FIRE-WALKING
Gives Up Its Secret

SCIENTIFIC AMERICAN

Including:
A DIGEST OF
SCIENCE & INDUSTRY

. . also . .

Amateur Photography
By Jacob Deschin

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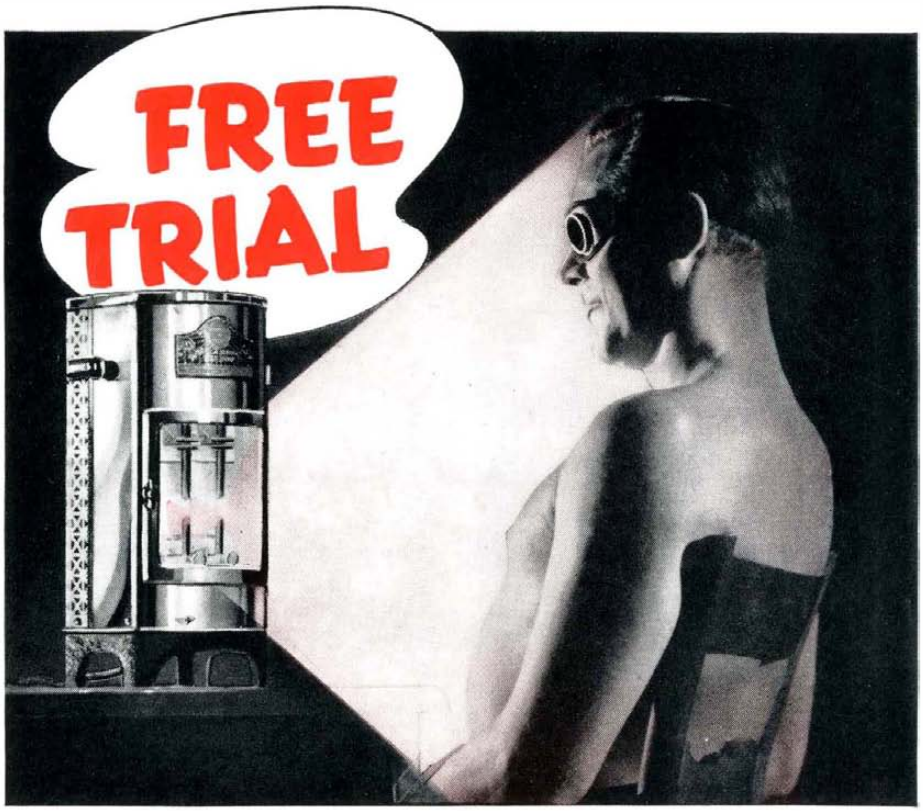
Win Success WITH A HANDSOME TAN THIS QUICK EASY WAY



IMPROVE YOUR APPEARANCE By the Magic of SUNSHINE

85% of success today is due to personality and ability to influence others

. . according to an exhaustive study recently made at Carnegie Institute of Technology.

That pale, pasty, inefficient, indoor look is a business and social handicap. Why put yourself at such an unforgivable disadvantage when you can get that *handsome, healthy TAN everybody admires so much* right in your home? Within ten days, you can improve your appearance remarkably—look like a million dollars—*as if you had just returned from a vacation in Palm Beach!*

Produces VITAMIN D

Aids Calcium and Phosphorus Deficiency

Palm Beach Sun Lamps furnish an abundance of the vital Ultra-Violet Rays that produce Vitamin D . . . the Sunshine Vitamin . . . and help build resistance against common colds and other winter ailments. These rays will also *prevent and cure rickets;* and are helpful in building sturdy bodies, and sound teeth in growing children. Ultra-Violet Ray radiation aids calcium and phosphorus deficiency; and has also been found helpful in clearing skin blemishes and pimply complexions. Let your physician advise you, if you wish, for your particular ailment.

PALM BEACH
ULTRA-VIOLET RAY
SUN LAMP

As leading makers of sun lamps in America, we have developed lamps to suit the needs of every pocketbook. We have single arc lamps using 2 carbons and having intensity of 4½ times mid-summer sunlight as well as double arc lamps using 4 carbons and having an intensity of 10 times mid-summer sunlight. Also there is available the Palm Beach De Luxe Model (Double Arc) having the same intensity as lamps used by hundreds of clinics and thousands of doctors throughout the United States. Just think of it—a 4-minute exposure gives you the equivalent of 50 minutes mid-summer sunlight. We are the first company in the United States that has developed a Double Arc Lamp (4 carbons) of this power at a price so low that it is within the reach of almost everyone.

AS LITTLE AS $1.00 DOWN

Any of our models can be purchased for as little as $1.00 down and the balance can be paid in easy payments. There is a Palm Beach model for every pocketbook—every model can be bought on easy payments and every model is subject to our 10-day Free Trial Guarantee.

SEND NO MONEY

Own your own SUN. Accept our FREE TRIAL OFFER now. Use lamp for 10 days—see for yourself the remarkable improvement in your appearance—how much better you look—how much better you feel. Pay down as little as one dollar. If for any reason you are not more than satisfied just return the Lamp and there will be no charge. You are the SOLE JUDGE.

$7.50 TO $14.95

FREE BOOK

Send coupon now for big illustrated 24-page book. Tells how to double power of your personality, increase business and social success, improve appearance, multiply vigor and energy — combat colds and other winter ailments. Priceless information absolutely free. Mail coupon now. Lamp Division, Keene Chemical Co., Inc., 206 East 23rd Street, New York, N. Y., Dept. S.A. 3-9.

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Lamp Division, Keene Chemical Co., Inc.
Dept. S.A. 3-9, 206 East 23rd St.,
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Send me your FREE BOOK and full details of FREE TRIAL OFFER ON THE PALM BEACH SUN LAMP

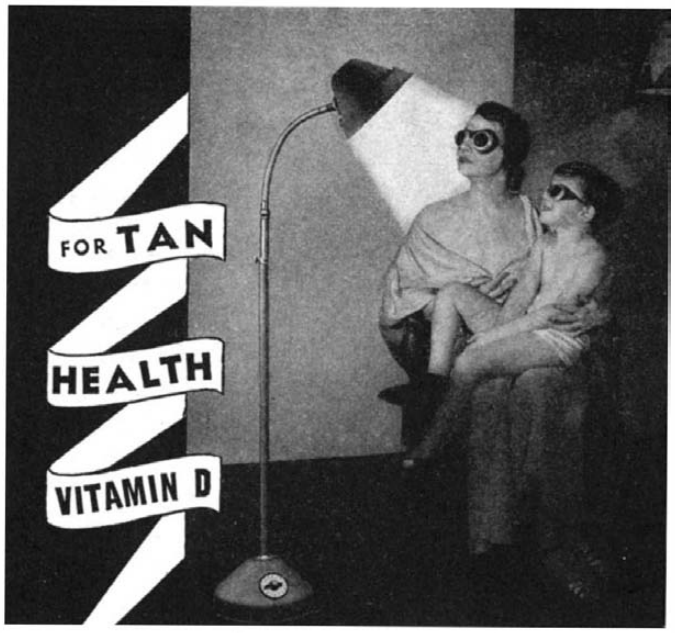
(Please write Mr., Mrs. or Miss)

Name .....

Address .....

City ..... State .....

This is not an order—Ship nothing C. O. D.



DON'T BE A "Pale-Face!"

TAN AND KEEP HEALTHY

WITH A *genuine*

MERCURY-ARC SUN LAMP

TILT AT ANY ANGLE TO PLEASE

10 DAYS' Free Trial

SUNSHINE AT A BARGAIN

There is no need any longer, to envy the fortunate few who are able to go to Florida each winter . . . and it's not necessary to spend a "small fortune" to get the benefits of the vital Ultra-Violet Rays of sunlight during cold, dreary winter days.

INEXPENSIVE—EFFICIENT
The Sun Lamp That Tans Quickly

The new, inexpensive, Home Model, Palm Beach Mercury-Arc COLD Ultra-Violet Ray Sun Lamps give you your own private solarium in which to TAN and keep healthy. These lamps are designed to meet the fast growing demand for low priced home units that are dependable and economical. They have all the beneficial qualities usually found in higher priced Mercury-Arc models.

Daily exposure of only 3 to 4 minutes per day will help to improve your appearance and health. Will give you that HEALTHY TAN *that everyone admires* . . . make you independent of weather conditions or season of the year. You get vital Ultra-Violet Rays at the mere turn of the switch.

FRONT VIEW

Almost Pure Ultra-Violet Rays

The special type Palm Beach burner is highly efficient and more than 90% of the energy emissions are in the middle Ultra-Violet Ray region, affording a source of almost pure Ultra-Violet Ray radiation.

PRODUCES VITAMIN D
Will Cure and Prevent Rickets

Radiation from the Palm Beach Home Model, Sun Lamp, produces Vitamin D . . . aids calcium and phosphorus deficiency. Powerfully anti-rachitic . . . will both prevent and cure rickets . . . and help build resistance to colds and other winter ailments. Rays are bactericidal in action, and will produce erythema (TAN) in half the time of ordinary sun lamps.

The Palm Beach Mercury-Arc COLD Ultra-Violet Ray Sun Lamp helps increase youthful vigor and vitality and tends to stimulate glandular functions. Remarkably beneficial in some forms of skin trouble. Often decidedly effective in cases of listlessness and anemia; many forms of sinus conditions are greatly benefited. Mercury-Arc Sun Lamps have been used by the Medical Profession and Hospitals for 35 years in the treatment of common ailments. They are now available for home use at a price you can afford to pay.

Amazing Sun Lamp Offer

If your dealer does not carry this lamp, you may purchase direct from us (this offer is for a limited time only), on our easy monthly payment plan, subject to the 10 Days' Free Trial offer . . . and a guarantee for 1 year. If for any reason you are not satisfied, return lamp after 10 days and your money will be refunded. There will be no charges. Your first expense is your last expense—no carbon replacements, low current consumption and high efficiency.

$5.00 Down . . . Balance in 4 Months

Table Model $20.00 **Floor Model $27.50**

For Built-In Automatic Timer Add $5.00 Additional

Beautifully finished in serviceable crinkled bronze finish, chrome plated goose-neck and trim. Adjustable to any position. Floor model adjustable from 54" to 67". Complete with 8 ft. extension cord, goggles and operating instructions. With or without built-in automatic Timer. Operates on 110 volts A.C., 60 cycles only. Draws less than 100 watts.

SA 3-9

U. V. R. Laboratories
206 East 23rd St., New York, N. Y.

Ship me (prepaid) the following Model for which I enclose $5.00 as first payment, balance in 4 equal monthly payments.

..... Model ..... $.....
(Floor or Table) Specify if Timer Desired

It is understood that if I am not satisfied, I may return the lamp after 10 days' FREE Trial offer and my money will be refunded without any charges.

Name.....

Street.....

City..... State.....

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 • MARCH • 1939

WALKING barefoot on a broad bed of red-hot embers, as shown on the front cover, is a feat performed by Hindoo fire-priests, to the exaltation and emotional frenzy of the natives. Supposedly supernatural, the performance has now been studied by scientists, and a detailed report of their findings appears in the lead article of the present number (page 135). It turns out that there is no magic trick and no deception to the feat, which is honestly performed.

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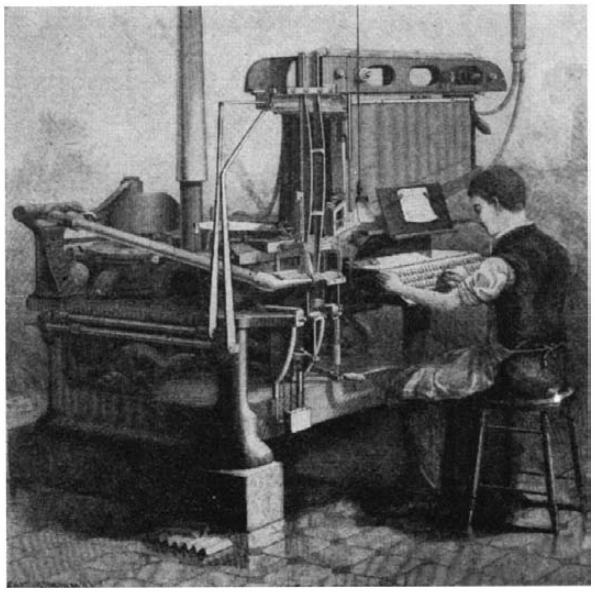
50 Years Ago in . . .

Scientific American

(Condensed From Issues of March, 1889)

DIPHTHERIA—"It is claimed that 'two professors connected with the Pasteur Institute have discovered the generative microbe of diphtheria, and that a preventive of this disease by means of vaccine virus is expected to follow.' Should this expectation be realized, the discovery and its successful application will certainly take rank among the most important triumphs in the realm of medical science."

LINOTYPE—"The accompanying illustration represents the latest, and in many respects the most remarkable, of the numerous machines which inventors and mechanics have from time to time devised in their long-continued efforts to find some practical means by which to supersede or cut short the tedious work of typesetting. It is known as the Linotype machine, from the nature of its product. . . . It is not, strictly speaking, a typesetting machine, but forms type bars, each of the length, width, and height of a line of type, and the exact counterpart of that which a compositor would set up, except that each line is formed of one entire piece of metal, instead of as many different pieces as there are characters, spaces, etc. . . . The key-board in front of which the operator sits has 107 keys, each marked for a capital or lower case character of a font of type, or the figures, points, or compound letters used in connection therewith, many of the letters most frequently used having several keys."



MEXICAN RAILROAD—"The engineers of the Mexican Southern Railway have laid out the lines as far as Tecomavaco, 58¼ miles south of Tehuacan. . . . The new line will carry the American and Mexican railway systems some 300 miles farther south, and will shorten the time from Europe and New York to South American and Pacific ports from a week to ten days in the former, and four to five days in the latter case."

BIG GUNS—"Two monster Russian guns were sent recently to Sebastopol . . . for the purpose of being placed in the new ironclad *Sinope*, and although some of the details must be inaccurate, the official description is too interesting to be ignored. They are 12-inch pieces, weighing 50 tons, and throwing projectiles of nearly half a ton. The powder charge is 270 pounds, and the initial velocity 3000 meters [*sic*], while the distance of the cannons' ranges is said to be 20 versts, or over 13 miles."

MAGNET—"The direct use of electricity as a labor-saving machine has been applied at the great steel works, Cleveland, Ohio, where a large electro-magnet is used, suspended from a crane, to pick up steel bars and billets. It will pick up 800 lb. billets and drop them where wanted, by the touch of a key, the movement of the crane being done by steam."

SMOKE—"The weight of the great smoke cloud daily hanging over the city of London, England, has been computed by Prof. Roberts at 50 tons of solid carbon and 250 tons of hydrocarbon and carbonic oxide gases for each day of the year, and its value at $10,000,000 per annum."

INVENTION—"Nine-tenths of the material prosperity of this American Union is due to inventors and their patents. A volume would not suffice to relate the many obligations we owe to the men whose patient investigation and ingenuity have cheapened processes and lessened labor for this prosperous people. Rather let us remove our hats before the man who has devised a machine by which we may get bread with less sweat."

LIGHT—"So far as we know, every city in the United States is now provided with arc and incandescent illumination, and the introduction of electric lighting is rapidly extending to the smaller towns. Already hundreds of villages of only a few thousand inhabitants have their electric light plants."

FUEL—"It has been demonstrated in Vaca Valley that peach stones will make as good a fire for household purposes as the best kind of coal in the market. . . . The fruit growers, instead of as heretofore throwing the pits away, dispose of the stones at the present time at the rate of $6 a ton. A sack of the stones will weigh about 80 pounds and will last as long as an equal number of pounds of coal, and give a greater intensity of heat."

TELEPHONE—"The Metropolitan Telephone Company, of New York, have recently erected a new central station building in Cortlandt Street, which is of special interest as embodying the latest improvements in telephone central station work and accessories, as well as containing the largest switchboard in the world. At present about 2500 subscribers use it, but all the connections are prepared for 6000, and the board can be extended so as to include 10,000. The building is fireproof throughout."

EIFFEL—"The question of the possible use of the Eiffel Tower for scientific purposes has been often raised, and as yet we have seen no authoritative document on that head signed by any scientific man or indorsed by any learned society, but scientific utility is possibly a secondary object in its construction. The tower will be such a curiosity in itself as to powerfully help to draw many visitors to Paris during the exhibition."

OUR POINT OF VIEW

The Picture Falls Together

FOURTEEN years ago the anthropologist and anatomist, Sir Arthur Keith, ablest authority among scientists on the skeletal remains of ancient man, concluded his notable work on "The Antiquity of Man" with a significant reference to the genealogical tree of human evolution as that tree was then known. "We may hope," he wrote, "to find many more branches." He sensed fully that the five humanoid types at that time known represented probably but a few fossil twigs of what would turn out later to be a many-branched tree of man, ape-men, and apes of the past.

On that tree were the Java ape-man, *Pithecanthropus erectus*, earliest offshoot from the main stem and 500,000 years old; Neandertal man; Piltdown man of England; Rhodesian man; and finally our own modern races and some of their nearer ancestors such as Boskop man, Talgai man, and Wadjak man—the widely-known Cro-Magnon man being the probable ancestral type of our own European race.

How extremely ably Sir Arthur Keith prophesied has been amply borne out by the subsequent progress of discovery. In brilliant succession has come major find after major find. In and after 1927 came the several skulls found excellently preserved in caves near Peiping—*Sinanthropus*, or Peking man, curiously combining modern and primitive characters and contemporaneous in age with the Java ape-man. In 1932 came the 50,000-year-old skull of Solo man found also in Java, a probable descendent of the Java ape-man. In the same year came the discovery in Palestine of 13 whole skeletons of a race in part like Neandertal man but greater in antiquity. In 1936 and 1937 two new skulls of the Java ape-man afforded the necessary evidence to throw him out of his former ape-man status and almost into the human trend of evolution. Truly, paleoanthropology, the science of ancient man, has been actively on the move.

