IN COLOR

By Anton F. Baumann and other contributors

MORE than 70 reproductions of color prints made with the Leica camera on Kodachrome film by Anton F. Baumann are the basis of this fine book, the principal aim of which is to demonstrate that "photography in colors has become accessible to every amateur." Edited by Kurt Peter Karfeld and translated by H. W. Zieler from the German edition of this work, the book includes, besides the well reproduced color pictures and notes explaining how each one was made, chapters by Dr. Hans A. Kluge on "Fifteen Minutes of Theory: About Colors and Color Photography" and "From the Color Transparency to the Book Print in Color"; by Dr. Otto Croy on "The New Agfa Color Film"; by M. McMaster on "Color Prints by the Eastman 'Wash-Off Relief Process'"; and by Mr. Baumann on "Taking Color Pictures." (48 pages of text, 90 illustrations and charts in colors.)—$4.60 postpaid.—*J. D.*

REFURBISHING THE HOME

By Carl G. B. Knauff

HOME workshop enthusiasts will find here eminently practical instructions for repairing and refinishing furniture, as well as doing other jobs that will help to make the home more livable. Included are suggestions for interior decoration and for the arrangement of furniture to give the best possible effect with the space and materials available. Painting, wall coverings, rugs and carpets, furniture styles, pictures and decorative accessories, are some of the other phases which are thoroughly covered in an understandable manner. (338 pages, 6½ by 9½ inches, numerous photographs and drawings.)—$2.85 postpaid.—*A. P. P.*

THE LIFE STORY OF THE FISH

By Brian Curtis, State of California Division of Fish and Game

FOR those fishermen (and others) who have scientific curiosity about things in general and fish in particular this is the book, and it provides evidence that there is a lot more science in one poor fish than some other poor fish who merely fish may realize. What a fish is, body covering, framework, senses and nervous system (some surprises here), air-bladder, internal workings, reproduction, growth, trout and salmon, other game fishes, habits and adaptations—those are the chapter headings and the approach is scientific without being too scientific, and is always friendly, informal, and readable, not pedantic or stuffy. Many common questions such as "Do fish feel pain?" are answered. (260 pages, 5½ by 8 inches, 38 illustrations.)—$3.10 postpaid.—*A. G. I.*

THE MAGIC WAND OF SCIENCE

By Eugene W. Nelson

POPULARIZED science is the keynote of this book, but not in the sense that an attempt is made to sensationalize and play up those aspects of science which approach the borderline of pseudo-science. The author has written particularly for the intelligent layman who has a definite desire to acquire a certain amount of knowledge regarding science, and who does not wish to delve deeply into the background. The text runs the gamut from microscopy to motion pictures, from soy beans to the fourth dimension, from enzymes to lightning; it covers briefly a wide field of interesting things in between. (213 pages, 5½ by 8 inches, 45 illustrations.)—$2.10 postpaid.—*A. P. P.*

We can supply our readers with any of the books reviewed in this department. Prices quoted include domestic postage. Foreign prices are necessarily higher due to increased shipping charges.

SCIENTIFIC AMERICAN
24 West 40th Street New York, N. Y.

FOR OTHER BOOKS YOU WANT, SEE PAGES 38 AND 44

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

ALUMINIZING one's own telescope mirrors is probably uneconomical, considering the time, materials, and cash required to build the rather elaborate apparatus. On the other hand, the man who rationalizes his decision to build it as "an economy," but is subconsciously simply seeking something that is fun to do, is a real living demonstration of Professor Hale's characterization of the amateur—a man who "works because he cannot help it." He is therefore altogether in order, or better. Guy R. Evans, 3007 N. E. Flanders St., Portland, Oregon, submits a description of a vacuum pump he has made and used in connection with Prof. Yeagley's aluminizing equipment described here in July and August, 1937, and he says it "gives better results than I ever thought would be possible." He made this diffusion pump because he did not find that the mechanical pump there recommended gave a good enough vacuum. Here is his description:

"The pump, shown in Figure 1, is constructed almost entirely of brass and copper tubing at least 1/16" thick (do not use cast metals). The end pieces for boiler and jet chamber are 3/16" sheet brass. The water jacket 5 may be 1/32" brass tubing.

"There are two stages in this pump. The first, or jet, stage is in the upper part, and the second, or annular, stage is located just below. The clearance of the first stage jet depends upon the fore vacuum, and should be adjusted to about 1/32". Most oils cool readily, so the heavy-walled copper tube 2 is insulated by a glass tube 10. Tube 2 rests on the bottom of the boiler, and is adjusted by a 1/4" cap screw 1. The jets are shaped in such a way that they will not clog with oil. This has been a serious defect of most oil pumps.

"11 is a pin for removing tube 2. It can be lifted out with a hooked wire.

"9 is soldered to the tube that comes from the boiler, and acts as a guide as well as a jet. The openings in this jet should have approximately the area of the copper tube.

"A 3/4" length of tubing is soldered to 9. This centers the glass insulating tube 10, so that when the copper tube is removed, the insulating tube will remain in place.

"7 is a glass insulating tube to insulate 8.

"The openings marked *B* serve as passages for the oil vapor to the first stage jet.

"15 is a copper spinning with a 1/2" hole in its center for the copper tube 2 to pass through. This part of the jet should be accurately centered and soldered in place.

"14 is a trap to let the condensed oil pass back to the boiler without letting the air and vapor through. This trap resembles the trap on a sink.

"13 is a 1/8" strip of brass that carries the oil to the wall of the pump.