In addition to these discoveries there is the remarkable series in South Africa. In 1924 at Taungs, the fossil skull of a previously unknown type of ape, much nearer to man than the chimpanzee or gorilla, was found by Dart. In 1936, at Sterkfontein, Broom, a physician-anthropologist, discovered the skull of an ape differing from the living apes and named it *Plesioanthropus*. In 1938 he found at Kromdraai the skull of another type of large ape and named it *Paranthropus*. Both are of Pleistocene age—dating from some scores of thousands of years ago.

And now has come the cap to the climax. Supplementary finds of arm, leg, and foot bones more recently discovered by Broom show clearly that these supposed apes walked erect and were probably nearly human.

Thus the mosaic is being rapidly filled in and the picture of the evolution of man from his ancestor begins to emerge. The prediction that more and more fragments of this picture will come to light is easier today than it was when Sir Arthur Keith predicted major finds. The American anthropologist Hrdlička has always urged that science was trying to build the picture on too few and uncertain fragments. In a relative sense this still remains true but the signs grow better. Prof. H. H. Wilder united man and the living apes in one family, a courageous act! Since Nature must have experimented with numerous others now extinct—a whole welter of forms intermediate between man and the living apes, whose fossils are likely to be discovered—the prospect for those who will be here to watch the progress during the next 25 or 50 years is likely to be decidedly interesting.—*A. G. I.*

If They Would Only Learn

PEDESTRIANS who are familiar with automobile operation stand a better chance of keeping out of traffic trouble than do those who lack this advantage. This definite conclusion is drawn from evidence that, of the 15,000 pedestrians who are killed in traffic accidents yearly, the majority do not know how to drive.

Those who walk, of necessity or by choice, have certain rights that cannot be disputed by any fair-minded automobile driver. But it is hardly fair to all concerned to uphold these rights regardless of the inclinations or desires of the pedestrian. The one factor that must be considered is the relative maneuverability of the walker and of the motor car. While the man on foot travels at a much lower speed than the motor car, he can jump, dodge, or change direction much more rapidly than can the faster moving and more bulky motor car. Then, too, the pedestrian from his more stable vantage point is often in a much better position to judge the speed of an oncoming car and be governed accordingly, than is the driver who has so many things to watch at the same time.

The point is this: The driver is familiar with both walking and driving; the pedestrian often is familiar only with his own pedal means of locomotion; would it not contribute to the peace of mind as well as to the bodily health of all if these two groups were placed on an equal footing of knowledge and hence of judgment? A start has been made in some sections where the fundamentals of automobile operation are taught in schools, thus providing the pupils with information that may later be instrumental in saving their lives.

It would be far better if every person, regardless of age, could receive the benefit of this sort of education. It is, of course, too much to hope that such a thing could be accomplished by compulsory education, but thinking people who do not own motor cars can take the lesson of statistics to heart and provide for their own safety. If these pedestrians will take the time and trouble to learn how to drive a motor car, even though they may never have occasion to do so, they will have laid a foundation of knowledge that will be as important to their futures as are the simple rules of health and sanitation.—*A. P. P.*

The Implications of Science

THE demand that science help the world to utilize its accomplishments constructively, for the common social and economic good, has been so urgent during the last few years that a plan has been worked out to do just that, according to a recent announcement. However, the plans will not be revealed until after consideration by the Council of the American Association for the Advancement of Science.

Naturally, every right-thinking person will welcome this new activity and wish its leaders well in their attempt to integrate the work of scientists. Yet we cannot suppress a certain cynicism. Science, no doubt, *is* far ahead of civilization, but if this is so, attention should be paid to education of the human being, not to the end-product of research. Who, for example, could have foretold the bombing airplane's domination of cities or its dictation of new national boundaries; or, having done so, could have thwarted this "misuse" of a scientific product except by education? Furthermore, that the planners worked for three years "in co-operation with a Congressional committee," reminds us too much of the useless 450,000-word report of the National Resources Committee.

Perhaps our cynicism is ill-founded. We hope so. But we will look for real results and be content with nothing less. "Reformitis" for its own sake is too much for stomachs far from queasy.—*F. D. M.*

Personalities in Science

SIR RICHARD GREGORY

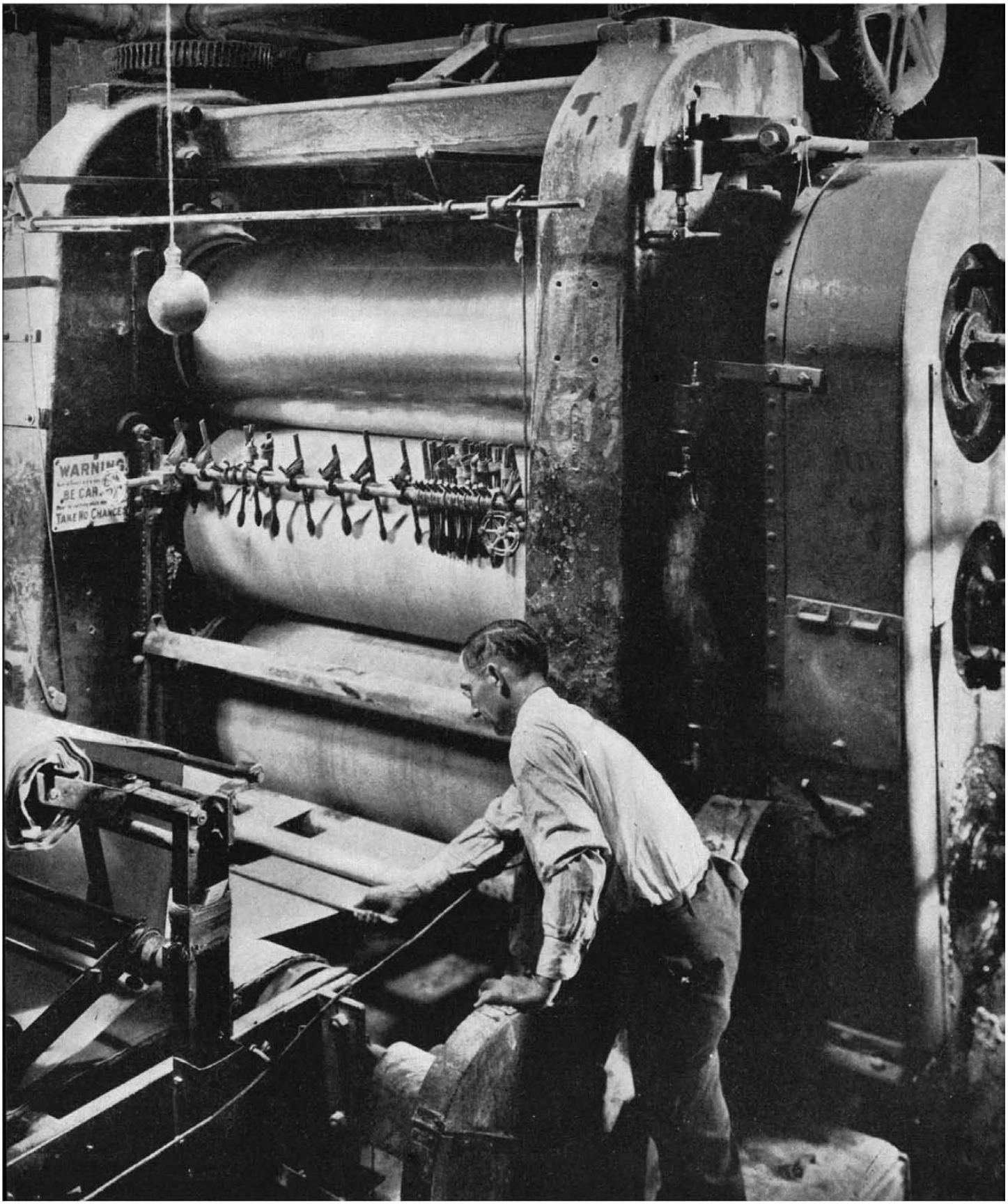
CONFUTING an occasional American impression that in England a man's rise in rank is heavily hampered if he does not happen to belong to the right class, is the career of Sir Richard Gregory, for 20 years the editor of *Nature*, the world's most outstanding journal of the sciences for the professional. He began life as a newsboy, in accepted American fashion, and many years later was knighted and given the hereditary rank of baronet by the King.

Richard Arman Gregory was born in 1864. After leaving school at 12 years of age, he became in succession a newspaper boy, page boy, machine boy in a printing office, and apprentice to the boot and shoe trade. Through his studies before and after factory hours, he was brought to the notice of Dr. J. M. Wilson, then headmaster of Clifton College, and was given a minor post in the physical laboratory of the College. From there he was successful in gaining a studentship at the Royal College of Science, London, which entitled him to free tuition and a maintenance allowance of about five dollars a week. After leaving the College, he became science instructor at H. M. Dockyard School, Portsmouth, but returned two years later to become a research assistant to the great astronomer, Sir Norman Lockyer, who in 1868 discovered in the Sun what was then an unknown gas, named by him helium, which was not identified on the earth until 26 years later. In 1893 Sir Richard became associated with Sir Norman as assistant editor of *Nature* and succeeded him as editor in 1919. For several years while engaged in the editorial work of *Nature*, Sir Richard was an Oxford University Extension Lecturer and professor of astronomy at Queen's College, London.

Among the academic honors conferred upon Sir Richard are the doctorates of science of the Universities of Leeds and Bristol, and doctor of laws of the University of St. Andrews. In 1933 he was elected a Fellow of the Royal Society of London under a special statute reserved for those who "either have rendered conspicuous service to the cause of science, or are such that their election would be of benefit to the Society." Only ten other living Fellows of the Royal Society, including prime ministers and peers of the realm, were elected under this statute.

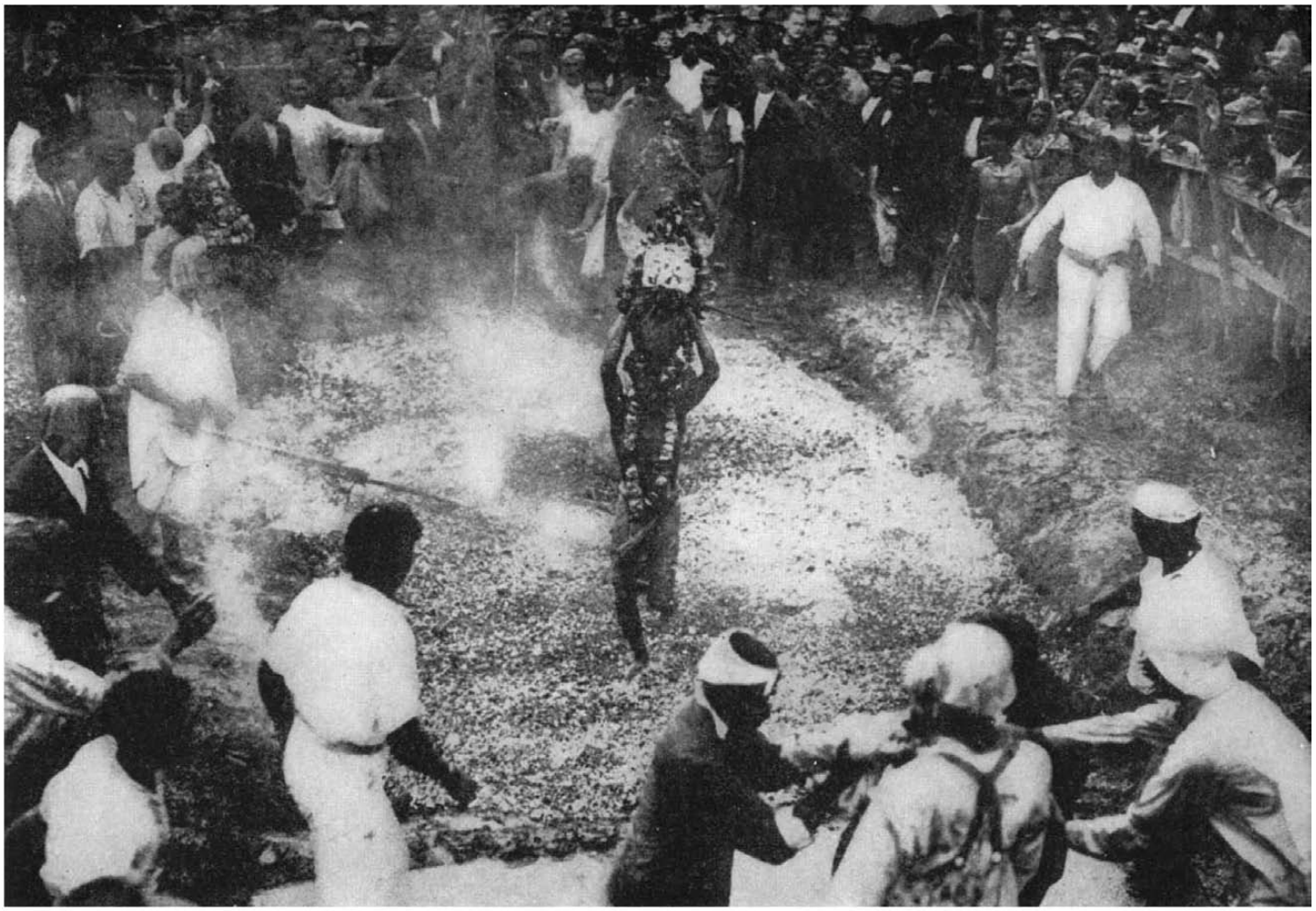
His view is that the main mission of science is to cultivate a habit of mind which may be usefully presented to many problems of modern life. "When scientific work is instituted solely with the purpose of securing commercial gain," he says in his book "Discovery," "its correlative is selfishness; when it is confined to the path of a narrow specialization, it leads to arrogance; and when its purpose is materialistic domination, without regard to the spiritual needs of humanity, it is a social danger and may become an excuse for learned barbarity."

Sir Richard's early contacts with social reformers and with the stern realities of life and labor made him familiar with the human aspects of applied science as affecting industry. This probably accounts for the attention given to the social relationships of science during his editorship of *Nature*, which is recognized as the leading organ of the professional scientific world. Its attitude toward social matters is that, as science is responsible for the industrial developments and economic changes which have caused violent disturbances in the social structure, and has provided also the means by which civilization may commit suicide, it has a duty to guide the human race to the wise use of the powers it has created. Sir Richard is regarded as the leader among British representatives of science, especially in the younger generation, in the promotion of closer relationship between science and social problems and the progress and use of scientific knowledge in the service of the world of man.



ACCURATE MACHINERY FOR BETTER TIRES

THIS huge machine, operating with a high degree of accuracy, is used in one step of the process of making the safe and efficient tires on which modern motor cars roll. It performs a calendering operation by which rubber is sheeted out thin between steel rollers, preparatory to taking its place in the assembly of tires as described on page 158. It is machines such as this, applied in the production of modern needs, that have made possible economies which result in high-grade products at low cost.



Fire-walking in India, a typical scene such as is described in the article. Fire-walking is a world-wide ceremonial rite of purification in which the performers walk barefoot across pits filled with red-hot stones or glowing embers of wood, without injury to the skin of the feet

FIRE-WALKING

When Investigated by Scientists, the Oriental and South Sea Island Feat of Walking Barefoot on Fire or Red-hot Stones Gives up its Mysterious Secrets

By ALBERT G. INGALLS

SURROUNDED with superstition and mystery for centuries has been the spectacular feat of walking barefoot over highly heated stones or white-hot embers without damage to the skin or flesh. In Polynesia and India, wizards and witch-doctors long have impressed and awed their peoples by these performances, which are undertaken after prolonged purifications and with ceremonial rite.

Innumerable times have Europeans and Americans witnessed these exhibitions, sent their observations to their home newspapers and attempted to explain, either as trickery or science, the obvious immunity of the participants. Their accounts make readable narrative but, with few exceptions, they have lacked what the scientist would call "essential detail."

Scientists at last have investigated fire-walking and the secret seems to be solved. The solution is simple. The feat is stripped of its atmosphere of mystery and hocus-pocus. Probably you could do fire-walking—simply by doing it.

There are two varieties of fire-walking: on heated stones and on glowing embers—stone-walking and ember-walking.

Stone-walking is practiced in Polynesia—Fiji, the Cook Islands, the Society Islands, the Marquesas, the Hawaiian Islands—glamorous Pacific isles of romance. In a broad, usually circular pit of knee depth an immense wood fire is maintained for hours around stones about the size of a sofa cushion, till some of them are raised to red heat. The fire-priest, after going to all possible lengths to surround the occasion with magic and mysterious ceremony, walks barefoot over the highly heated stones. His feet are not even blistered.

Ember-walking is mainly East Indian in origin. It is, however, performed not alone in India but in other parts of the world where Indians have colonized—Trinidad, Natal, Mauritius, for example. It is also performed in Japan. In a knee-depth, rectangular pit, perhaps six by twelve feet or even larger, many cords of wood are first burned. When the flames die down, and the large, deep bed of embers glows red-hot, the performer plods straight across it from end to end, barefoot and in no particular hurry. He reveals no pain and there are no dire results. Often he repeats the performance. Is it supernatural?

Anthropologists have long been familiar with fire-walking as a folk-custom. Frazer, in his "Golden Bough," and Andrew Lang in "Magic and Religion," landmarks in the literature of human folklore to which the anthropologist turns for reference in matters of cults and practices, describe the preparatory rites, the exorcism of the fire, the re-

ligious fervor, the fasts of the sorcerers, likewise the meaning of the ceremony to primitive man. Fire is an opponent of evil—of bad health, for example. The ghost, witch, warlock, wizard, or other hobgoblin of the imagination that causes the ill, dares not pursue the victim through the fire. Good logic, if you like its premises.

PROFESSOR Langley, of the Smithsonian Institution and early airplane fame, witnessed a stone-walking ceremony in Raiatea, near Tahiti in the Society Islands. The pit measured 21 feet in length, was nine feet wide and knee-deep. Cords of wood were placed in it and on top of the wood about 200 rounded stones of porous basalt, weighing from 40 to 80 pounds each, were heaped in a mound. The wood was ignited and after four hours the inner stones were red-hot and bursting with loud reports. Four times the fire-priest crossed the center of the pile of stones, barefoot, unharmed. Langley removed one hot stone on which the fire-walker had stepped and dropped it into a bucket of water. It boiled the water for 12 minutes: proof that the rock was a slow conductor of heat. A good conductor of heat would cool much more rapidly—also burn the fire-walker's feet, no doubt. He brought the stone to Washington and reheated it to the same hue, thereby ascertaining the temperature to have been about 1200 degrees, Fahrenheit. Lead melts at 621 degrees. Only recently have scientists made more exact experiments in connection with fire-walking than this simple one of Langley's.

Percival Lowell, the astronomer, witnessed the ember-walking rite in Japan. A pit 12 to 18 feet long was filled with charcoal which was brought to a red-hot glow. Now the priest breathes in and out of his pursed-up lips—"a great purifier." After a few consecrated words he strides with dignified unconcern over the whole length of the fire-pit—barefoot. His exorcism of the fire has quite deprived it of its power to injure. Lowell, however, preferred to explain the immunity on more rational grounds—the toughness of the man's soles, the less sensitive nervous organism of the Oriental, and the exaltation and ecstasy of the performer, a combination of the physical, the physiological, and the psychological. Now that we have the approximate answer to the question, none of these three general explanations can be wholly excluded, but one of them comes out on top, quite definitely. In advance of the final answer, how would the reader rate the three?

A few years ago a reader of this magazine inquired whether an account of stone-walking in Tahiti, which he had read in Frederick O'Brien's "Mystic Isles of the South Seas," was really truthful or whether its author had not perhaps been under the spell of hypnotism when he witnessed the ceremony. This question was published and, as a result, eye-witness accounts of fire-walking in different corners of the earth have trickled in to the editor ever since. A reader from India, for example, offered this:

"I was an eye-witness to at least two fire-walking ceremonies and was indeed struck by the remarkable freedom from injuries which characterized the ritual. At one of these which I saw at Pallavaram, in the Chingleput District, there were 18 men of ages from 18 to 65, who participated in the ritual. The fire was about 16 feet by 12 feet by 4 feet deep and was made up of huge logs of wood which were allowed to burn for over six hours before the men went into it barefoot and with only a wet loin cloth on their person.

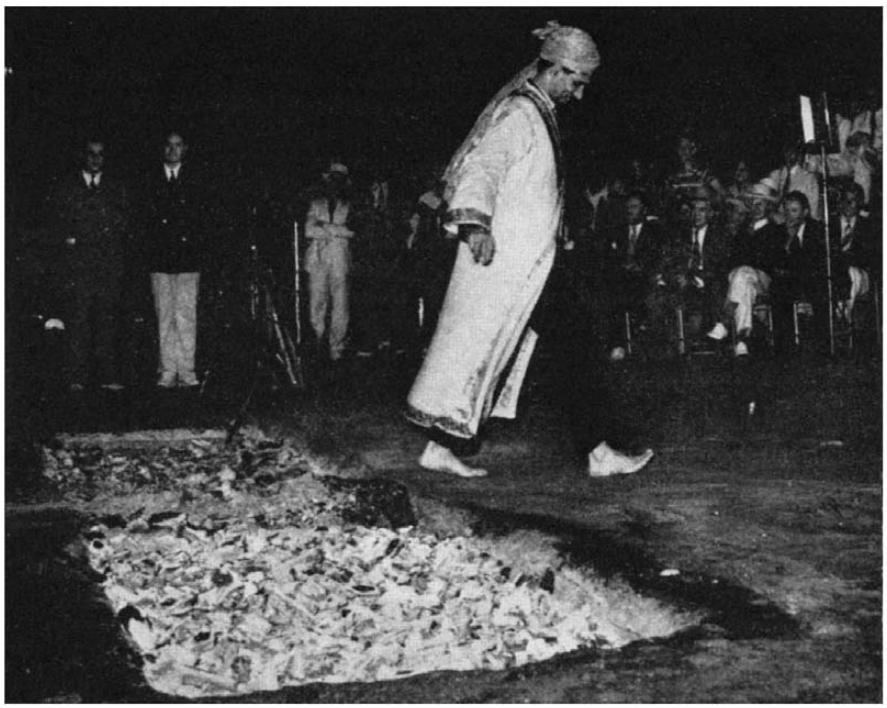
"These men took a bath immediately before they got into the fire, and with the wet loin cloths on their person, freely walked over the red-hot embers, chanting some weird religious songs.

"The only rational—at all events, what appeared to me to be rational—explanation was that these fire-walkers smeared their bodies with the juice of some leaves, which had the remarkable property of desensitizing the skin to fire. Other explanations ascribe the freedom from injury to mystic and occult powers, and to religious fervor in the walkers, which transcended all physical feelings.

"In the second instance 55 men took part in the ceremony but only one was hurt. If the whole thing was a fake, how can we explain this observed fact of one man being injured?

"I honestly feel it is not a stunt. But, at the same time, I cannot for one moment reconcile myself to the idea that fervor, however deep, can save the victim from some bodily injury. It must therefore be some sort of anesthetic effect that is induced in the walkers by the previous application for some days or hours or even perhaps minutes, of some powerful juice which, while producing this effect, is not washed away by the bathing to which the walker subjects himself before the assembled audience—apparently to show them that they had nothing on their bodies to protect them from the fire.

"I would like that you invite a free expression of opinion on this matter from your readers over the globe."



Kuda Bux, a Moslem magician from India, whose fire-walking tests are described in the text, after traversing barefoot the long fire-trench shown behind him

IN Natal Province, Union of South Africa, are many East Indians, and another reader, F. Hawley Williams, of Pietermaritzburg, describes ember-walking as practiced there. "This ceremony," he writes, "is a religious penance ceremony and is carried out for the purpose of purifying the participants from sin, and to confer immunity from evil-doing in future. The candidates are required to undergo a preparation for at least ten days, during which time they are not allowed to eat meat, nor drink alcoholic liquor, nor come into contact with women. Each must bathe the whole body twice daily. Ceremonies are carried out every day at the temple and the candidates recite many prayers to their gods, prostrating themselves before the images. No drugs are administered and no treatment of the skin is given, but the majority of Indian workers do not wear boots and the soles of their feet become leathery.

"On the day of the final ceremony the

devotees are ceremonially bathed under the direction of a priest, in a nearby stream, while a crowd of women dressed in the sacred color—yellow—sing, dance, shout, and clap the hands, and youths play Indian musical instruments; the whole combining to make to European ears a hideous din. The devotees are next led to the temple grounds, preceded by an image of the goddess Mariamman carried on a platform on the shoulders of men, also by men beating tom-toms, playing wind instruments which produce a worse noise than bagpipes (with apologies to bagpipes), and clashing cymbals.

"On arrival at the gate of the temple grounds those taking part in the fire-walking are in a state of religious frenzy, leaping, shouting, and pushing to obtain a front place in the path to the fire-pit. This year 15 men took part. Immediately before the first one crossed the burning embers a goat was sacrificed by decapitation at the edge of the pit. This was about 30 feet in length, ten feet wide, and 18 inches deep and was a mass of hot wood embers, raked down fairly level.

Courtesy Harry Price

Ahmed Hussain, another magician from India, walking across 12½ feet of red-hot embers at a temperature of 1067 degrees, Fahrenheit, leading three Englishmen in their maiden fire-walk

"A PRIEST crossed the red-hot embers first, at an ordinary walking pace, followed by the devotees in twos and threes. Some of them ran with long strides, others with short, sharp steps. A few completed only a part of the total distance and, their faith failing them, they ran to the side of the pit and scrambled out. The remainder completed the course, being assisted to reach the grass verge and to stand until the hysterical condition had passed off.

"No harm came to the participants.

"As the result of a long conversation with an ex-president of the Hindu temple, Mr. J. Sobiah, an educated Natal-born Indian, the writer feels that there is positively no trickery or faking connected with this ceremony, no preparation of the feet to harden the skin or in any way to cause the skin to resist the action of fire. Two Europeans submitted themselves to the ordeal, took the prescribed ten-day preparation, and one walked safely over the red-hot embers, the other having a small blister on one toe. What gives immunity from fire is not understood. The Hindus ascribe it to faith in their gods, coupled with the purification. One hears many theories advanced to account for the apparent loss of feeling—hypnosis, use of stultifying drugs, skin treatment and so on—but one must accept the word of men whose statements can be relied upon that, beyond purification, dieting, and prayer, nothing is done which can in any way account for the result. Faith is the great factor."

From Colorado another reader advances a hypothesis that is usually given consideration by most persons of scientific inclination while canvassing possible explanations for fire-walking immunity. A woman ironing, he suggests, will test the degree of heat by moistening the finger and touching the iron. The moisture on the finger creates a vapor cushion which protects it temporarily from being burned. Plumbers, he points out, are accustomed to direct the flow of molten lead with the bare palm of the hand, and here the same principle applies. Some moisture would be left on the body of the fire-walkers after the preliminary bath, he argues, since they probably do not use towels, and this would continue the supply of moisture after the first moisture of the bath had evaporated.

The phenomenon described is well-known to scientists as the "spheroidal state of a liquid." The liquid, in drops (hence the word "spheroid"), floats on a layer of its own vapor and, though it does not itself reach boiling temperature, it rapidly evaporates from its exposed surface because of the adjacent heat. Water drops dancing on a hot stove give probably the most familiar illustration of the spheroidal state.

Unfortunately, two objections stand against this scientific phenomenon as an explanation of immunity in fire-walking. First, it would be impracticable. It would be easier for a man to carry an armful of live eels the length of a day's walk than to try to make a wet loin-cloth feed a uniform supply of water down the legs to the soles of the two feet, even if no one were watching. Second, no fire-walker, unless he had temporarily lost his memory of the effects of the first attempt, would try this method a second time. The reason will appear later.

Richard Martin, of San Francisco, describes his observations: "I once saw a performance of fire-walking, and to my mind there is no mystery at all.

"The fire-walking took place in the South Pacific, in the island of Tahiti. It was performed by a group of natives from the island of Raiatea. Hearing of the coming event, I questioned several of my native friends for an explanation. They all explained it upon superstitious grounds, which I did not believe, although I did not tell them so. I believed that the laws of nature could be the only explanation. I was convinced that if a native could perform it, then I could do likewise, in which I was partly wrong. I made up my mind to attempt to do all that the natives would do if nobody opposed me.

"The day of the fire-walking arrived, and I found that a pit had been dug, about 18 feet long, 12 feet wide, and three feet deep. The bottom of this pit was covered with boulders about 12 or 14 inches in diameter, such as may be found in the bed of any of the streams. Upon these boulders a fire of logs was burning, with flames reaching about six feet high.

"THAT afternoon I returned to the location and found a crowd of people waiting. The fire had now been burning several hours, and was being allowed to burn itself out. The boulders were covered with red-hot coals, with low flames above them. The natives now placed the ends of long poles under the red-hot boulders, turning and prying them up, so that soon the red-hot coals were below the boulders. This caused the surface of the upper halves of the boulders to lose their redness, but the lower halves remained red.

"About six of the natives, clad only in a cotton cloth around their waists and reaching to their knees, now approached the pit in single file. The leader carried a bunch of long leaves in his hand. To natives, this kind of leaf has a superstitious meaning. Reaching the edge of

Courtesy Harry Price

Reginald Adcock walking on a bed of embers having a surface temperature of 1472 degrees, Fahrenheit. The English tyro equalled the Orientals' best feats

the pit the leader stopped and, turning his face toward the sky, spoke in a loud voice about two dozen words in the native language. Next he stooped and, reaching into the pit, struck one of the boulders three times with the bunch of leaves. My native friends told me that all this was necessary to prevent the performers from being burned. Without hesitation the leader now calmly stepped with bare feet on the hot boulders in the pit and walked leisurely across its 18 feet, closely followed by his associates. After crossing the pit they repeated their walk in the opposite direction. This concluded the performance.

"AS SOON as the performers were out of the pit, I stepped to its edge, barefoot, to test the heating properties of a boulder, as I had previously planned to do. Extending one leg into the pit, I placed my bare foot heavily upon a boulder, then quickly removed it. I found the conditions just about as I had expected. Immediately I stepped upon the boulders and walked across the pit with bare feet. Then I repeated the walk in the opposite direction. Although I duplicated the performance of the native fire-walkers, I admit that I did not do it in quite such a leisurely manner; in fact, I walked rather fast, and for a very good reason! I then examined my feet and found them uninjured, although they did not feel as comfortable as could be desired. Within two minutes after walking on the stones, I repeated the performance, thus walking across the pit four times. This second walk was a mistake, because upon examining my feet again I found a blister the size of a 25-cent piece on one foot; also my feet were twice as uncomfortable as before. The boulders did feel very hot, as indeed they were, but they were not unbearable.

"The boulders used were of the kind that are characteristic of this group of volcanic islands. They have the same appearance as a rubber sponge and were undoubtedly at one time molten lava filled with bubbles of gas. This structure makes them ideal as poor conductors of heat. In addition, the performer has thickened skin on the soles of his feet."

The stone-walking variety of fire-walking may permit as many as 25 steps. The stones are heated red-hot but usually unevenly, because the flames do not play on them evenly. Professor Langley observed that the parts that were not red-hot were nevertheless very hot. Even so, stone-walking is not usually so severe a test or so difficult a feat for the same distances as ember-walking, for here only a relative few steps may be taken with immunity. Usually, also, the embers are hotter than the stones used in stone-walking. At least they are hotter than the portions of the stones that are stepped on, or else there are other differences.

AND now we reach the London investigations, for the first time the active participation of physicists, and the solution.

The University of London Council for Psychical Investigation consists of ten members, four of whom are professors. Its Honorary Secretary is Harry Price and its Laboratory is at University College, in the heart of London.

A few years ago the Council decided to look into the question of fire-walking and authorized Harry Price to advertise for fire-walkers. Letters arrived from many who had seen fire-walking but none wanted to try it themselves! However, an (East) Indian magician, Kuda Bux, a Mohammedan, turned up and stated that he was a fire-walker. Tests were planned. The following is quoted from one of two reports[1] on experimental fire-walks. "The object of the experiments," Harry Price states in his report—the first of the two—"was to ascertain if Kuda Bux was immune from burning when walking over the fire; if so, why? Is fire-walking based on trickery? Can anyone do it? Do the performers prepare their feet? Can they convey their alleged immunity to other persons? Do the 'walkers' prepare their feet with a paste made of alum, salt, soap, and soda, as has been alleged? Do they have to be in an ecstatic or exalted condition? Do they have to possess faith? Do they inject an anesthetic into their feet? Do the wood ashes form an insulating layer on top of the fire, and thus prevent burning? Does the performer have to hurry along the trench, or can he stroll? Does he fast, or otherwise prepare himself—mentally or physically—for the ordeal? Kuda Bux stated that his immunity from burns was due to faith. He also claimed he could convey his immunity to another and take him over the fire without injury."

A TRENCH one foot deep, three feet wide and 25 feet long was dug. Three tons of wood were laid in it and on the appointed day this was ignited. After an hour and a half, a load of charcoal was added, an idea of Harry Price's, in order to make a hotter, cleaner, and smoother surface. After three and a half hours from the beginning these fuels had burned to a glowing mass of red and black embers three inches deep. This was too shallow, but the researchers were unacquainted with fire-walking and in this and other ways on their first attempt to provide suitable conditions they did not quite attain the desired ideal. Kuda Bux said he preferred at least nine inches of embers. He could give no clear reason for this but alleged that it was much easier to walk on several layers of embers than on a thin layer of fire. However, he walked.

Before the test Kuda Bux's feet were examined by Dr. William Collier, of Oxford, who was present and pronounced his feet normal. Swabs were then taken and handed to a pathologist for analysis but nothing was found. One foot was then washed, evidently as a check or control on the other, in case of some substance having been applied.

Kuda Bux stood at the end of the trench and muttered a prayer from the Koran. He then stepped on the fire and took four steps, each foot making contact twice. He did not run, but walked

(*Please turn to page* 173)

[1] "A Report on Two Experimental Fire-walks," Bulletin II of the University of London Council for Psychical Investigation, by Harry Price; "A Report on Three Experimental Fire-walks," Bulletin IV, by G. Burniston Brown, M.Sc., Ph.D.; respectively 5/- net and 1/- net, or $1.25 and $.25, foreign. Rooms of the University of London Council for Psychical Investigation, 19 Berkeley St., Mayfair, London W.1, England. Not available direct from Scientific American.

An Electrical Voice

Speech Created . . . Skilled Operation Requires Long Training Period . . . Result of Research

The Voder in operation. Foot pedal gives inflection to synthesized speech from loudspeaker

BUILT almost entirely of apparatus used in everyday telephone service, an electrical device which, under control of an operator at a keyboard, actually talks, is a development of Bell Telephone Laboratories. It was designed as a scientific novelty to make an educational exhibit for display at the San Francisco Exposition and at the World's Fair in New York.