"16 is the return tube to the boiler.

"Joints marked *A*, in boiler and connecting tubes, also 8 and 16, are silver soldered or brazed. Other joints may be soft soldered.

"The cover, 6, shown in detail, sets in a seat and is waxed in.

"The detail of 8 shows a section of the top of the boiler, also the tube that connects the boiler with the jet chamber. This piece, also the ends for the boiler, jet chamber and water jacket, should be turned in a lathe.

"5 is the water jacket that surrounds the jet chamber. It has two short lengths of 1/4" pipe. The water intake should be at the bottom, to prevent trapping.

"The boiler is made of telescope tubing slid into the outer casing. All joints in the boiler should be silver soldered and then turned in a lathe, so that it can be slid into place.

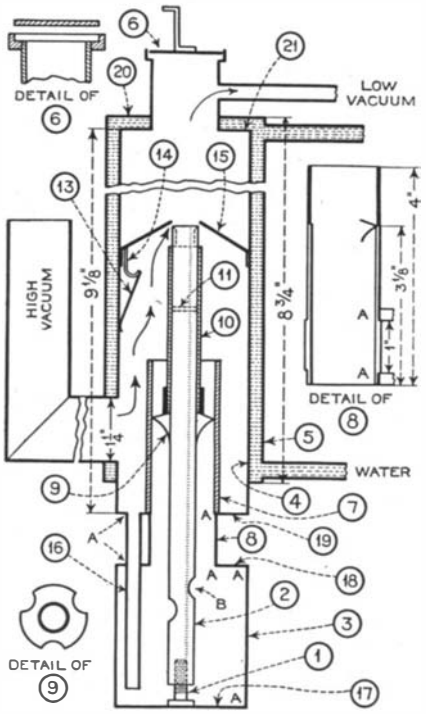


Figure 1: Vertical section of pump

"When you have completed the pump, connect to a Cenco-Hyvac or equivalent. Make as short connections as possible, especially from oil pump to vacuum chamber. Fill boiler about half full of Apiezon oil 'B'. Place cover on pump and seal with wax. Dr. Strong's mixture, as described in 'ATMA' is O.K. Start the fore pump and scout for leaks. If none is present you should have a high enough vacuum in 15 minutes (using a 9" bell) to start the diffusion pump.

"Heat may be applied to the boiler by a bunsen burner or electric plate. Care should be taken not to overheat. You can tell when the pump is too hot by placing your hand on the high vacuum pipe that goes to the bell: this pipe should be just warm about 3" from the pump. In a short time you will notice the discharge rapidly getting lighter (for this pump works rather fast), until it finally goes out with a clean-up voltage of about 10,000 or 12,000 volts. A neon sign transformer may be used. Let the pump run for 10 or 15 minutes longer, to be sure the vacuum is O.K. Then fire your aluminum. When the coat is thick enough, turn the heat off, but do not stop the fore pump until the diffusion pump has cooled enough to let the oil condense. Then shut down the fore pump and open the air valve to the vacuum chamber. The articles in the July and August, 1937, issues of the Scientific American take you through these steps very thoroughly.

"With this set-up I have aluminized in 17 minutes, although I generally allow 30 minutes. The resulting coats are beautiful—far better than any silvering I have ever done.

"*List of materials:*

12" of 2 1/2" inside diameter brass tubing 1/16" thick or thicker.

9" of 3" inside diameter brass tubing 1/32" thick for water jacket.

12" of 1 1/4" inside diameter brass tubing 1/16" thick.

1" of 5/8" inside diameter brass tubing 1/32" thick.

About 1 1/2" of 1 1/4" diameter cold rolled brass for 2nd stage jet.

3 1/2" of 1/4" inside diameter copper tubing.

9" of 1/2" outside diameter copper tubing.

1 short piece of copper tubing 1/8" inside diameter for 14.

Enough sheet brass 3/16" thick, for ends of boiler, jet chambers, 17, 18, 19, 20, and 21.

Enough sheet copper 1/32" thick to complete first jet.

1 1/4" by 1" cap-screw.

3 1/2" of 1/2" inside diameter glass tube for 10.

3" of 1 3/8" inside diameter glass tube for 7.

"The Apiezon oil can be obtained from the J. G. Biddle Co., Philadelphia, Pa."

THE above description was submitted to Dr. John Strong, who suggested that the reader also see the *Review of Scientific Instruments*, Vol. 6 (1935), page 66, describing a similar pump, and the same, page 75, describing another approved design. He mentioned that a good up-jet design that is simple to build would soon appear in a book he was writing. He found some minor faults with Evans' pump, just described, but, on the whole, commended his enterprise. This book, "Procedures in Experimental Physics," has subsequently appeared and it contains a 57-page chapter on the technique of high vacuum, with another chapter on evaporating. These cover this subject of aluminizing with more thoroughness than anything thus far made available anywhere, and in a wholly practical manner; in fact, anyone contemplating the construction of an aluminizing apparatus would probably miss more tricks than one if he did not first learn what is in this new book by the leading authority on this work.

IN the September number F. M. Garland, of Pittsburgh, told how he made a strain tester for glass, using a lamp in a box, a ground glass screen and polarizing eyeglasses. Just after we inserted that note we espied an advertisement for the kind of equipment which the Polaroid Corporation makes up as a stock product for inspecting glass containers, tubing, tableware, and so on—that is, doing essentially the same thing

as Garland—and asked them for a photo. This is reproduced in Figure 2, merely to show how the professional makes up the same general elements into a stock product. In their reply, the Polaroid people referred to Garland's rig as "ingenious." They also sent a sample of Polaroid Type I for reducing the apparent brightness of the night sky. "The light from city lamps reflected from particles in the air is often so strongly polarized," they state, "that our friends from Harvard tell us it is possible to get rid of a great deal of this light by making the observation through Polaroid, rotating the

Figure 2: Commercial strain tester

Polaroid till the darkest condition is obtained. This reduces the intensity of the celestial object but it reduces the stray illumination to a very much greater degree and so increases the contrast."

FAVORITE pitch lap mixtures of outstanding professional workers:

Of D. O. Hendrix, Mt. Wilson optical shops: Coal tar pitch, melting point 170, 2 lbs., Mefford Chemical Co., 1026 Santa Fe Ave., Los Angeles, Calif. Pine tar oil (drug store), amount depending on hardness of the pitch; start with 2 liquid oz. and increase judiciously toward 4 oz., if needed in order to bring to desired hardness. To these add 1½ oz. beeswax. In addition, the lap is given a thin coating of beeswax, not alone to eliminate sleeks and scratches due to grit but to reduce polishing friction. Prof. John Strong, in his book "Procedures in Laboratory Physics," mentioned above, includes a 60-page account of Hendrix' methods of working optical surfaces, which will intrigue advanced workers. We amateurs are plainly not so far behind, but there are things we can learn, too.

Of M. H. Brown, optical shops of the California Institute of Technology, for general use, including work on the 200" mirror: Resin, 1000 grams (about 2 lbs.). S. A. E. Penn Oil No. 30, 4 oz. paraffin, amount depending on need; start with 75 grams (about 2½ oz.) and increase judiciously toward 150 grams. Do not paint the paraffin on top.

As the reader will readily understand, so much special work engages the attention of these two men at present, pressing for completion on schedule, that, against their inclinations, they will hardly find it possible to answer inquiries such as persons mentioned in these columns usually receive in considerable numbers.

THE BEGINNER'S CORNER

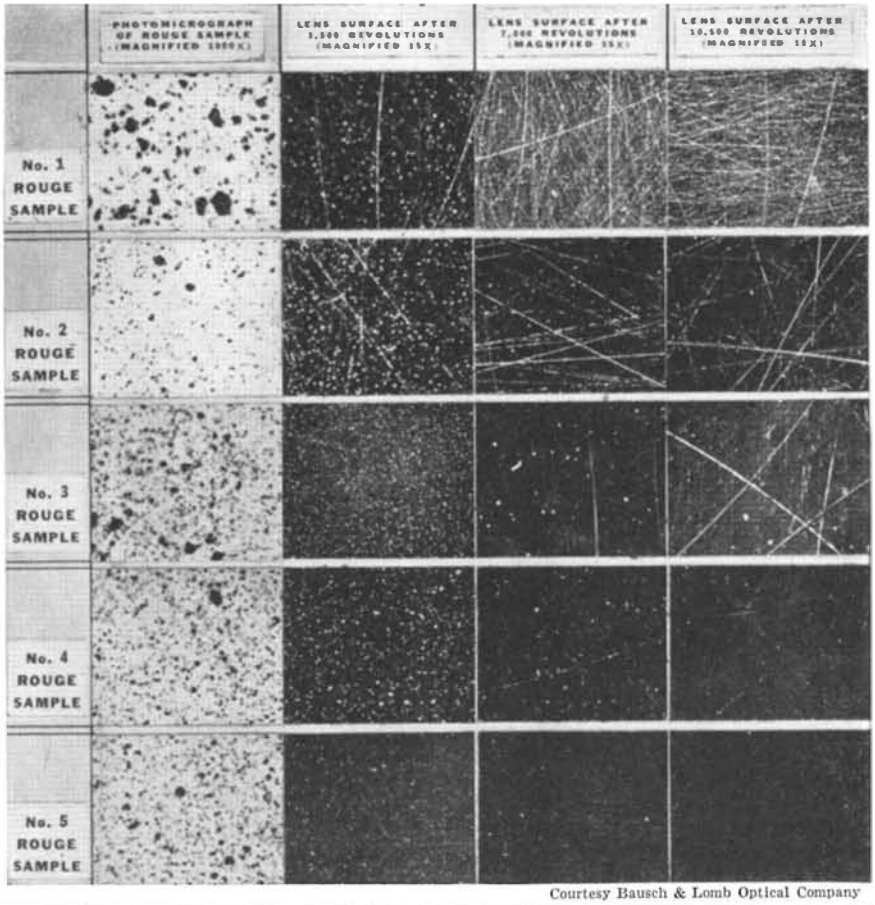
SOMETIMES the unsuspecting tyro telescope maker endeavors to economize by purchasing low-priced rouge. Some have even used jeweler's rouge from their local shops. Trouble often followed, which the beginner, without previous experience by which to judge, regarded as unavoidable. There is rouge, and rouge; yes, there is even rouge and rouge, and *rouge*. Polishing silverware (jeweler's rouge) doesn't require anything fancy—this would be just a waste of money. Polishing eyeglasses requires much better but not the finest; the latter would therefore be a needless expense. Third standard of work, precision optics (including telescope work) requires real Rolls-Royce rouge, but even that grade is inexpensive.

The photomicrographs shown below tell us something about rouge, and rouge, and rouge. Each horizontal row reveals the magnified surface of a lens which has rotated on a spindle under a different grade of rouge. This is machine work, it is true, but the findings apply equally to the amateur's hand work. Top row shows a rouge that would be very decidedly unsatisfactory. Each row below shows a better grade and the effects thereof. Only No. 5 (B. and L. 358-52738) is suitable for precision work.