The Voder, as the device is known, creates speech. It is the first machine in the world to do that. Individual vowels and consonants have been made by a variety of instruments, but they have never been linked into connected speech. Seated at a keyboard something like that of the old-fashioned parlor organ, an operator can carry on a conversation simply by pressing keys, singly or in combination. It takes a good deal of practice and some time to learn—not as much time as it takes the human to learn the mechanisms he is born with, but still quite a while. And it talks with what might be called a slight electrical accent. Nevertheless a skilled operator can make it say what she wants.

Designers of the Voder provided it with electrical equipment corresponding to the two kinds of speech sounds. One kind of sound is made by forcing the breath through the mouth, past tongue, teeth, and lips. Turbulence in the air-stream sets up a hissing sound which contains a great many vibration-frequencies. Some of these are reinforced by resonances in the mouth cavity; that is the way in which are made all the sounds of speech when one whispers, and such sounds as "s," "th" and "f." In the Voder there is an electrical hiss, and with some of the keys the operator can control its quality so as to make those sounds. Other keys make the "stop" consonants like "d," "k," and "p."

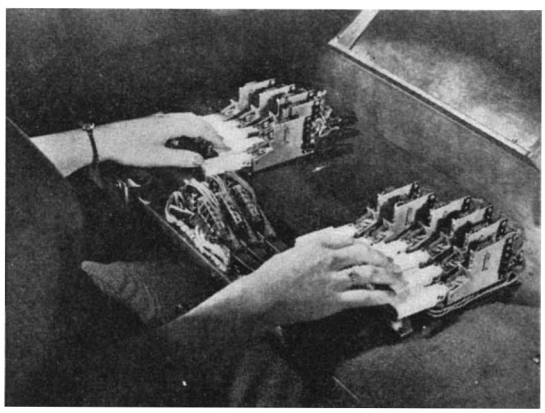
Another kind of sound enters into human speech, most importantly in the vowels, like "a," "e" and "o." It comes from the vocal cords, and is very complex and somewhat musical. In the Voder, therefore, there is an electrical source of sound corresponding to the vocal cords; and there is a pedal for changing its pitch and for giving to speech a rising or falling inflection as desired. When the operator wants the sounds made by the vocal cords, instead of whispered sounds or consonants, an arm rest switch is depressed. Then the particular parts of this vocalized sound which are wanted are selected by pressing the proper keys.

THE source for this sound is the so-called "relaxation oscillator" which gives a saw-toothed wave in contrast to the smoothly rounded wave of a pure musical note. This saw-toothed wave has a fundamental note which gives the whole sound a definite pitch. Broad changes in this pitch mark the difference between male and female voices; gliding change of pitch over a smaller range constitutes inflection. The Voder may be posed as a man or a woman by turning a knob; it may state a fact, ask a question, or emphasize a word according to the motion of its pedal.

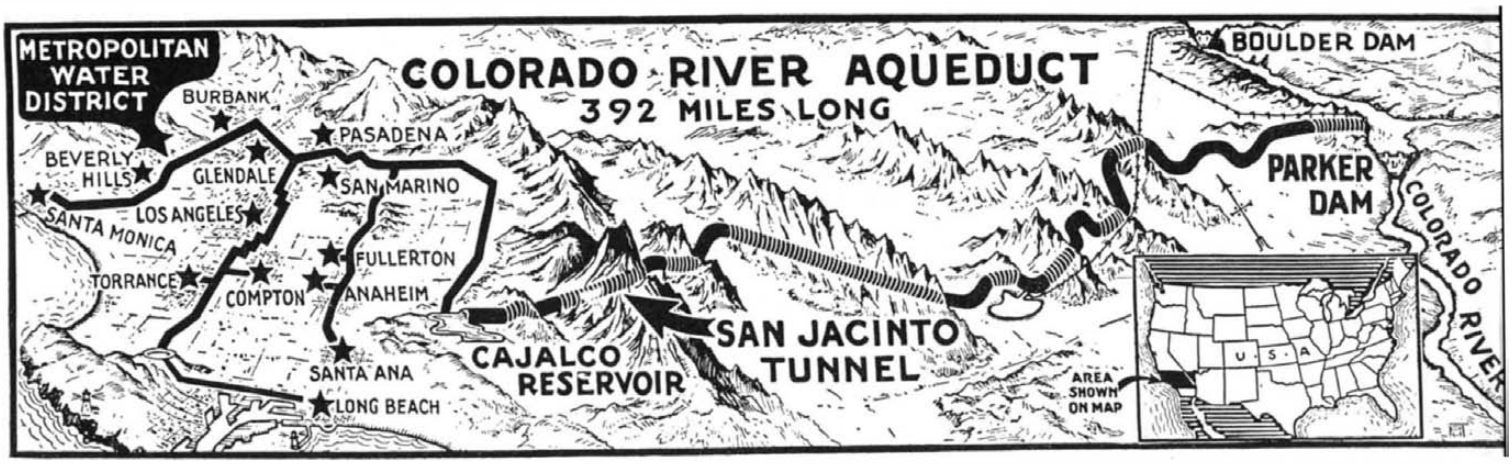
When one talks, one shapes his mouth cavity so that some particular parts of the complex sound come through clearly while other parts are suppressed and unheard. This makes the difference between the vowel sounds. For the same purpose the Voder is provided with ten keys. Each of these controls the current in a definite frequency range. Source of current for each attenuator is an electrical filter which picks from the saw-tooth wave one particular group of its overtones. The Voder seems to speak most understandably when unimportant overtones are suppressed.

Considering all the keys, there are 23 different sounds available to the Voder operator. By combinations of keys she can mix these sounds and by the fingering she can control the shading. All speech sounds can be produced, but the number any operator can make use of depends on her finger dexterity; even granted the ability, only long practice will bring skill.

The Voder is an outgrowth of fundamental researches in telephony carried on in Bell Telephone Laboratories as part of this program. Homer W. Dudley, in the course of one of these researches, developed a speech synthesizer which could be controlled electrically by a speech analyzer. When the Bell System exhibits were projected for the Expositions at San Francisco and New York, the synthesizer part of the apparatus seemed to offer possibilities for development into a demonstration which would have educational value since through its use the formation of speech sounds could be shown. Mr. Dudley and R. R. Riesz thereupon constructed a model which has been put into form for exhibition by W. A. MacNair of the Laboratories' technical staff. Difficult tasks of working out its linguistic possibilities and a technique for its operation were undertaken by S. S. A. Watkins, who developed a course of training and instructed a corps of operators.



Ten of the white keys each control a speech sound; the eleventh is for volume. The three black keys make the "stop" consonants. The wrist switch changes from consonants to vowels



Boring Through a Rainstorm

San Jacinto Tunnel, Part of Colorado River Aqueduct System, Presented Engineering Difficulties . . . Rock and Water . . . Pioneer Tunnels Driven Ahead

By LYNN DAVIS SMITH
Metropolitan Water District

THIRTY-SIX million gallons of water pouring down through the rocks of Mt. San Jacinto in Southern California every day. . . . Underground rainstorms which beat unceasingly against several hundred workers. . . . Solid rock, shifting rock, and unconsolidated rock which threatened constantly to fill the 13.2-mile tunnel being driven through those storms. Yet hard-rock miners pressed ahead through the downpour, completing recently the dramatic job of boring the long hole through which eventually a billion gallons of water will flow on its 392-mile journey from the Colorado river to Southern California.

San Jacinto is one of 38 major tunnels on the Colorado River Aqueduct system. Totaling 108 miles in length, these have constituted one of the biggest tunneling jobs in construction history. Much of the 392-mile aqueduct system has been constructed without strenuous opposition from the forces of nature; she seemed to concentrate most of her might at one point—Mt. San Jacinto. This spectacular peak, which, with its foot in the desert only 400 feet above sea level, rises a sheer two miles into the air, is a fitting spot for a show-down fight between man and nature. For her principal weapon against man, nature chose the very thing that he will carry through that mountain —water.

Water was encountered when sinking both the Cabazon and Potrero shafts from which the tunnel was to be bored. Following several delays, construction was started on large-capacity pumping facilities at both shafts. These consisted of large bottle-shaped chambers cut out of the solid rock adjacent to the two shafts. Batteries of pumps having a total capacity of 29,600 gallons per minute at Cabazon and 17,400 gallons per minute at Potrero were installed in these chambers.

Auxiliary controls on the surface were provided so that the pumps, in their water-tight chambers, could be operated even though the tunnel should be completely flooded. Large steel pipe lines ran from these stations to the tunnel headings. The pumps continued to operate until Cabazon holed through to the east portal and Potrero holed through to the west portal, after which the water was carried through the tunnel and out at the portals.

Protected against falling rock fragments by "hard-boiled" hats, and against water by raincoats and boots, the drill workers pushed ahead in the hard rock through which water poured

WITH adequate pumping facilities installed, the hard-rockers once more turned their attention to driving headings. Work continued in the tunnel 24 hours a day, seven days a week, the two exceptions being Christmas and the Fourth of July.

Working in high-pressure water, four to eight men were needed to change drill steels. Holes at the bottom of the face had to be drilled under water. Sticks of dynamite had to be strapped to poles and the poles wedged into the drill holes so that the powder would stay in place long enough to be fired.

The greatest amount of water encoun-

tered at a working face was in East Potrero, where it once reached a peak of 15,800 gallons per minute. Oddly enough, as though the old man of the mountain had found that even this didn't stop the crews, the heading almost immediately advanced into a dry section. So decided was this change that the front of the drill jumbo was completely dry, while the back end was being doused with 10,000 gallons of water per minute.

For the purpose of reducing the length of time required to excavate the tunnel, an additional access point was constructed. This is known as the Lawrence adit, and is located approximately midway between the Cabazon and Potrero shafts.

This adit, which is a mile long, is built on a 25 percent grade, and drops 1324 feet from its portal to its intersection with the line of the main tunnel. The adit was completed three months ahead of schedule, and headings were immediately started east toward Cabazon and west toward Potrero.

About the time that construction of the Lawrence adit was started, both the Cabazon and Potrero headings were in heavy going. The engineers then decided to use pioneer tunnels paralleling the main tunnel. These pioneers are 10 feet square and were driven south of and parallel to the main headings, which, by this time, had both been angled north to intersect the Lawrence adit. In bad ground, these pioneers immediately proved their advantage. Being smaller, they were driven faster and thus were able to get considerably ahead of the main headings. This made it possible to explore the ground in advance and also to shoot cross drifts over to the line of the main tunnel, from which new headings could be put into operation.

A common sight during the boring of the San Jacinto tunnel was a downpour of water such as this. At one time the inflow to the tunnel at the working face was 15,800 gallons per minute

WHEN the main heading at Cabazon had crossed all known major faults between Cabazon and Lawrence, and the Potrero main heading was able to keep pace with its pioneer, it was possible to suspend pioneer operations, although all equipment was still maintained, ready for immediate use should heavy water flows or broken ground again make its use advantageous.

Throughout the course of work on the San Jacinto Tunnel, the engineers were constantly confronted with problems that affected every man on the job and which had to be solved quickly and efficiently before the fight against nature could be carried on.

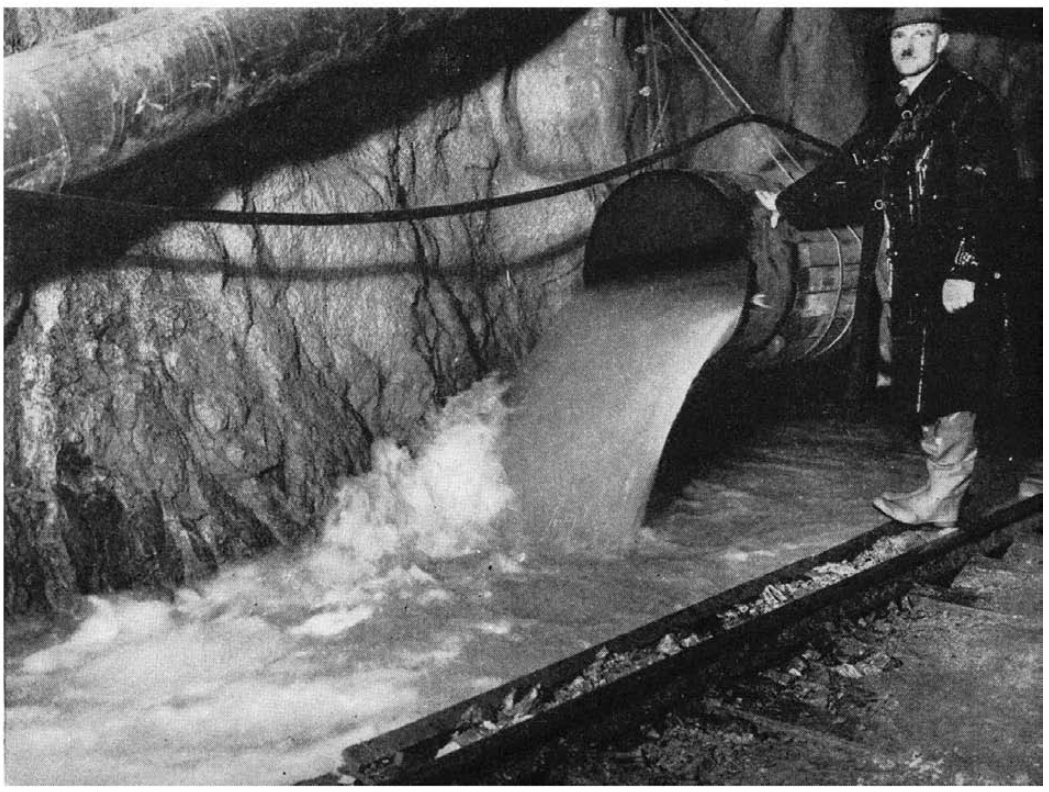
Today, with rock-moving in the tunnel completed, it is impossible for the average visitor—unless he himself is a tunnel man—to realize the tremendous odds that have been overcome in this battle against the mountain. As he speeds along on the tunnel train, mile after mile, his principal impression is of the seemingly unending length of the bore. The scars of battle have largely been covered over, for more than seven miles of the tunnel have already been lined with concrete and completed.

His guide may stop the train in an unlined section and point out giant timbers, 16 inches square and standing together "skin tight." Here a few months, or a few years, ago the heading was brought to a standstill—for a day or for weeks—while the hard-rockers battled water and heavy ground. Ground so heavy that it crushed huge timbers as though they were matchwood, and bent and twisted heavy steel ribs into grotesque shapes. It required the heaviest timbers available, standing together as tight as they would go, to hold the mountain in its place at such points and keep the tunnel clear of debris.

A little farther along, the train may stop in a section where the visitor is told that this is good ground, and here the face was advanced 40 feet in a single day. Here the gray granite stands clean and unsupported, and the crews drove "full face" with eleven drills working on the heading at one time. Eleven drills working in a solid rock chamber, 18 feet square, and each drill making more noise than a machine gun!

But those noises are silenced now. Drills no longer sputter and rattle. The big bore is finished except for lining with concrete. Another few months will see it ready to receive water.

One of the outlets from the huge pumps that kept the tunnel relatively free from water. At times, more than 36,000,000 gallons of water a day flowed into the tunnel through the rock



As Astronomers Meet

Among Themselves Astronomers Specialize On a Wide Variety of Problems, and Then Meet Twice Yearly to Tell Each Other About Their Researches

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

SCIENTIFIC societies are sometimes criticized for devoting their attention to one narrow field: but anyone who listened to such a list of papers as were presented before the recent meeting of the American Astronomical Society in New York could hardly repeat this charge. Half the range of human knowledge seemed to be represented—from the utmost limits of the Milky Way to the internal structure of atoms; from simple — and beautiful — photographs showing the stars in their natural colors, to the intricacies of mathematical theory; from a star 100,000 times as bright as the Sun to the feeble flash of meteors —yet all had a direct connection with the science.

Beginning "at home," we may note an interesting report by Dr. Woolard of the Weather Bureau on the influences which modify climate. If the Earth's surface, like the Moon's, had practically no power of storing up the Sun's heat, the longest day of Summer would be the hottest, and every night cold. Also the South Pole in its midsummer would be the hottest place in the world. Storage of heat, mainly in the ocean waters, modifies this profoundly. In the deserts along the Mexican border, the hottest temperature of the year comes, on the average, ten days after the summer solstice: on the California coast near San Francisco the year's hottest weather comes three months later! A hundred miles inland, the lag is very much less. When the great major seasonal variations are so profoundly influenced by local conditions, it is no wonder that the minute and barely measurable changes in solar radiation connected with the sunspot cycle have no practically perceptible effects.

Next in order of distance should come Whipple's studies of meteors from photographs taken at Harvard. If one turns a camera on the stars for an hour or two there is not one chance in a hundred that a meteor bright enough to record its passage will flash across the field of view. But when the stars are systematically being photographed for other purposes, two cameras, at Cambridge and Oak Ridge, 25 miles apart, can be pointed at the same part of the sky—or more precisely, toward a point 50 miles or so up in the air, at the level where meteors appear. Once in a while a meteor will be caught and the converging lines drawn from the two stations to points upon its path suffice for an accurate survey of its position in space.

Moreover, by arranging a narrow revolving shutter which cuts off the light for an instant 20 times every second the speed of the meteor on its path can also be found. Four meteors recently observed, whose lines of flight, when they met the Earth, were almost parallel in direction, were thus found to have almost exactly the same speed, relatively to the Sun, and to have been moving in orbits of nearly the same size and shape, similar to those of short-period comets. It is, of course, no news that meteor swarms of this kind exist; but the observation of individual meteors with such precision that their orbits may be accurately calculated is something new, and opens up an important line of regular work for the future. In particular, if the orbits of meteors belonging to our solar system can be calculated accurately, it will be possible to be quite certain in other cases that meteors have come in from interstellar space. Little clear evidence of such invaders has yet been secured, but more may be anticipated as the work goes on.