Now you have an idea, thanks to these high magnification close-ups, about the great differences between rouges. Yet they all look alike when seen at the bottom of the parcel they come in.

It is worth while to go back and study the same photomicrographs again by vertical columns, comparing each. In the first column especially, note the bad but increasingly better particle size distribution. Study also the pitting effects of each, in photomicrographs to the right (pits shown by little white dots).

As stated in the manual of the telescope making hobby, "Amateur Telescope Making," the particles of rouge are roughly 1/30,000 to 1/50,000 inch in diameter—that is, for good rouge.



Courtesy Bausch & Lomb Optical Company

TELESCOPTICS

(*Continued from preceding page*)

IN *The Journal of the American Ceramic Society*, 2525 High Street, Columbus, Ohio, Vol. 20, No. 2, appeared an article entitled "The Scratch-resisting Power of Glass and its Measurement," by James Bailey of the Hamburg, N. Y., firm of Bailey and Sharpe (now the Optical Glass Products, Inc., by the way). The following paragraphs, quoted from this article, throw an interesting sidelight on borosilicate and other glasses, and complement our discussion of glass, begun in this department last month.

"If one piece of glass is scratched by drawing across it the corner of another piece, the contact area is small and the unit pressure is comparatively high. When the corner moves rapidly, the work done in overcoming friction easily generates sufficient heat to raise the temperature of the sliding corner above the softening point of the glass; the sliding corner, moreover, becomes so highly heated that it produces a streak of light readily visible in the dark.

"This heating effect brings into the scratching process a new factor, namely, the fusibility of the moving point. Thus a piece of

quartz glass, though softer than ordinary window glass, will easily produce a long, deeply cracked scratch in a piece of window glass when drawn rapidly across it, because the rubbing corner remains hard at the temperature attained. A glass corner will not scratch the quartz slab under the same conditions because it softens and loses its sharpness almost at once. It is possible, however, to make a deep crack and scratch on the fused quartz with the corner of a piece of window glass by keeping the rubbing velocity at a very low figure, such as one millimeter per second or less. In this connection, all the common abrasives such as sand, corundum, silicon carbide, and emery have very high melting points, while diamond, the hardest of all, is infusible.

"Grinding experiments show that quartz glass and glass containing large amounts of silica and B_2O_3 are the most difficult to grind. The ball test shows that these types are really softer than most other glasses. The reason for this is apparent if a fresh scratch made with a diamond is observed under a microscope. The scratch in quartz glass, once made, undergoes almost no change. The initial fractures do not extend nor does any appreciable amount of material fly out of the scratch. The same applies to a considerable extent in the case of high B_2O_3 glasses. With glasses of the conventional window-glass and bottle types, the initial scratch is small, but pieces begin to fly out of the body of the glass along the sides of the scratch almost at once, and this process continues for a period of several minutes, at the end of which time vastly more glass has been loosened than was initially cracked or apparently injured by the scratch. The ability of a material to resist abrasion, as in grinding, is a measure of its work-absorbing power rather than its true hardness."

NOMOGRAPHS is the name given by their "worker-out," G. W. Gasper, 3245 Woodford Rd., Cincinnati, O., to six 12" blueprint wall charts on each of which a required datum can be found simply by placing a straight-edge through two known values inscribed along a line and then looking for its intersection with a third line; hence the term alinement charts, also applied to them. For example: Given mirror diameter and focal ratio, automatically find accuracy required in parabolization; or given diameter of eyepiece field lens and focal length of objective, find angular field of view; or given mirror diameter and f.l., find parabolization depth. Similar charts are for exit pupil, for diagonals and for compound reflectors. Not merely a lot of arithmetical slavery saved but the designer can swing a straightedge up and down the lines and visually arrive at his optimum condition, also getting more closely acquainted with the whole gamut. For these charts Gasper asks about a quarter of what might be charged; evidently it's a labor of love. He is a member of the Amateur Telescope Makers of Cincinnati.

SOLICITUDE—or something: Professional optical manufacturer who has evidently just heard of amateur telescope making hobby writes that he learns that amateurs in it "attempt to grind and polish their mirrors themselves," and kindly offers to "prepare to produce these mirrors in quantity." A medal will be awarded to the amateur who submits the most suitable reply (on asbestos) to this optical illusion. "Attempt." Grrrrr!

CURRENT BULLETIN BRIEFS

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

SMALL HOME BUILDERS' YEAR BOOK—1938-1939 is a 64-page symposium of attractive information on designing, financing, constructing, equipping, decorating, and furnishing a home. The articles are thoroughly illustrated and several interesting plans of small homes are presented. Every home owner will find something of interest here. *National Small Homes Bureau, Inc., 572 Madison Avenue, New York City.—25 cents.*

GEOLOGIC MAP OF CALIFORNIA is a six-colored, lithographed wall map 6½ by 7½ feet, sent in six sections, indicating in detail the general geology of that state. *Division of Mines, State of California, Ferry Building, San Francisco, California.—$4.00.*

THE SCOTTISH INDUSTRIAL ESTATE is a 24-page illustrated booklet that tells of the industrial advantages of the Estate at Hillington, near Glasgow. This Estate exists to alleviate unemployment by offering industrial facilities to attract new industries and branches of existing industries to this area of Scotland. *Scottish Industrial Estates Limited, 29 St. Vincent Place, Glasgow, C. 1, Scotland.—Gratis.*