LARGE-SCALE photographs of the Moon, showing very fine detail, were described by Burns of the Allegheny Observatory, and color-photographs of the recent lunar eclipse by Stokley and by Hoffman. A more unusual observation dealing with the Moon comes from Mount Wilson. When a star disappears in occultation, it vanishes instantaneously, so far as the eye can see—that is, within not much more than a tenth of a second. Now the Moon's motion in the sky is about half a second of arc in a second of time, or 0″.05 in a tenth of a second. Even a huge star like Antares, with an angular diameter of 0″.04, would disappear in one twelfth of a second. But modern electrical recording devices can observe far more rapid changes. Putting a sensitive photocell at the focus of the 100-inch telescope, and connecting it by a series of amplifiers with a device recording on a rapidly moving film, Whitford has found that the disappearance of the 3rd magnitude star β Capricorni was by no means instantaneous, but took more than a hundredth of a second. The changes in light look at first sight very strange—a slight drop, a rise a little above normal, and then a rapid and deep fall to disappearance. But this, too, was anticipated. Since light consists of waves, the shadow of a clean-cut straight-edge is not perfectly sharp but is bordered on the outside by faint diffraction fringes, while inside the geometrical limit the light falls off gradually. This has been a familiar laboratory experiment for a century—the fringes being so narrow that they require a magnifier to observe them. But with the shadow-casting edge at the Moon's distance, the width of the first bright fringe is about 60 feet, and, as the shadow is carried by the Moon's motion, this will take about one fiftieth of a second to pass over the observing telescope. The exact calculation of the changes of light is complicated, since the observing cell is sensitive to light of very different wavelengths, whose effect must be separately computed and added. When this was done the observed curve agreed very closely with the calculated. If the star itself has a perceptible diameter, the shape of the curve will be somewhat changed; and there is hope that, in this way, star-diameters too small to reach in any other way may be measured.

One might suppose that when the occultation was almost a grazing one, and the star disappeared obliquely behind the Moon's limb, the time-scale would be drawn out and the observations increased in precision. This would happen if the Moon's surface was smooth; but the effective part of the Moon's edge, at a given moment, is not more than a quarter of a mile long, and the surface is so rough that this might be inclined at almost any angle.

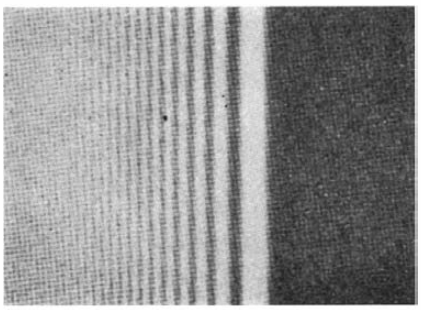
Our nearest planetary neighbor, Venus, was the subject of a noteworthy paper by E. C. Slipher of the Lowell Observatory—the most experienced photographic observer of the planets. At

her conjunction last November Venus was only 3 degrees from the Sun. In this position the planet's atmosphere, illuminated by the Sun's light coming from almost directly behind, can be seen as a luminous ring, completely surrounding the disk. This, again, is not a new thing; it was first seen by Rittenhouse in 1769, and has been observed several times since. But the ring phase has never been photographed before, nor seen when Venus was so far from the Sun. The clear Arizona air at the high altitude has probably something to do with this success; but only great observational skill could have succeeded in getting successful photographs with blue light as well as red, despite the foreground of intense light from our sky. The permanent record of this elusive phenomenon should increase our knowledge of Venus' atmosphere. Indeed, it already appears that the hazy layer in it which is lit up brightly enough to be seen in broad daylight was of variable depth from place to place and day to day.

A VERY different side of planetary study appeared in Brouwer's announcement of a new calculation of the orbits of Uranus and Neptune. Our present knowledge of the orbits of the planets, out to and including Saturn, is very accurate, but Neptune was discovered in 1846, and had been observed over little more than a quarter of its orbit when Newcomb calculated the existing tables of its motion. Any minute errors in the observations of this limited arc would be greatly magnified in the predicted positions for the unobserved portion, and so it is no discredit to Newcomb's work that his tables now disagree by five seconds of arc with the observed position. Most of this discrepancy can be removed by small changes in the assumed size and shape of the orbit, without seriously affecting the agreement of calculation with the older observations. But to obtain tables which may be trusted for prediction as long as possible, it will be necessary to repeat the whole laborious calculation of the perturbations of Neptune by the attraction of the other planets—and also to revise the present tables of Uranus, which show smaller errors of the same sort. The very extensive calculations can be greatly shortened by the use of computing machines of the punched-card type, and the work will be done at the bureau recently established at Columbia University by the friendly co-operation of the manufacturer of these machines.

Solar problems were represented, among others, by Menzel's suggestion that the force which holds up the prominences may be radiation pressure, provided that the hydrogen lines in the extreme ultra-violet (the Lyman series) are bright in the solar spectrum. (We cannot test this directly, because the Earth's atmosphere is opaque to such light.) This may explain also why masses of hydrogen are observed to be driven away from the Sun at nearly constant speed, despite the powerful pull of gravitation.

Coming to the stars, a series of papers by several authors may be noted, dealing with eclipsing variables. By careful ob-



As Professor Russell mentions in his article, diffraction patterns usually are so fine as to require magnification to be seen. Here, however, is a diffraction pattern made with a straight-edge and much larger than is common. It was photographed by Prof. Mason E. Hufford, of Indiana University, under arrangements comparable with those in which the Moon is the straight-edge: The light-source (monochromatic) was 110 feet and the straight-edge 55 feet from the plate. The result was as many as 40 dark fringes visible on the original plate. (The fine mesh pattern on the illustration is an extraneous feature due to reproducing one half-tone from another half-tone —in this case from the one published in *The Journal of the Optical Society of America*, December, 1937, from which the photograph is taken and in which other photographs of broad diffraction bands are shown)

servation of stars of this sort we can find out many things which can not be determined otherwise.

For example, when the stars of a pair are close together, they are pulled out by their mutual attraction into egg-shaped forms, with their long ends pointing toward one another. When these bodies are seen broadside on, half way between eclipses, the total light is naturally greater than when they appear nearly end on, just outside eclipse. From accurate photometric observations, we may find the amount of this ellipticity. But theory shows that the shape produced by the tidal forces will depend not only on the sizes, masses, and distance apart of the stars, but on the distribution of density inside them. A star with the material greatly concentrated toward the center will be less elliptical—other things being equal—than a homogeneous mass. Calculations on this basis indicate that the increase of density toward the center is small. But another effect of the elliptical form is that, if the orbit is eccentric, the point of closest approach of the stars will gradually move forward along the orbit. Sterne, of Harvard, from an extensive discussion of the rather complicated theory, finds that, for the two stars of this sort which have so far been fully observed, the density at the center must be about 50 times the mean density.

A way out of the discordance appears in a note by the present writer. The theory of the escape of radiation from a star indicates that, on an egg-shaped star, the surface should be brightest at the points nearest the center—where the force of gravity is greatest—and least at the ends. When we see the star end-on, the less luminous portions fill most of the visible disk: when it is side-on, the brighter parts do so, thus increasing the range of variation. Allowance for this, and also for the fact that, like the Sun, the star's disk should appear brighter at the center than at the edge, removes the discrepancy.

Kopal, of Prague—now working at Harvard—pointed out that, in some eclipsing pairs, the observed ellipticity effect is smaller than might be expected, and explained this on the very reasonable assumption that one star of the pair had "broken away from the tidal control of the other, and was rotating more rapidly—in which case, though flattened at the poles, it would not be egg-shaped." Hall, of Amherst, presented observations of our old friend Algol—in the infra-red with modern plates—showing that the loss of light at the principal eclipse, when the small hot star is partially eclipsed by its companion, was less, and that at the other eclipse greater, than for visual light —which adds confirmation to the proof that the companion is redder, and therefore cooler, than the primary.

McLAUGHLIN reported from Michigan on the remarkable star Upsilon Sagittarii. From the peculiarities of its spectrum, which is like that of the supergiant Alpha Cygni, but much "more so", it has long been suspected that this is a very bright object. The interstellar calcium lines in its spectrum are very strong and from this McLaughlin estimates that the distance is 2000 parsecs—6500 light-years, and the absolute magnitude —7, or about 60,000 times the brightness of the Sun, and comparable with the brightest stars in the Magellanic Clouds.

Shapley, from the Harvard studies of faint variable stars, has found evidence that there are scattered stars extending to a distance of at least 35,000 light-years on each side of the plane of the Milky Way. Though so remote they belong to our system.

Though incomplete, this sketch of what the astronomers told one another in two days' meetings may give some idea of the present activity, and of its varied range.—*Princeton University, January 5, 1939.*

POLLUTION KILLS FISH

Industrial Wastes, Sewage, Mine Waters Pollute Rivers, Harbors . . . Fin Fish, Shellfish Seriously Affected . . . Research Needed To Correct Evil

By L. M. FISHER
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POLLUTION in streams tends to increase with population. New and expanding industries produce an irregular but progressive pollution invasion of once clean streams, while an increasing number of people seek recreation in sports-fishing in National, State, and local parks and forests and on private estates and properties, and commercial fishermen continue their age-old efforts to obtain a "catch."

The problem of stream pollution is, therefore, of direct concern to those who gain a livelihood in the fisheries industries, to consumers of shellfish and fin fish, and to those who at intervals fortify their health and strength with recreational fishing.

The value of the catch of 40 species of edible fish, as reported by the U. S. Bureau of Fisheries in 1934, was $70,905,000. About 73 percent of this income was derived from species of fish that may be subject in greater or less extent to the effects of coastal pollution.

In the vicinity of large cities which discharge sewage into tidal estuaries, the damage is greatest. For example, near New York City approximately 105,000 acres of productive shellfish areas have been closed, including Raritan, Jamaica, and Newark Bays, Kill Van Kull, Arthur Kill, East River, Harlem River, Hudson River as far as Yonkers, and portions of Long Island Sound beyond the Connecticut line. Near Norfolk, Virginia, approximately 38,400 acres, including all of Hampton Roads, have been closed. Some of the areas are valued at several hundred dollars per acre. The cities of Providence, Rhode Island, and Baltimore, Maryland, located near important shellfish growing areas, have spent large sums for sewage treatment works. Where the river carrying the sewage flows relatively long distances before it reaches the tidal estuary, as in the case of Philadelphia and Washington, D. C., less damage is done from the standpoint of destroying shellfish beds because the river has a chance to purify itself before it reaches the shellfish growing areas.

INDUSTRIAL wastes, on the other hand, sometimes objectionable in high dilutions and difficult to treat, may remain potent over long periods of time and may affect both aquatic life and domestic water supplies at relatively long distances from the source of pollution.

While this subject is only one phase of the broad problem of water pollution, it is important, since it deals with a direct effect on public health in that shellfish have been involved more or less frequently in the spread of disease. It deals with an indirect effect on public health in that trade wastes and sewage tend to make certain valuable sea foods scarcer and more expensive, thus depriving a portion of the population of the benefits of foods rich in iodine, iron, copper, and other essential food elements and vitamins.

Among the causes of the progressive but irregular increase in pollution of streams by industrial wastes are the reestablishment of the fermentation industries discharging exhausted mash, the sudden growth of the cellulose textile industry with its spent chemical wastes, the development of the mid-continental oil fields, and the gradual extension of mining, the latter industry contributing vast quantities of dilute sulfuric acid produced by the action of air and water on exposed sulfur compounds in the mines.

Twenty years ago, all the tributaries of the Ohio River, with the single exception of the Monongahela, were alkaline. Now the Allegheny in Pennsylvania, and many of the streams in West Virginia are acid most of the time, and the acid line in the Ohio River is being extended farther down each year, although the mine-sealing operations recently undertaken give promise of retarding this encroachment. Another invasion by trade-waste pollution may be expected in southern streams and coastal waters as a result of the recently developed process for manufacturing paper pulp from slash pine, resulting in the discharge of chemical wastes and paper fiber into our streams.

While water is being polluted by trade wastes throughout the whole country, the

Courtesy Conservation Department, State of New York

A sample of what stream pollution can do and often does. Millions of fish, some of them quite large, were destroyed in the Niagara River from this cause in one year

Courtesy West Virginia State Health Department

Entrances to abandoned coal mines sealed to exclude air and thus prevent formation of sulfuric acid which has seeped into nearby rivers and acidified them

problem is more acute, generally speaking, in the section north of the Ohio and Potomac Rivers and east of the Mississippi River which contains 65 percent of the total urban population.

Sewage and industrial wastes affect shellfish and fin fish directly in one or more of several ways. They may decrease the oxygen content of the water to a point below which fish life cannot be sustained (usually stated to be about 2 parts of oxygen to a million parts of water). They may destroy fish by increasing the acidity, alkalinity, or salt content of the water, or by introducing poisonous substances; or they may increase the turbidity so as to exclude light and prevent the growth of food. Again, they may deposit a blanket of fibers and waste material on the bottom of the stream so as to destroy the fish food found there. Some wastes impart disagreeable or repulsive odors or flavors to fish or shellfish, and others produce unnatural discoloration which makes the fish objectionable to would-be consumers.

THE most frequent offenders in decreasing the oxygen content of waters are domestic sewages and those industrial wastes containing large quantities of organic matter, such as the scouring water and milk wastes from dairies; blood and offal from packing plants; hulls, vegetable pulp, and wash water from canning plants and beet sugar plants; spent mash from breweries and distilleries; sawdust from sawmills; wool scourings, grease, and dyes from textile plants.

The polluting material which reaches our streams in the greatest volume, and which is detrimental to fish over the largest stream-bed area, is probably acid mine wastes coming principally from coal mines. There are thousands of mines, both active and abandoned, discharging acid drainage which in the aggregate amounts to thousands of tons of concentrated sulfuric acid daily. A considerable reduction in acid from abandoned mines has been effected in recent years by a WPA mine-sealing project sponsored by various state health departments.

Discharge of sewage into our streams or coastal waters, in addition to decreasing the oxygen content of the water, may result in forming sludge deposits on the bottom, and films of grease and scum on the surface, which tend to interfere with the absorption of oxygen from the air and to destroy small forms of aquatic life. Not infrequently, sewage contains industrial wastes and poisons, discharged either by design or accident. Such substances may cause great destruction to fish life—as occurred at Buffalo, New York, in November and December, 1937, when hundreds of tons of fish, valued at more than a million and a half dollars, were killed by the discharge of poisonous industrial wastes.

Municipal sewage frequently contains oil from garages and industries—in some instances in sufficient amount to interfere with fish life. In coastal waters the principal sources of oil are probably the bilge water of vessels, leaks in oil storage tanks, refineries, and uncontrolled oil wells. The oil has a two-fold effect on oysters and other shellfish. It retards and interferes with the propagation of diatoms, which constitute the principal diet of many mollusks; and it reduces the rate of feeding by exerting a narcotizing effect on the feeding mechanism. The water-soluble substances impart an oily flavor to the meat, rendering sea food from oil-polluted water unsalable. It also destroys fish spawn and fry.

When domestic sewage reaches shellfish-growing areas in sufficient concentrations and freshness, it may contaminate the bivalves with disease-producing organisms. In numerous instances, shellfish so contaminated have been held responsible for the spread of disease. The most recent large epidemic of this type in the United States occurred in the winter of 1924-1925, when several hundred cases of typhoid fever in Chicago, New York, and other cities were ascribed to contaminated oysters. The wide publicity given this outbreak destroyed the market for shellfish overnight, and the Public Health Service was requested to assist in restoring public confidence in the safety of shellfish as a food. As a result of this request, the Public Health Service formulated minimum requirements for the sanitation of the shellfish industry. The various states have adopted regulations at least equal to the minimum requirements, and issue certificates good for one season only to shellfish dealers who comply with the standards. These certificates are listed by the Public Health Service as long as it has confidence in the effectiveness of the control measures of the various states, and copies of the list are supplied to state and local health authorities throughout the country. Municipal health authorities are usually quick to exclude from their markets shellfish not obtained from shippers on the lists of the Public Health Service. This plan has been in operation for 12 years and has provided effective control.

SHELLFISH grow extensively only in protected coastal waters receiving the runoff from large rivers. These areas are definitely limited; they cannot be appreciably increased or extended. Hence, the character of the wastes discharged into streams tributary to them is of great importance. A number of these areas are now so contaminated with domestic sewage that shellfish cannot be marketed from them directly. Their existence is a constant threat to the health of consumers in our coastal states because of the surreptitious taking of shellfish from them by individual poachers.

Fiber wastes and chemical wastes constitute the chief sources of pollution from pulp mills. The fibers eventually deposit on the bottom of streams a blanket of imponderable material which stops the normal growth of plant and animal life.

Mercaptans, which are sulfur ethers, or alcohols, found in the cooking process in sulfate pulping operations, have a very disagreeable odor and have been found poisonous to fish in concentrations as low as one part per million. They impair the nervous system of fish so that death eventually results.

The waste liquor from sulfite processes quite readily combines with the dissolved oxygen in the stream into which it is discharged. It also has an acidifying effect on the water and may introduce compounds of a poisonous character, such as the lignin salts.

Several detailed studies of the effects of pulp mill wastes on oysters have been made—among them one in Puget Sound at Oakland Bay, Washington, and another on the York River in Virginia.

Symbolic of our great shellfish industry: a pile of oyster shells. Already a number of large oyster beds have been abandoned because of water pollution

In the Puget Sound study, it was found that sulfite liquor, when added to sea water in concentrations of 0.5 to 10 parts per thousand, is decidedly unfavorable to oysters, and in the laboratory produced death in from 2 to 29 days, depending upon the concentration. The report that followed the investigation recommended that pulp mills using the sulfite process should totally exclude their waste liquor from waters in which oysters are grown.