OPERATORS HANDBOOK deals specifically with truck, bus, and farm and industrial tractor tires, presenting statistical material of interest to every operator of such vehicles. Particular attention is paid to truck-tire failures, including the heat-speed problem. Pocket-size, 68 pages. *The B. F. Goodrich Company, Akron, Ohio.—Gratis.*

SOME COMMON FALLACIES ABOUT WOOD brings out many interesting facts regarding various types of woods found in the United States. For example: Wood does not necessarily decay with age. Decay is caused by the attack of a fungus. Request Mimeograph R1167. *Forest Products Laboratory, Madison, Wisconsin.—Gratis.*

THE EARLY HISTORY OF AIR TRANSPORTATION, by Edward Pearson Warner, is a 74-page booklet based upon a James Jackson Cabot Professorship lecture. It has been prepared in an attempt to reconstruct the atmosphere of significant periods in the development of aeronautics and to suggest historical implications and the influence on the future of the more significant events. A brief bibliographical appendix gives valuable references to source material. *Norwich University, Northfield, Vermont.—50 cents.*

WHAT'S WHAT IN RAYON is a 22-page booklet that tells in question and answer form everything that the average user of rayon could possibly want to know about the fabric. For example: What is spun rayon yarn?; How has rayon contributed interesting color effects in fabrics?; In what price ranges are rayon fabrics found?; Do they stretch?; Will they wash?; Will they shrink? *Rayon Division, E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.—Gratis.*

THE PROBLEMS OF A CHANGING POPULATION is a 306-page book containing a report of the National Resources Committee concerning some of the major problems of our human resources. Data is presented in regard to population trends, anticipated stable population, changing age groups, migration within the country, health, education, economic opportunity, and so on. *Government Printing Office, Washington, D. C.—75 cents (coin).*

THE STORY OF WESTERN ELECTRIC is a 32-page thoroughly illustrated pamphlet that tells of the work which has made possible the highly efficient telephone system that exists today. This service of supply for the Bell System is a gigantic, highly organized institution that has contributed largely to efficient as well as low cost telephone service. *Western Electric Company, 195 Broadway, New York City.—Gratis.*

RADIO TROUBLE-SHOOTER'S HANDBOOK, by Alfred A. Ghirardi, has been prepared to cover every phase of radio repair service. It contains hundreds of pages of tabulated job data condensed and tabulated for easy reference. A large number of charts and tables will aid the service man in his work. *Radio & Technical Publishing Company, Department 35, 45 Astor Place, New York City.—$3.00. Illustrated circular free.*

MICROSCOPE EQUIPMENT FOR THE AMATEUR is a 24-page pocket-size booklet that deals with microscopy as a personal hobby. It shows some interesting photo-micrographs and describes and illustrates various types of microscopes and other equipment that will aid in the pursuit of the hobby. *Bausch & Lomb Optical Company, Rochester, New York.—Gratis.*

PHOTOGRAPHY BY POLARIZED LIGHT discusses various types of Pola-Screens, describes the effects produced by their use, and illustrates these effects by drawings and photographs. Discusses exposure time, filters, accessories and negative materials to be used when employing Pola-Screens. *Eastman Kodak Company, Rochester, New York, or photographic stores.—50 cents.*

RADIO FOTO LOG, edited by Samuel Kaufman, contains 32 pages of information for radio listeners. It gives tuning data on American and foreign stations and presents 151 photographs of prominent radio stars. Recent advances in television are also covered. *At your radio dealers or from National Union Radio Corporation, 57 State Street, Newark, New Jersey.—15 cents.*

IMPROVING THE FARM ENVIRONMENT FOR WILD LIFE is a 62-page illustrated booklet which shows how the farmer can best provide for the small birds and animals that live on his farm, with a minimum of trouble and expense and a maximum of return on the investment. Farmers' Bulletin No. 1719. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

LEGAL HIGH-LIGHTS

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

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

Shredded Wheat

THE status of the name "Shredded Wheat," which has undergone frequent and repeated changes in the Federal Courts, has been finally determined by the United States Supreme Court. The Supreme Court has held that the name is not a trade mark but is a generic name of a pillow-shaped biscuit made of wheat and can be used by anyone. The question arose in a suit for trade-mark infringement and unfair competition brought by the original owner and user of the trade mark Shredded Wheat against a competitor who used the same name on a similar product.

The product known as Shredded Wheat was patented in 1895 and the defendant contended that upon the expiration of the patent the right to the exclusive use of the name Shredded Wheat also expired. We have previously discussed this case on this page and at that time we pointed out that the question was not free from difficulty. The Circuit Court of Appeals for the Third Circuit at first decided that the name was generic and that upon the expiration of the patent on the product the right to use the name passed to the public. A re-hearing was had before the Circuit Court of Appeals and the Court reversed itself and held that the name was the exclusive trade-mark property of the plaintiff. The defendant then filed a petition to the United States Supreme Court asking it to review the case. At first the Supreme Court refused to review the decision but subsequently the Privy Council in England decided that the name Shredded Wheat was not a trade mark and following this decision the Supreme Court of the United States decided to review the case.

The Supreme Court agreed that without doubt the defendant would profit by the good will established in the name Shredded Wheat but held that, unfortunate though it may be, the name was generic and could be used by anyone. The element of conflict and doubt presented by the issues in this case is evidenced by the fact that two of the judges of the Supreme Court dissented from the majority opinion.

Flash

THE imitation of a purely functional or utilitarian feature of an article does not constitute unfair competition and in the absence of patent protection such imitation cannot be restrained. This principle is illustrated by a case in the New York State Supreme Court involving a flashlight.