ON the York River, Virginia, the oyster industry has been declining markedly during the past two decades, according to reports, but it was not until 1935 that sufficient funds were available to establish a field laboratory to make systematic ecological observations and physiological experiments. The results indicate the existence of an environment in the upper part of the York River that is decidedly harmful to oysters; and physiological experiments yield direct evidence of the harmful effects of pulp-mill effluent, reducing both the number of hours of feeding and the rate. Oysters taken from polluted areas in the York River and planted in clean waters improved markedly; glycogen content, which fairly expresses the quality of the meat, increased to normal levels. Shells were strengthened by deposition of lime, and growth was resumed.

The conclusion is reached by the Bureau of Fisheries that "the presence of pulp mill waste in the water is the cause of the failure of oysters to grow and fatten in the upper part of the river and that the elimination of pulp mill pollution is a prerequisite for the restoration of the oyster industry in the York River."

At present the paper industry is engaged in studies to discover useful by-products which can be made from pulp mill wastes, as well as methods which can be economically employed to keep objectionable wastes from streams. As a result of this research, sulfite waste liquor may eventually become an important chemical raw material, and some progress in reducing the quantity and destructiveness of sulfate wastes is apparently also being made.

Of the sulfite waste liquor, 65 percent is fermentable. Bakers' yeast is prepared by neutralizing the waste liquor, inoculating it with yeast, and allowing this to grow under carefully controlled conditions. Approximately 20,000 pounds per week are being produced at one plant in Nova Scotia, and equipment to double the output has been installed.

In Washington, one pulp and paper mill sprays the waste liquor down a stack 120 feet high, concentrating it to about 50 percent solids, and sells the product as a binder for secondary roads. Concentrated sulfite liquor also has some uses as an adhesive and forms the base for most of the linoleum cements on the market. It also can be burned in a manner similar to fuel oil, but while this is practical from the viewpoint of pollution prevention, it is inefficient from the viewpoint of chemical utilization. Other products, such as tanning extracts, phenol, vanillin, and fertilizer material can be obtained by precipitation methods, it is reported.

Industry is essential to the continued existence of modern civilization. Without industry, present standards of living could not be maintained. Practically all our wealth, as represented by goods, is produced by industry. However, those industries which provide food to sustain life are basic and must exist before the production of goods can be undertaken. Because of this it seems reasonable that we should be interested in taking such steps as may be necessary to safeguard a natural food resource, responsible for producing such an important item in our food supply as fish and shellfish; and further it seems logical to conclude that no private industry should be permitted to damage or destroy another existing industry by the discharge of harmful wastes. The principal cost of carrying on research work to discover profitable methods for utilizing wastes or economical methods for disposing of them harmlessly should fall upon the industry responsible for their production. It should be recognized, however, that there is a large public interest involved.

RESEARCH laboratories adequately financed with public funds should be able to evolve methods for recovering profitable by-products. Patent rights could then be issued to the government, making the processes available to all without the payment of royalties. It is conceivable that in this way sufficient returns to the public might accrue to repay fully the expenditure. Money spent for such work should not be considered as just another form of government spending, but as an investment for the welfare of the people, who benefit from a judicious use of the country's resources. The principal source of public funds for studying such a research problem should, perhaps, be the industries themselves, but their contributions should be supplemented by other public funds.

In all fairness, the issuing of summary orders to effect abatement of stream pollution should be limited, for the time being, to those industries for the treatment of whose wastes feasible methods are now available. Also, all units of a given industry, regardless of their location, should be required to effect abatements simultaneously, so that no single plant or group of plants would enjoy an advantage over competitors. Such a program calls for federal participation.

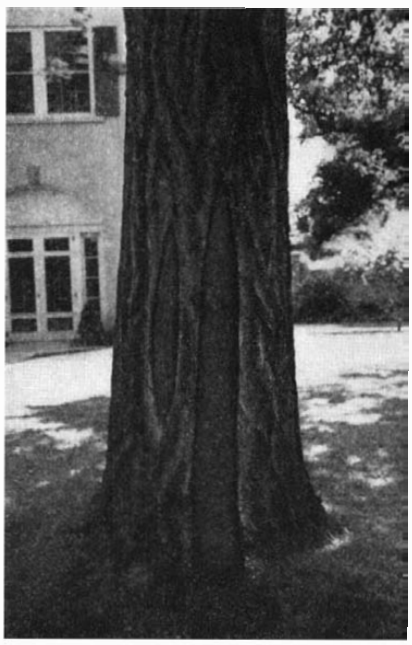
To anyone who has noted the increased demands of the public in recent years for the effective cleaning of streams and coastal waters, it must be apparent that the time is rapidly approaching when an intelligent and comprehensive plan for dealing with the problem must be evolved. If industry and government co-operate in finding a solution, it will be easier, less costly, and less disruptive than if a thoroughly aroused public, irked by delays and subterfuge, finally insists on immediate, drastic, and precipitate action.

Rubber Saves Trees

MODERN tree surgeons are leaning more toward use of materials of a highly resistant nature which will give with the tree's motions, will not harm the tender growing cells by chafing, and will at the same time permit the growth of an even, natural roll or callousing of the cambium layer over the filling. Rubber has been found to be the most satisfactory material to meet these exacting requirements. Of over 5000 cavities that have been filled with rubber, formed in special interlocking strips, not one has failed and all have healed rapidly. Consequently, the use of rubber is spreading.

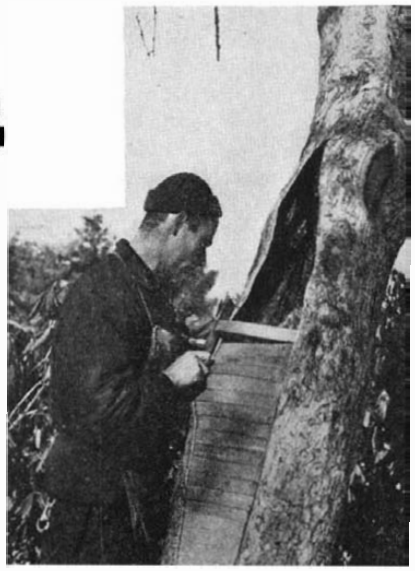
Fitting an end of a strip. The concave upper and convex lower sides interlock all strips in a cavity. The "T" on the rear of the strip ties in with the cavity-filling compound

Fitting a section of a more recently designed strip. On the rear face of this there is only a single channel to interlock with the filler. Rubber may, of course, be used in filling tree cavities in any weather, thus giving it a big advantage over other materials



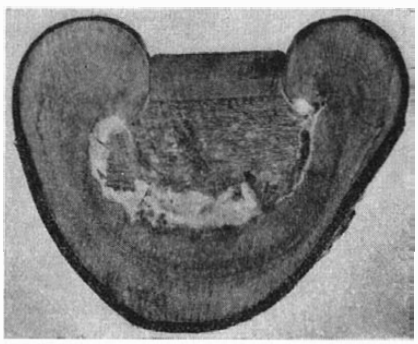
A filled tree is sightly and in some cases its wounds are scarcely noticeable. Nature soon completes repairs with healthy growth

The special, new machine which forces melted, sterilized wax, by steam pressure, into the cavity back of the rubber dam. Rubber and wax effectively exclude water, bacteria, and fungus and let the tree heal



After a cavity is cleaned and dressed with tar, sections of the specially compounded rubber strips, cut to proper length, are wedged into the clean opening

After the strips are wedged in tightly, a motor-driven buffer rapidly takes away the slightly projecting edges of the strips and leaves a smooth, natural looking surface



Section through a cavity showing how this process, developed by Goodrich research men and Van Yahres Tree Service, permits rolling growth of new wood over the cavity

VISUALIZING

An Attempt to Peer Into the Fourth Dimension of Space by Constructing a Three-Dimensional Model or Analogy to be Used as a Taking-off Point

THERE is no need for any remarkable machine, the brain-child of some science-fiction author, to enable us to peer into the fourth dimension.

But is there any fourth dimension into which to peer? Or, if there is, isn't time the fourth dimension, and how can one peer into time?

Time is sometimes treated mathematically as something like a fourth dimension, but time is "imaginary" in the mathematical sense of involving the square root of minus one. The fourth dimension which I am about to discuss is a fourth *space* dimension, exactly like the three—length, width, and height—with which we are all familiar; and standing at right angles to all three, just as each of them stands at right angles to the other two.

We need not agree as to whether or not such a fourth dimension actually exists, or even *could* exist. Being three-dimensional creatures, we could not sense the existence of a fourth dimension, even if there were one. We are like the two-dimensional man of Dr. Edwin Abbott's story, "Flatland," who failed to

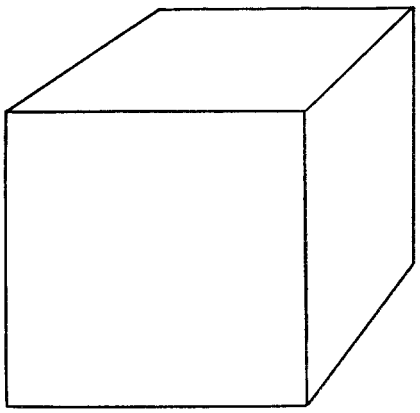


Figure 1: A cube in perspective

grasp the significance of "upward." But, by the use of the familiar principles of perspective, we can visualize exactly what hyperspace would look like, if there were such a thing as hyperspace.

For, in much the same way by which perspective enables us to represent a cube on a sheet of paper, the same principles enable us to visualize the fourth dimension (if there is any) by means of three-dimensional figures.

The four-dimensional analogue of a cube is generally known as a "hypercube" or "tesseract." But the word "hypercube" includes objects of more than four dimensions, and so I prefer the word "tesseract," which applies specifically to a cube of only four dimensions. A five-dimensional cube is called a "pentact." And so on.

Figure 1 shows the familiar two-dimensional picture of a cube. It clearly demonstrates how easy it is to give an accurate idea, in $n-1$ dimensions, of what an object of n dimensions looks like.

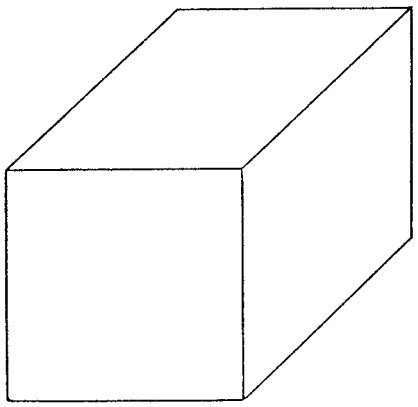


Figure 2: Cube picture, isometric

There is another kind of perspective, known as "isometric," characterized by the fact that no distortion of lengths takes place. Figure 2 shows an isometric picture of a cube.

By following the exact analogy of what we did to get Figure 2, we can make a three-dimensional model of a tesseract. Figure 3 is a sketch of such a model. But this sketch, of course, involves using perspective twice in succession; it constitutes a two-dimensional picture of a three-dimensional model of a four-dimensional object—too far removed from the tesseract itself to convey a very clear idea of what a tesseract really looks like.

We might just as well try to visualize a cube from a one-dimensional representation of the cube. The two-dimensional

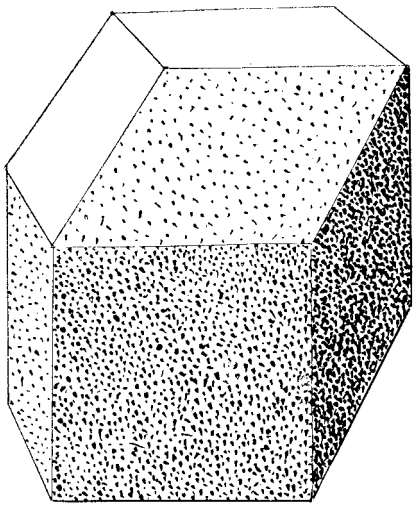


Figure 3: Model of a tesseract

picture of the cube (Figure 1 or Figure 2) gives us a pretty good idea of what a cube is like; but a one-dimensional representation (Figure 4) would be almost meaningless. Similarly, a three-dimensional model of a tesseract would give us a very good idea of what a tesseract is like; whereas Figure 3 gives us no idea at all.

So it is suggested that the reader build himself a cardboard model, by making an enlarged copy of Figure 5, cutting it out with shears along the outside border, bending it on the lines, and then pasting it together by the flaps. For convenience in pasting, I have key-numbered each of the flaps, and have given corresponding numbers to the edges to which the flaps are to be pasted.

Now, to digress for a moment in order to discuss the number of points, lines, and so on, in a tesseract, a pentact, and others, let us start with *no* dimensions: that is, a point. The one-dimensional analogue of a point is a line segment,

Figure 4: Almost meaningless!

obtained by moving the point a short distance into the added dimension. This motion gives us two terminal points and one line.

The two-dimensional analogue is a square, obtained by moving the line into the added dimension, a distance equal to its length. This motion doubles the number of terminal points, and produces four margin lines. The reason for this last number is as follows. The original line is one, this line in its new position in the new dimension is one more, and each of the two ends of the original line traces a line by its moving.

THE three-dimensional analogue is a cube, obtained by moving the square into the added dimension, the same distance as in each of the former shifts. This motion doubles the number of corner points, thus producing eight. The number of lines equals twice the original number of lines plus the original number of points: 12 in all. The number of surfaces equals twice the original number of surfaces, plus the original number of lines: six in all.

Before proceeding to the tesseract, let

HYPERSPACE

By RALPH MILNE FARLEY, M.A.

TO many minds there is a strong fascination in the more uncommon, often bizarre aspects of mathematics, of which the geometry of hyperspace provides an example. From time to time such mathematical articles will be offered if the response to the present one indicates a sufficient volume of reader interest.
—The Editor.

us tabulate these results obtained thus far:

Object	*Points*	*Lines*	*Squares*	*Cubes*
Point	1			
Line	2	1		
Square	4	4	1	
Cube	8	12	6	1

An inspection of the above table shows us that (for the reason given under our discussion of the square) each number in any row is equal to the sum of twice the number directly above it, plus once the number diagonally above it to the left. This consideration enables us to compute readily the number of elements of a tesseract and of a pentact, thus extending our table as follows:

Object	*Points*	*Lines*	*Squares*	*Cubes*	*Tesseracts*	*Pentacts*
Cube	8	12	6	1		
Tesseract	16	32	24	8	1	
Pentact	32	80	80	40	10	1

By use of the same technique, this table can be extended indefinitely, to show the number of elements in hypercubes of higher order.[1]

Let us now consider our pasteboard three-dimensional model of a tesseract. Referring to Figure 2, we see that, in this pictorial representation of a cube, three of its six faces are invisible. They are "within" (that is, behind) the three visible faces. Similarly, in the case of the cardboard model of the tesseract, 12 of its 24 faces are invisible, being "within" the 12 visible faces.

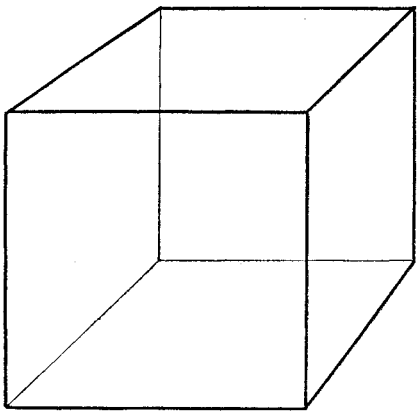


Figure 6: **If a cube were transparent**

If, in Figure 2, we had represented a *transparent* cube (see Figure 6), then all six faces would have been visible. Similarly, if the reader will fasten 32 matches together with sealing-wax, to represent a projection of the 32 edges of a tesseract, he will be able to see all 24 faces of all eight cubes which go to make up this projection of a tesseract into three-dimensional space.

[1] Algebraically expressed, the number of elements of order a in a hypercube of order b is $2^{b-a}b!/a!(b-a)!$. The sum of all the numbers in any row of the table is 3^b.

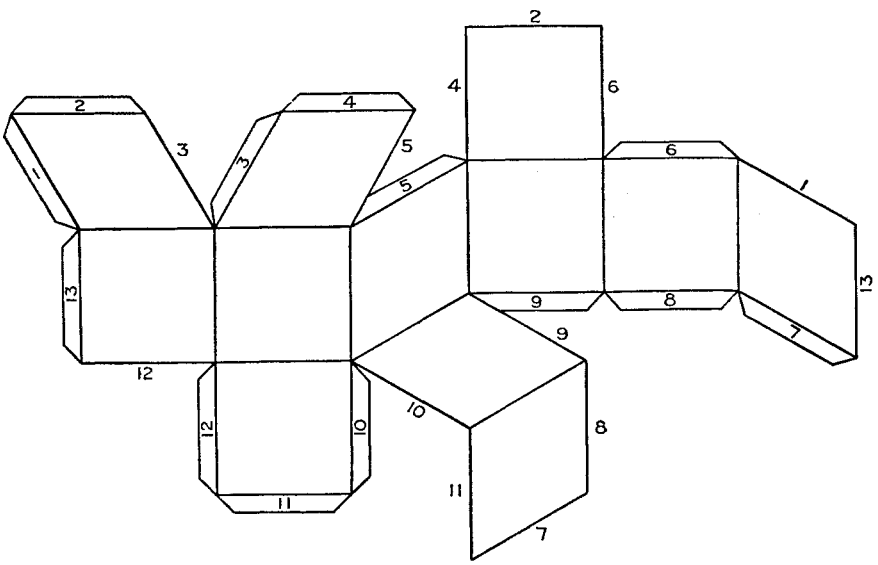


Figure 5: **A reduced tesseract pattern. For convenience it may be enlarged**

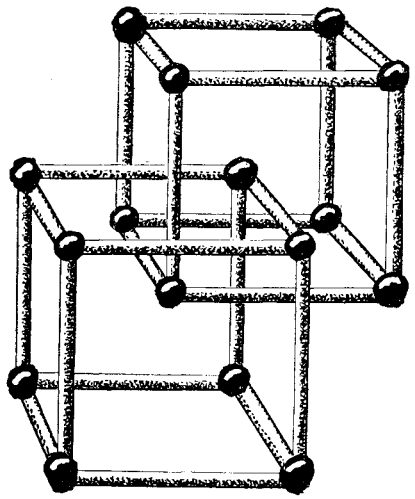


Figure 7: **Building with matches**

To hitch these matches together, first form two cubes, with one corner interlocked, as shown in Figure 7. Then, using eight parallel matches set diagonally, run one of these eight matches from each corner of the first cube to the corresponding corner of the second cube, as shown in Figure 8.