The plaintiff manufactured and sold a flashlight having a lens and bulb at one end in the usual manner. Around the sides of the bulb the flashlight was provided with a red translucent band so that the flashlight cast a red danger light on all sides.

The defendant manufactured and sold a flashlight having a similar red translucent band and the plaintiff sought to restrain the defendant from manufacturing and selling the flashlight on the grounds that the use of the band constituted unfair competition. The Court refused to grant an injunction, pointing out that the red translucent band was a functional or utilitarian feature and that in the absence of patent protection imitation of the feature could not be restrained. In this connection the Court stated:

"There is no dispute concerning the fact that the red translucent band is a functional feature of the flashlight and that the red rays, visible for some distance, provide an additional safeguard to the user. Since plaintiff has no monopoly by patent on this feature, it cannot under the guise of a claim of unfair competition gain such a monopoly."

Patently Unpatentable

PRINTED stationery and forms are not subject to patent protection when the invention is predicated solely on the arrangement or content of the printed matter. This question arose in a recent suit of interest in the advertising field which involved a patent for so-called "personalized" letter paper. The patent disclosed letter paper to be used primarily for advertising purposes and provided with a border having pictorial designs with blank spaces or "breathers" adapted to be filled in with the name of the intended recipient of the letter. The patentee contended that the letter would appeal to the vanity of the recipient and in that way would attract his attention.

The trial court held that the patent was valid and was infringed by the letterhead used by the defendant. An appeal was taken from the decision of the trial court and the Circuit Court of Appeals reversed the decision, holding that the patent was invalid. The Court pointed out that under the patent statute a patent could be obtained only on a "new or useful art, machine, manufacture, or composition of matter." In behalf of the patentee it was contended that the letter paper was an article of manufacture. However, this contention was rejected by the Court on the grounds that the paper was physically the same as other letter paper, the only difference being in the printed matter appearing thereon.

In this connection the Court stated:

"It is to be noted that the patented product has no physical characteristics other than the paper itself and the lettering and pictorial representations upon it, also that the value of the invention resides only in the idea of personalization and not in the sheet itself and that the achievement of the object of the invention is only reached when the blank is finally filled in with the name of the prospective customer. In our opinion these things are not enough to render the sheet an article of manufacture."

In the past there has been some confusion as to whether patent protection could be obtained on printed forms or stationery. At the present time it is uniformly held that such articles do not constitute patentable subject matter. This viewpoint was tersely expressed by the Court of Customs and Patent Appeals as follows:

"Patentable novelty cannot be predicated upon printing alone, but must reside in physical structure."

Presumption-less

IT has been held that the usual presumption of validity attaching to a patent is weakened or destroyed where, during the pendency of the patent application, an interference proceeding is settled by agreement between the parties rather than by means of a full and fair hearing before the tribunals of the Patent Office.

In a suit for infringement of a patent on silk stockings it was found that, while pending before the Patent Office, the application was involved in interference with six other patent applications for the same invention. Normally the question of priority of invention involved in an interference is determined in a judicial or quasi-judicial fashion by the Examiner of Interferences after the parties involved in the interference have had an opportunity to take testimony and present evidence. In the case under consideration the parties to the interference agreed to arbitrate the question of priority between themselves. The Court held that in view of this agreement the Patent Office did not have an opportunity to pass upon the question of priority and accordingly the usual presumption of validity did not attach to the patent.

The Court summarized its opinion in the following manner:

"Moreover, the mode in which the patent issued as between these applicants shows that the usual presumption arising from the grant of a patent does not here arise. Instead of fighting out the question of priority in the Patent Office, the applicants agreed among themselves to have an arbitration to determine priority, with the evident purpose of forming a patent pool of which the alleged inventors should share."

This case involves another rather important point. It has frequently been stated that where numerous applications for patents based upon the same invention are filed in the Patent Office it is reasonable to assume that the improvement or development disclosed in the applications represented a natural advance in the art rather than a patentable invention. In the present instance seven applications for the same improvement had been filed in the Patent Office. With regard to this the Court commented:

"These facts tend to show that the idea was not the original act of an individual inventor but the simultaneous solution of half-dozen mechanical improvements, so making the alleged invention nothing but the natural advance of the art herein involved."

SCIENTIFIC AMERICAN ADVERTISERS
January · 1939

Advertising Manager
CHARLES H. STEINHART
24 West 40th Street, New York City

Western Advertising Representatives
EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.

BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

EDITORIAL STAFF · ORSON D. MUNN, EDITOR

ALBERT A. HOPKINS
A. P. PECK
PROFESSOR HENRY NORRIS RUSSELL

F. D. McHUGH

ALBERT G. INGALLS
A. M. TILNEY
PROFESSOR ALEXANDER KLEMIN

CONTRIBUTING EDITORS

A. E. BUCHANAN, Jr., Director of Research, Remington Arms Company.

L. WARRINGTON CHUBB, Director of Research Laboratories, Westinghouse Electric and Manufacturing Company.

JACOB DESCHIN, Amateur Photography.

CHURCHILL EISENHART, Department of Mathematics, University of Wisconsin. Statistician, Wisconsin Agricultural Station.

MORRIS FISHBEIN, M.D., Editor of the *Journal of the American Medical Association* and of *Hygeia.*

WILLIAM K. GREGORY, Professor of Vertebrate Paleontology, Columbia University.

LEON A. HAUSMAN, Professor of Zoology, New Jersey College for Women.