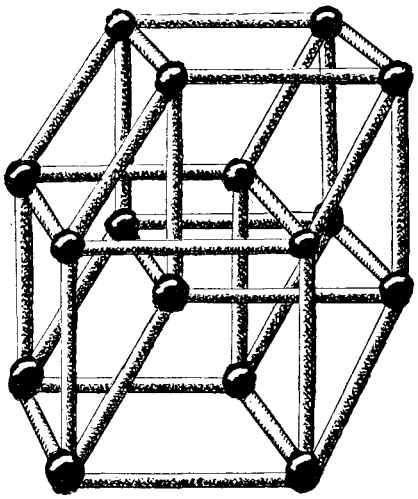


Figure 8: **Containing 32 matches**

As stated at the beginning of this article, I am here expressing no opinion as to whether a fourth *space* dimension does or does not exist. We three-dimensional humans are so three-dimension-conscious that we never can answer this question.

But the match-model of Figure 8 will enable us to visualize exactly what a four-dimensional cube would look like. if there were a fourth dimension and if we were permitted to peer into it.

●

Your Inferiority Complex—if you own one—is the subject of an article to appear in an early number.—The Editor.

How Much Snow?

New Science of Snow Surveying . . . Quantity of Snow in the Mountains Determines Later Run-off Below . . . Knowledge is Vital for Power Plants, Irrigation

By MYRON M. STEARNS and BLAINE STUBBLEFIELD

LAST winter, at 682 different locations in the Rockies and high Sierras, more than 30,000 exact measurements of snow depth and water content were taken, in order to estimate how much water the mountain snowfields would supply in the run-off during summer months. To make this survey cost more than $100,000. On it was predicated the expenditure, and saving, of millions.

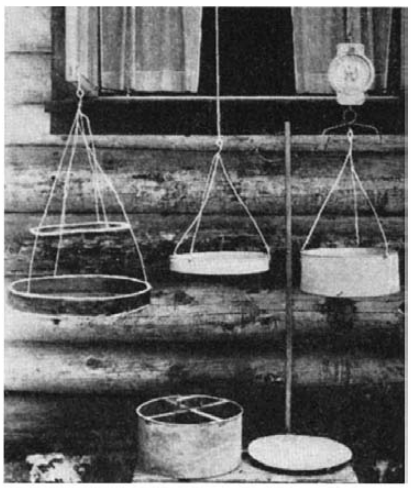
While the science of surveying snow is still in its infancy, its extent and importance are increasing rapidly. Ridiculed at first, in the last few years it has taken on world-wide aspects. To grasp its significance in our western states, picture a series of snow-covered mountain ranges that by their streams make life possible in dry intervening valleys. Abundant snow means abundant water. Abundant water means power, and cheap electricity. More important still, it means abundant crops. Dearth of snowfall in the mountains means dry river beds in August, machinery standing idle, thirsty cattle, and dying plants.

In states where rainfall is fairly constant the year around, extensive snow surveys are for the most part still unknown. But in states where no rain falls from spring until late autumn, stream-flow is the measure of life and prosperity. During years of drought the stream-flow, even in the mountains, sometimes drops to less than a third of normal. In extremely wet years it rises to three times normal.

Power companies build plants only where they can be assured of enough water, season after season, to turn their turbines. Western cities need to know, far in advance, whether or not the water supply for their great aqueducts will meet their demands. Cattle men turn stock into valleys where they know grass will remain green and springs will not dry up. Flood control and soil conservation districts alike need to know how much water they may expect. And even beyond that there are uses for snow-knowledge for which few of us would even think: how large the culverts should be under new highways across the Utah deserts; how deep the water will be in navigable rivers like the Sacramento in California; how far upstream salt tidal waters will force their way, making the current unfit for irrigating delta orchards.

TO make the snow survey, state, federal, and private agencies join hands. Some of the work is supervised by the United States Forest Service, some by the National Park Service, some by power companies. Some is done by cities, by irrigation districts, by utility districts, by private land and lumber companies. California, like several other western states, has a state bureau of water resources. With a slender annual appropriation of $15,000, the United States Bureau of Agricultural Engineering steps in and co-ordinates all the different reports into a single survey for the entire mountain area from Mexico to the Canadian border, and, with the co-operation of Canadian authorities, even beyond the boundary.

In April, forecasts based on the snow surveys go on the main news-service wires. Newspapers print them in full. They are carried in radio broadcasts. Ranchers, hotel keepers, river men, orchardists, western salesmen of farm machinery, automobiles, and almost everything else, store keepers, dwellers along the great sand rivers of the Southwest—all take note and build or modify their plans accordingly.



Evaporation pans used in snow surveying. *Hanging:* Tree pan, ice pan, and snow pan. *Below:* A core cutter for filling the snow pan, and a false bottom to raise the contained snow above the level of the melted snow

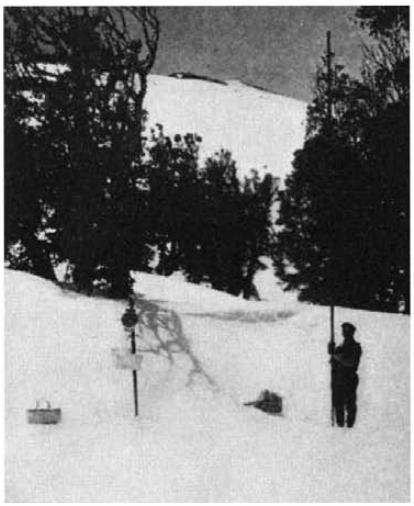
To determine the stream-flow of the great Colorado River into Boulder Dam, snow surveys cover an area of more than 100,000 square miles along 330 miles of mountain crests.

In 1931 the residents of the Humboldt Basin were told that only 51 percent of the normal snowfall had been found at the source of their streams and that, owing to lack of spring rainfall, dry river beds and the like, they could expect barely 10 percent of the normal run-off:

Mt. Rose Observatory, on the summit (10,800 feet) of Mt. Rose, in Nevada, where, in 1905, Prof. J. E. Church established the first western snow surveying camp

no use of planting any late-maturing crops in the Humboldt Basin *that* year. (The Humboldt River rises in the mountains of Nevada, and was described by Mark Twain as being so small that the Forty-niners could run and jump across it for exercise, and then drink it dry to cool off. He might have added that in years of flood they could have sailed over the entire valley for a thousand miles.)

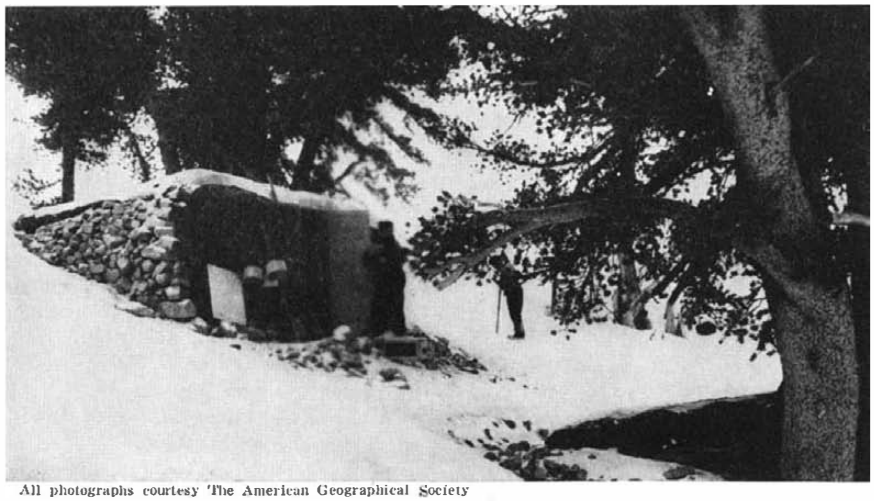
In 1934 the Utah Co-operative Snow Surveys forecast a severe drought in the Utah area. With this warning thus provided in time, diversion ditches were hastily dug to bring water from Bear Lake, on the Utah-Idaho border, to forestall a part of the shortage. It is estimated that, through the timely snow surveys, a saving of nearly $4,000,000 was effected. This is the first time in history that a drought conference was called before the drought.



The height of the snow sampler in the man's hands shows snow depth

The leading snow scientist in this country is Dr. J. E. Church, of the University of Nevada, oddly enough a professor of classics, although endowed with the flaming scientific spirit of an Audubon. That Dr. Church should be teaching literature and art, instead of science, is one of Fate's ironies. Enrolled as a youth at the University of Michigan, he took the classical course because he was told it was the hardest. Upon graduation, he was offered a chance to teach Latin at the young University of Nevada. He has remained there, honored and contented, ever since. But he was interested chiefly in geology, in the beauty of the mighty Sierras, in exploration, in snow.

In the middle of the winter of 1894, on a dare, he climbed to the summit of Mt. Rose, south of Reno, 10,800 feet high. He attempted a winter ascent of Mt. Whitney, highest peak in California and the United States, only to be foiled when near the summit by a layer of soft snow above a harder crust. In 1904 the problem of the value of forests for conserving snow was being bitterly debated. Upon his return from Mt. Whitney, Dr. Church, because of his knowledge of conditions in the Sierras, volunteered to procure data. Under the vision of President Joseph E. Stubbs of the University, and the enthusiasm of Samuel B. Doten, later Director of the Nevada Agricultural Experiment Station, which undertook the task, the funds provided by the newly created Federal Adams Act for research were applied to the problem. Mt. Rose Weather Observatory was born. There was little besides hardship in the undertaking, but it added to his snow-knowledge, which most people still thought utterly useless.



All photographs courtesy The American Geographical Society

At a height of 9000 feet at Contact Pass: A refuge hut and snow survey station made of sand bags. A wall of rocks on the windward side prevents erosion

Then there came a winter of deep snows—1906-1907. Lake Tahoe, which lies in the Sierras between Reno and the California plains, rose far above its normal level. Cabins along the shore were flooded, and boat landings were carried away. Summer cottagers blamed the power company which had erected a shallow dam above the lake's narrow outlet. When other heavy snows impended they threatened to dynamite it. The power company then called in Professor Church to aid them in guessing how much water would descend into the lake the following spring—and American snow surveying, for practical purposes, was born.

THE depth of mountain snows has been of interest for thousands of years, but it was not until the late 'nineties that Russian scientists began melting snow to see how much water it contained. Not its depth but its weight determines what water will run off when snow melts. In this country, in 1900, Charles A. Mixer tried melting samples in Maine. He wanted to forecast the run-off of the Androscoggin River and estimate how much of a stream there would be in the spring to float out logs. Only a short time later Robert E. Horton in New York actually drove a tube into the snow and weighed the snow core.

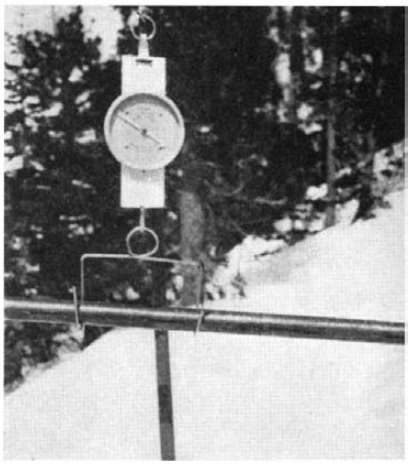
But early estimates based on depth had not been accurate enough. Dr. Church devised a measuring tube known as the "Mt. Rose snow sampler." It consists of a long pipe, slotted along one side so that you can look into it and poke into it. The depth of snow is measured by a scale on the tube. Then, to determine the all-important water content, the core of snow that has been pushed up inside the tube in the measuring process is carefully weighed. The Mt. Rose balance records the net water inches in the snow directly. Thus it is possible to tell how much water there is in a snow field.

Still the job of estimating the total water content of a whole watershed was too complicated. As a short-cut, Dr. Church proposed finding out first what the *average* snowfall in each region was, by comparing records of different years. After that, all they had to do was find out each spring just how much more, or less, than the average amount of snow had fallen during the month. Half as much snow as usual meant that half as much water would run off next summer. The system of measuring snow only in terms of the average snowfall has now also been universally adopted.

Actually, of course, many other factors enter in. For example, the condition of the mountain soil on which the first snow falls—whether dry and porous or frozen after early rains—makes a great difference in the run-off. A succession of clear, windy days during the period of run-off may mean some loss of snow-water through evaporation. A heavy thaw in April, or a cold, late spring, may change the order of run-off materially.

One year Dr. Church's early prophecies were nearly 50 percent wrong. The expected high water did not occur. To Dr. Church, nature had plainly interfered and he prayed that she would repeat the trick. Lack of precipitation during run-off was soon found to be the cause. But the damage was already done.

An irate irrigation project manager became hostile, and federal funds were withdrawn. Had it not been for Major Paul M. Norboe, of the California State Engineering Department, who had enough vision to foresee how valuable snow-surveying would eventually become, much of the work already done would have gone for nothing. As it was, Major Norboe made an offer from the



A Mt. Rose snow sampler, slotted pipe held horizontally in its balance

State of California to buy all the equipment being abandoned, and continue the experiments. Dr. Church accepted the offer with a thankful enthusiasm such as only a scientist can feel. He got Nevada to combine in a limited way with California in support of the snow-survey continuation, and later on, when the value of the work became more and more apparent, the Experiment Station came into the picture again.

The men who make the actual surveys are foresters, water-men, mountaineers. There are more than a thousand of them. They have to be tough. Courses are located at altitudes ranging from 6000 to more than 11,000 feet. Climbing the snow peaks of the Alps, in summer, for fun, is hazardous enough; climbing over the snow-fields of our western mountains, in the dead of winter, to make hundreds of careful, scientific measurements, perhaps with the thermometer far below zero, is more dangerous still.

Although the survey-men regard risks and hardship as all in the day's work, they are never allowed to make their trips alone for, without a companion, a slip might mean even their bones could not be found until spring or summer. Mostly they work in pairs or, on longer journeys, in threes. They are ordered to maintain contact with each other at all times. Usually they travel on skis or snowshoes over snows that lie 10, 12, sometimes 20 feet deep. In 1917 Mt. Rainier had more than 27 feet. A record depth was reported in 1911 at Blue Lakes, source of the Mokelumma River: 36 feet, 2 inches.

Snow banks 30 to 50 feet deep are not uncommon, and in the southern Sierras one mountaineer, in summer, saw ax marks on tree-trunks 35 feet above the ground, where a trapper had blazed his winter trail over drifted snow. In Oregon one drift was found to be 110 feet deep.

Winter temperatures on the mountains are formidable. When gale-driven they wither the flesh. Near the borders of Wyoming, Idaho, and Utah, 50 degrees below zero is often encountered. Sixty-two below was noted in Yellowstone Park. In the Ruby and Wasatch Mountains of Nevada and Utah, swings of 70 degrees in a single day are fairly frequent: from 30 above zero, barely freezing, at noon, to 40 below at night. Climbing steep slopes over deep snow, with heavy packs, the men sweat even when the mercury is below zero; then, stopping to rest, they have to be careful not to freeze their hands or feet.

Shelter cabins are built for the surveyors high on the ranges. They are strong, in order to carry the great weight of snow that may pin them down. One snow surveyor in Oregon carefully measured the snow on the roof of one small cabin in the Cascades, and found it to weigh almost 13½ tons.

SNOWED-UP cabins are sometimes hard to find. To help locate them, shovels are tied high in nearby trees. Chimneys through which a man can descend are built to save the work of digging down to them. In some cabins, to make sure they can be found, a pole is left sticking up even higher than the chimney.

Before a survey trip is ordered, weather maps are studied as carefully as for a transatlantic flight. When conditions seem favorable the men are ordered out. They go as far as they can by auto, and sometimes a few miles farther on horseback. Then the real climb begins on foot. Packs are kept as light as possible. There is a snow sampler, a tube 21 feet long. For ease in carrying, it is made in three-foot sections that can be screwed together. Care has to be taken not to touch the tube with a bare, moist hand when the temperature is very low; the skin would freeze to it instantly.

Surveyors sometimes travel at night to avoid the danger of slides. At Wagon Wheel Gap, Colorado, one surveyor was killed in a slide while his companions were marking snow courses.

The snow courses are from half a mile to three miles long, usually in the form of a letter X. Measurements are taken each year at exact distances, from perhaps 20 to as much as 100 feet apart, at points previously determined, with a total of sometimes 100 samplings for an entire course. Each course provided with a shelter cabin means, as a rule, a three-day trip—one day to get in, one day for snow measurements, and a day to get out. Cabins are stocked with a variety of dried foods, in tin-lined bins to keep out rats. "Freezing," say the instructions, "has no particularly detrimental effect upon any of the above foods"—the list runs from black tea to canned grape fruit—"during the first year."

So important has snow-surveying now become that an International Commission of Snow was formed in 1933, under the presidency of Dr. Church, with more than 170 prominent scientists representing nearly every country in the northern hemisphere and a few from below the equator. The first meeting was held in Edinburgh in 1936, and Dr. Church was re-elected president. Scientific papers were offered that, in printed form, total more than 800 pages. The second meeting will be held this year in Washington.