WALDEMAR KAEMPFFERT, *New York Times.*

D. H. KILLEFFER, Chemical Engineer.

IRVING LANGMUIR, Associate Director, Research Laboratory of the General Electric Company, Schenectady.

M. LUCKIESH, Director, Lighting Research Laboratory, Incandescent Lamp Dept. of General Electric Company, Nela Park, Cleveland.

D. T. MacDOUGAL, Associate in Plant Biology, Carnegie Institution of Washington.

ROY W. MINER, American Museum of Natural History.

RUSSELL W. PORTER, Associate in Optics and Instrument Design, California Institute of Technology.

W. D. PULESTON, Captain, United States Navy.

J. B. RHINE, Associate Professor of Psychology, Duke University. Chairman, Research Committee, Boston Society for Psychic Research.

PHILIP H. SMITH, Industrial Research.

R. A. WILKINS, Vice President and Director of Research, Revere Copper and Brass, Inc.

R. W. WOOD, Professor of Experimental Physics, Johns Hopkins University.

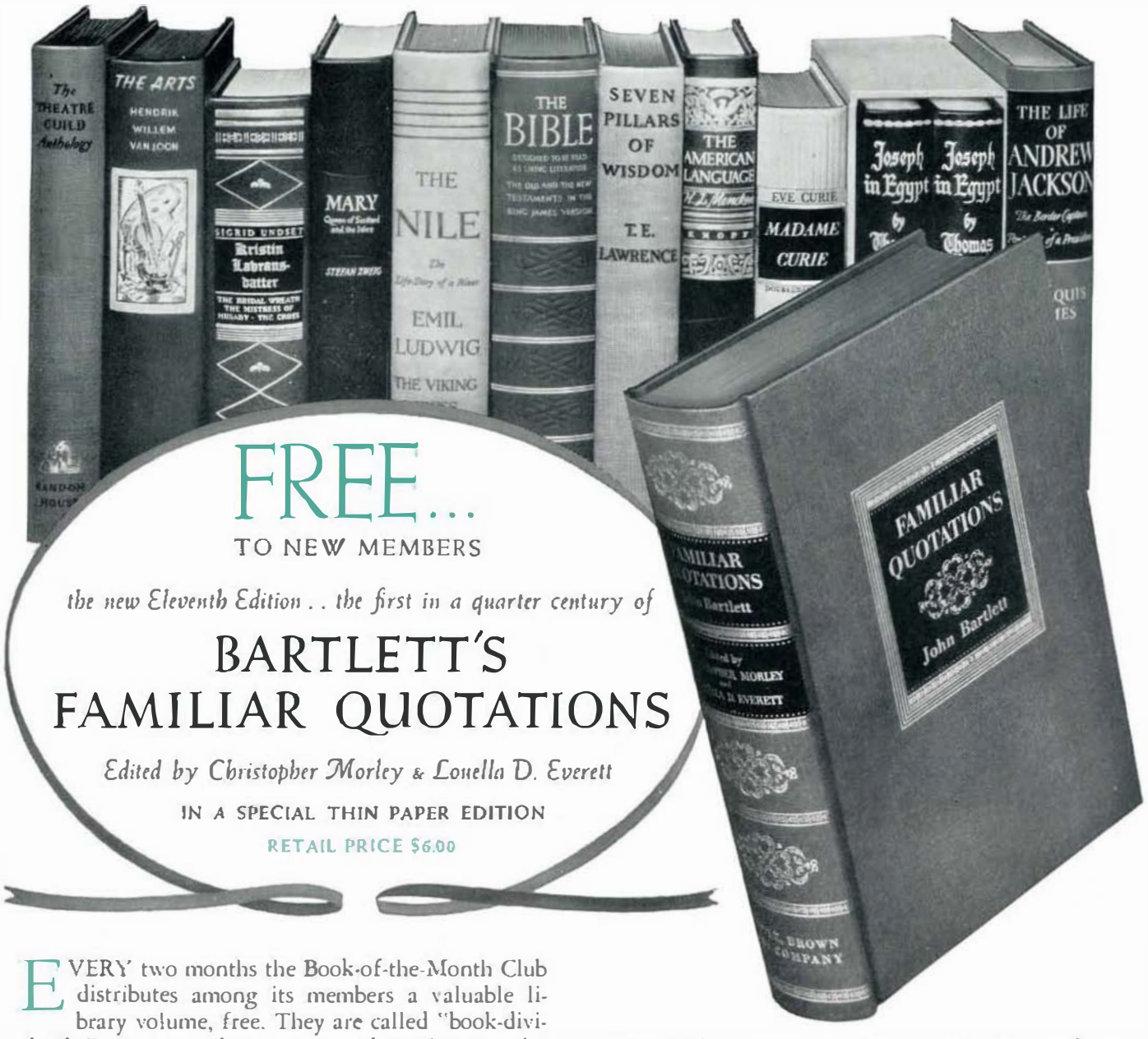
VLADIMIR K. ZWORYKIN, Director, Electronics Research Laboratory, RCA Manufacturing Company, Victor Division.

Vol. 160, No. 1, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid.

Printed at The Condé Nast Press, Greenwich, Conn., U. S. A.

ALL THESE BOOKS WERE DISTRIBUTED *Free*

among members of the Book-of-the-Month Club



FREE...

TO NEW MEMBERS

the new Eleventh Edition . . the first in a quarter century of

BARTLETT'S FAMILIAR QUOTATIONS

Edited by Christopher Morley & Louella D. Everett

IN A SPECIAL THIN PAPER EDITION

RETAIL PRICE $6.00

EVERY two months the Book-of-the-Month Club distributes among its members a valuable library volume, free. They are called "book-dividends." As a member, you would receive one *for every two books-of-the-month* you bought. All the books illustrated above were such book-dividends; BARTLETT'S FAMILIAR QUOTATIONS is the one being currently distributed.

If you watch best-seller lists, you will observe that the book-of-the-month is always considered, by the reading public itself, among the most popular current books. Frequently it is a book you are extremely anxious not to miss. Whenever this is the case, obviously you benefit enormously by buying it from the Club—because of this unique book-dividend system. Last year over $2,500,000 worth of books were distributed free—not sold, mind you!—among the Club's members.

You Buy What You Please

But, please understand, there is no compulsion upon you, as a member, to take any book-

CONTINUED ON OTHER SIDE

FIRST CLASS
Permit No. 419
(Sec. 510 P.L.&R.)
New York, N. Y.

BUSINESS REPLY CARD

(No Postage Stamp Necessary if mailed in the United States)

POSTAGE WILL BE PAID BY

BOOK-OF-THE-MONTH CLUB, INC.

385 MADISON AVENUE

NEW YORK, N. Y.

CONTINUED FROM OTHER SIDE

of-the-month our judges choose. Nor—this is another frequent misunderstanding—are you obliged to buy a book every month.

All important new books are very carefully reported upon. As a member, at your pleasure, you can do one of three things in any month: order the book-of-the-month; order some other new book you are particularly anxious not to miss (you would be charged only the regular retail price, plus postage); or, instruct the Club not to send you any book at all. Your only obligation is to buy four books a year from the Club; if all four were books-of-the-month you would receive, in addition, two book-dividends.

You Pay No Fixed Sum Yearly

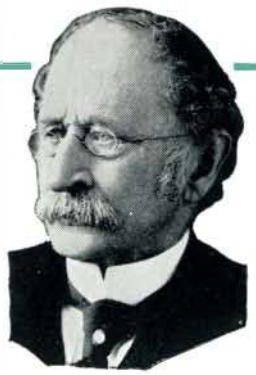
In short, all the marked economies and conveniences which the Book-of-the-Month Club provides *cost you nothing*. There are no fees for joining, *and you pay no fixed sum per year*. You simply pay for each book as you get it—and you pay nothing more!

Moreover, you are neither urged nor expected to buy all—or even most—of your new books from the Club. You buy those which it is clearly to your advantage to buy. A large proportion of our members, those who live in neighborhoods with well-stocked bookstores, actually buy only the book-of-the-month from the Club, whenever they find it is a book they surely do not want to miss. They continue to "browse in bookstores" for their other books.

Why BARTLETT'S FAMILIAR QUOTATIONS is offered to you—FREE

As explained above, BARTLETT'S FAMILIAR QUOTATIONS is one of the Club's latest book-dividends. We offer to give it to new members as a demonstration of how advantageous it is to subscribe to this unique service.

If there is one book—aside from a good dictionary, a Bible, and a Shakespeare—that belongs in every American library, it is surely BARTLETT'S FAMILIAR QUOTATIONS. The new Eleventh Edition offered here (the first revision in a quarter century) is inexhaustible. Its index alone covers 447 pages.



JOHN BARTLETT
The Old Cambridge Bookseller

Old John Bartlett's bookstore was a rendezvous for Harvard students and professors back in the eighteen fifties. Whenever they were not sure of the origin of a quotation, they would go to John Bartlett, confident that they could depend upon him for the correct answer. After a time, the old bookseller began jotting down these quotations and their sources in his notebook. This was the genesis of his famous FAMILIAR QUOTATIONS in 1855.

Edition has followed edition, and now comes the Eleventh Edition, the first in a quarter century. One wonders what old John Bartlett would say today if he could see this monumental volume. Its index alone covers 447 pages. Not only are the shortsighted omissions of the past corrected (Hawthorne, Melville, Emily Dickinson, William Blake, and many another were curiously omitted). But here is also a welcome gathering of newcomers, where one is sure to find an old friend, whether he is looking for George Ade or for Thomas Mann, for Hervey Allen, T. S. Eliot, or Will Rogers.

What to Do

Mail the postcard below, and a copy of this great volume will be put aside in your name. We will then send you a booklet outlining in detail precisely how the Club operates. In particular, it will explain how such enormous values can be given to book buyers.

If, after reading the booklet we shall send you, you decide to join the Club, and send in your subscription, we shall at once send you the free copy of BARTLETT'S FAMILIAR QUOTATIONS being held for you.

Over 175,000 book-reading families—composed of just such discerning but busy readers as yourself—now use this sensible, thorough and economical means of keeping up with the best new books.

MAIL THIS CARD

•

NO STAMP NEEDED

IMPORTANT—PLEASE READ— No salesman will call upon you. If you send this card, you will simply receive the booklet explaining how the club operates. After reading it, should you decide to subscribe, you will receive a free copy of BARTLETT'S FAMILIAR QUOTATIONS. *Minors will not be enrolled as members without a parent's consent.*

PLEASE send me without cost, a booklet outlining how the Book-of-the-Month Club operates. This request involves me in no obligation to subscribe to your service.

Name Mr. / Mrs. / Miss .....
PLEASE PRINT PLAINLY

Address .....

City ..... *State* .....

Books shipped to Canadian members, DUTY PAID, through Book-of-the-Month Club (Canada) Limited

From Scientific American A-701