Sweden, first European country to adopt the Mount Rose system of snow measurement and surveying, is interested in forecasting stream-flow for running logs to saw-mills. Southern Australia surveys snow to forecast stream-flow as a source of power. Switzerland is studying the effect of snow on the formation and movement of avalanche and glaciers. England wants to know more about the effect of snow on the formation of incipient ice-caps. Denmark's

A snow pan protected from falling snow by a special covering or hood

problem is England's in reverse: Danish soil is too sandy and dry, so how can further erosion of soil and snow be checked? Finland is scrutinizing snow-surveys from three different angles: stream-flow for water-power, the relationship between snow and frozen soil, its relationship with frozen harbors. Esthonia, Latvia, Lithuania, and Russia are all interested in the effect of frost and ice on the winter flow of their streams and the choking of intakes. The rivers of all those countries are capable of producing power—but they have to be coaxed.

Our own Department of Agriculture estimates that, through snow surveys and the development of all possible water conservation, the 18,000,000 irrigated acres of our western states can eventually be increased to 50,000,000 acres, an area as large as England.

Now Helium Saves Lives

A Mixture of Helium with Oxygen is Beginning to Be Used by Physicians to Tide Respiratory Cripple Cases, Such as Chronic Asthmatics, Over Their Crises

By NORMAN GOLDSMITH, M. D.

AN infant lies gasping. Something is blocking his air passages. With each effort to breathe, the spaces on his chest between the little ribs become deeply marked. He keeps growing more and more tired. Soon he will stop trying entirely. If there were only some way to lessen the work those tiny lungs must do.

Since 1934, there has been a way—*helium.*

Most people think of helium as an inert gas, discovered in the Sun's spectrum before it was found on earth, whose sole use is for filling dirigibles because, even though heavier than hydrogen, it is non-inflammable and the ghosts of the *Hindenburg* still haunt.

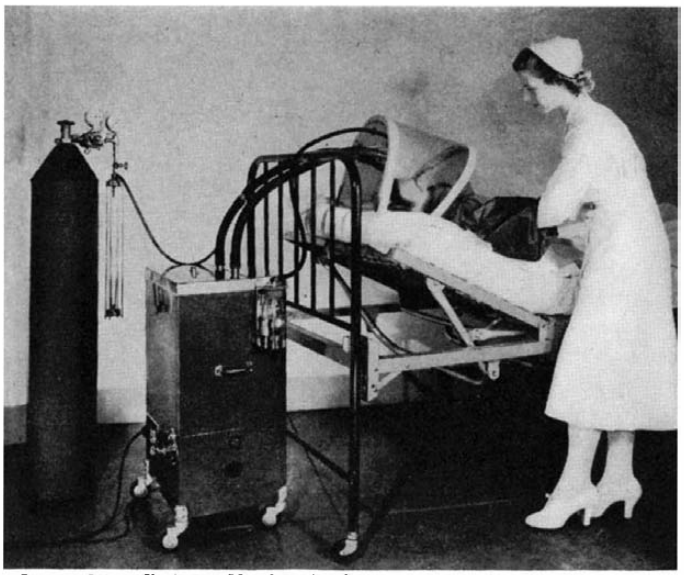
But there is another use. Basically, air consists of 21 percent oxygen and 79 percent nitrogen. Helium weighs only one seventh as much as nitrogen. Hence a mixture of 21 percent oxygen and 79 percent helium possesses certain interesting physical qualities. Thus it has only one third the density of air and, more important, requires only about half the effort to pass through a narrow orifice.

Now what has this to do with a respiratory cripple like the infant referred to or a patient with chronic asthma? It means simply that if overtaxed lungs are allowed to breathe a helium-oxygen mixture, they need do only about half the work as if they were breathing ordinary air. To a well person this may not mean much. Put him in such an atmosphere and his voice will sound very high and an ordinary whistle will reach a lofty pitch, but that is all. For a patient with respiratory struggle, however, anything which takes some of the load away may well mean the difference between life and death.

It all started back in 1923, when Charles Cooke received a patent for the use of helium with oxygen for divers, based on the lesser possibilities of this mixture causing "the bends." Then, in 1926, Sayers and Yant found that animals could be decompressed in a helium atmosphere in one third the time necessary for air.

The major contribution, however, toward the treatment of patients was made in 1934 by Dr. Alvan Barach of Columbia University. To prove that the gas was absolutely innocuous he kept mice in a helium-oxygen atmosphere for two months. The animals thrived and came out of their artificial environment perfectly well. Following this, he turned his attention to humans. Patients have been in such an atmosphere as long as four and a half days and, to prove that there were no harmful effects, he has had professional singers switch from one medium to the other without ill effect.

In what conditions is the helium-oxygen mixture of use? Asthma, certain anesthesia difficulties, any obstruction of the air passages, and asphyxia of the newborn. If we take the infant who was struggling so pitifully, with his rib spaces deeply accented, and place him in the helium atmosphere, his chest wall smooths out and he breathes comfortably. Or take the old man wheezing with chronic asthma, his lung tissues so fatigued that they react no longer to adrenalin. Place him in the new atmosphere and he has time literally to catch his breath. His apprehension diminishes and he may be able to sleep. Such treatment may be continuous for from one to five days or intermittent—a few hours each day. In grave cases, such measures have proved life-saving. Also, the tissues again become able to react to adrenalin and the patient acquires a new lease on life.



Courtesy Oxygen Equipment Manufacturing Company

Apparatus—cylinder, rebreather, tubes, and tent covering patient's head—for supplying the oxygen-helium mixture

Now helium-oxygen is not a cure. It is merely an aid in the same sense that an elevator is an aid to a person with a bad heart or a cane to one with a defective leg. The mixture saves work and, when the patient comes out, the temporary rest may give him enough strength to carry on himself. Further attacks for a while may be less frequent.

How much does helium cost? All helium is owned by the United States government but special dispensations have been made for its use by practising physicians, an interesting contrast to the government's refusal to sell the gas to Germany for a possible war use. The gas is sold in cylinders which contain about 200 cubic feet, an ample quantity for one patient for 24 hours. The charge for this is between $10 and $14, depending on freight distances.

Distribution is through the same channels as oxygen, there being approximately 50 oxygen supply companies in the New York area alone. The giving of helium is more difficult than that of oxygen since it is necessary to maintain the actual concentrations of the two gases without any inward leakage by nitrogen. This is obtained by a special hood tent which fits around the neck. Special accessories permit considerable salvage for rebreathing, as shown in the illustration on this page.

Already the helium-oxygen mixture has been employed, in addition to New York, in Washington, San Francisco, Boston, Cincinnati, and at the Mayo Clinic.

BISKUPIN

By J. KOSTREWSKI

THE village of Biskupin is situated in the northern part of Great Poland, 65 miles to the northeast of Poznań and to the southwest of Toruń, the capital of Polish Pomerania. Nowadays it is famous, not only in Poland but throughout the world, for the remarkable discoveries made in its vicinity by the Poznań University Archeological Expedition. Excavations have been carried on for four years, and have revealed the ground plan of a prehistoric stronghold which was built on a peninsula jutting into the lake of Biskupin, on the surface of a former peat bog, in the Early Iron Age, between 700 and 400 B.C. but abandoned in consequence of its inundation by the waters of the lake. The site was covered with a thick deposit of sand and mud, which protected the remains against atmospheric influences, while the dampness of the ground caused the preservation in excellent condition of the lower portions of the huts and the wooden defensive works, as well as the roads and breakwaters.

During the Bronze and the Early Iron Ages a great part of western and central Poland as well as eastern Germany was inhabited by an agricultural people known as the Urnfield people, of Lusatian type, and who are considered by nearly all Polish prehistorians as ancient Slavonic. Being threatened with invasion by the cist-grave and face-urn people of Pomerania, who were probably of ancient Baltic stock, they took refuge in forts constructed of wood and earth placed in inaccessible spots, for the most part on islands and peninsulas. Nothing but the necessity of defense can have induced the prehistoric inhabitants of the neighborhood of the present Biskupin to establish themselves on the damp and peaty peninsula extending into the lake, which was both unhealthy and unsuitable for building. This peninsula, surrounded on three sides by the lake and cut off on the land side by a broad strip of marshy ground, was further fortified, as the excavations hitherto made have indicated, by a wooden rampart filled with beaten earth, which was carried round the whole site. This rampart was built three times, and each time nearer to the center of the peninsula. Only small fragments of the earliest and northernmost have survived; it was clearly destroyed by water. Later the area enclosed within ramparts was reduced and the first breakwater constructed, and within its shelter a second rampart was raised. When this latter was partially destroyed by fire, it was replaced throughout a considerable length by a third, rather narrower, wooden rampart eight feet wide, running parallel inside and south of it, which however is not continuous, but is interrupted by a row of huts, because the old rampart was well preserved at this point. It was constructed of beams, overlapping and placed crosswise, chamfered at the intersections for security, and supported by piles driven in vertically on the inner side. The result was two or three rows of caisson-like chests, which were then filled with stamped earth. Considerable remains of the middle and latest rampart, in places as much as three feet high, have been laid bare in the north and east of the peninsula, while on the south the rest of the rampart, which once prevented access on the land side, can even now be clearly identified.

ALONG the middle rampart a row of piles were driven in obliquely to protect it against the undermining action of the waves. Farther toward the lake is a double row of similar piles, constituting the oldest actual breakwater, and beyond it again another, consisting of seven or eight rows of great piles driven obliquely into the edge of the lake and strengthened by the imposition of horizontal beams. The innermost of these breakwaters is considerably lower—perhaps two and a half feet—than the second. Obviously, then, the original low breakwater had to be replaced by a new one, higher and a little farther toward the lake, owing to the rise in the water level. Access to the rampart was facilitated by a circular street running along the inner side of it, and three great piles, driven into the edge of this road at a point where a sharp turn rendered it difficult to build a house, seem to have supported a kind of gangway leading on to the top. Within the latest rampart were found heaps of stones, apparently laid there to be hurled against an advancing enemy.

The area thus fortified was occupied by a populous settlement, composed of from 80 to 100 huts, built on a layer of birch fascines resting on the surface of the peat-bog. The ground plan was laid out in a masterly fashion which would have done no discredit to a modern town planner. In the area so far excavated eight perfectly parallel roads or lanes have been laid bare, running from west to east and connected by an outer one, running round in a half circle within the rampart. These lanes were of corduroy construction, that is to say, made of thick oak logs. On either side of each street were rows of wooden huts standing end to end and actually touching. Indeed there was frequently only a single common end wall. The huts were about ten yards square, and their doors, sometimes eight feet across, were always on the south side, evidently serving to let in light. These huts usually contained two rooms; a main one with the hearth and a vestibule, six or eight feet broad, which took up the whole front. Sometimes, the main space was divided into two compartments; one, smaller than the other, having perhaps served for the accommo-

Photo by W. Koczka

Remains of wooden ramparts at Biskupin, surrounded by the expedition's dyke. Remnants of the earliest ramparts show at right—successive ones to the left

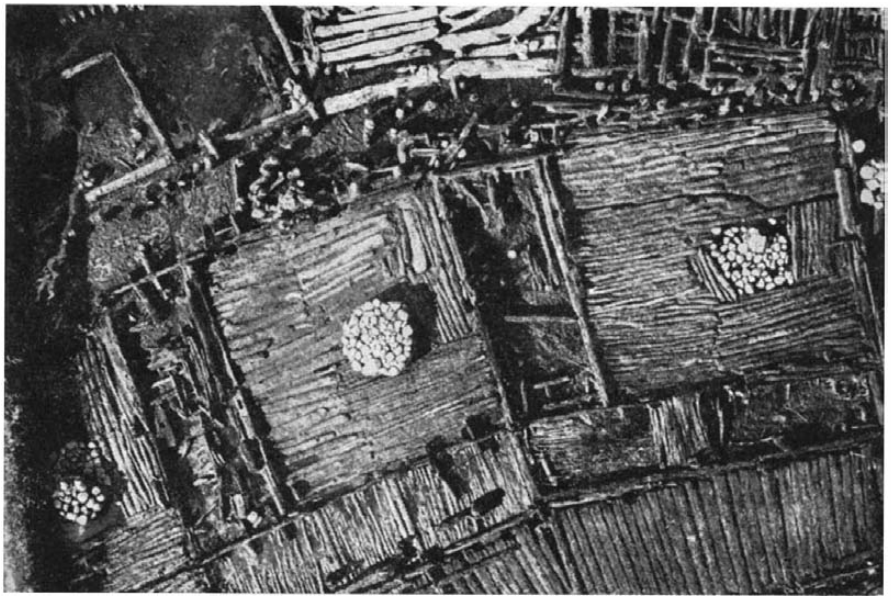
From *Antiquity*

dation of cattle or as a sleeping-room. To the right of the entrance, in the main room, was the round (rarely square) hearth, most frequently made of stones and as much as six feet in diameter, but occasionally of nothing but clay. The floors were composed of wooden beams resting on fascines of crossed or sometimes interwoven birch sticks and branches, and were covered with a layer of clay to diminish the danger of fire. The stone hearths themselves were also overlaid with clay, which preserved them from being blackened or split by the heat.

All the houses are built on the same plan. At the corners are placed round posts of pine, in each of which are cut two vertical grooves, running the whole length of the post, an angle of 90 degrees separating the one from the other. Between these corner posts are flat ones, usually of oak, with two vertical grooves. Into these grooves are fitted, one upon another, beams or rough-hewn planks with flattened ends. In some of the better preserved huts as many as three still remain in position. The door posts were also grooved on the outsides, their door sides being smooth. At the bottom all these posts were supported by cross pieces running through them and projecting on either side, to prevent them sinking in the peat-bog. This method of building is still employed in various parts of Poland, and even at Biskupin itself there is a peasant's cottage constructed on exactly the same principle, so it may be that an ancient building tradition has been preserved for 2500 years. As the upper parts of the huts have been destroyed, it would have been impossible to estimate the height had not two or three posts from destroyed ones been preserved by being used a second time in the floors or the lower parts of the walls. Some of these are 13 feet long, so that, allowing for three feet in the bog, the height of the walls was probably ten feet.

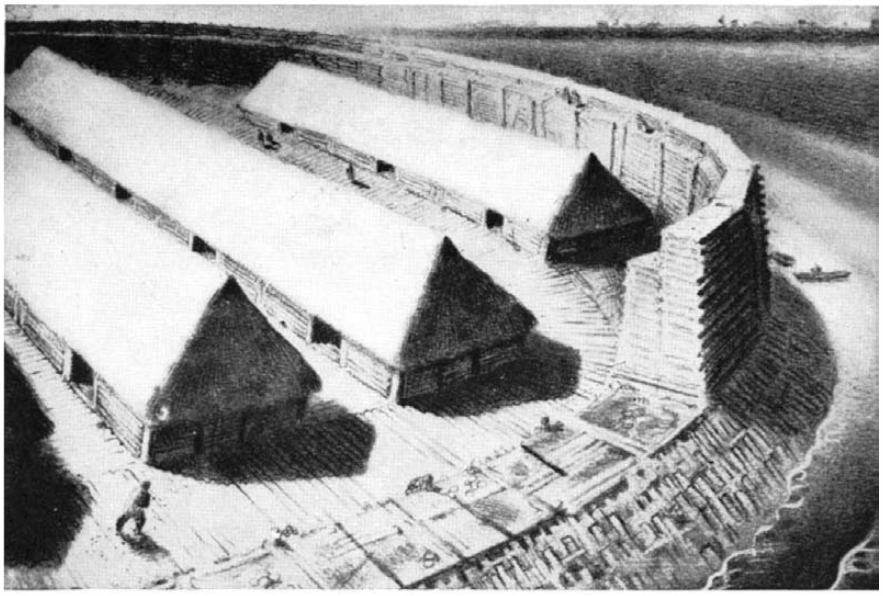
A number of observations go to show that the huts excavated at Biskupin are not all of one date. Huts were frequently destroyed by fire, and new ones built on the same site, in which case remains of the old ones were so far as possible incorporated in the new. In some, therefore, we find two door posts side by side, or two corner posts, or flat wall beams from two separate huts that were built in succession on the same site; indeed there are occasionally remains of three huts built one after the other on the same site at different periods. Two floors and two hearths, one above the other, are found comparatively frequently, separated by a layer of soil 12 to 20 inches thick, and there are a few examples, especially in the lower or northerly portion of the area, of two or three levels in a street. In either case the lower level, alike in hut and street, is solidly constructed of thick oak trunks while the upper is carelessly and hastily composed of thin birch poles. These later road and floor surfaces are evidently to be connected with some great flood which inundated the settlement and compelled the inhabitants to raise its level. When this settlement was founded the level of the lake must have been considerably lower than it is today, even though it was markedly lowered a few years ago by the deepening of the Gasawka stream, which runs through it. Evidence of this is found in the fact that the hearths of many huts which have been excavated are now below the surface of the lake. During the course of the settlement's existence, however, there must have been a marked increase in the volume of water in the lake, due not only to local causes such as the silting of the bed of the Gasawka, but also to a general increase of rainfall; for the researches of paleobotanists show that in the Early Iron Age the climate of Poland, in common with that of a considerable part of Europe, was steadily becoming damper and colder. Our excavations confirm this for the northern part of Poland. The influx of water due to the increased rainfall seems finally to have become so great that the inhabitants abandoned the flooded site. But that which was a catastrophe for them has turned out a blessing for archeology. For, although everything which was above water level has been completely destroyed, the foundations and lower parts of the huts and the other constructions, covered with

The Excavation of an Early Iron Age Village in Eastern Europe Brings to Light Artifacts Showing the Daily Life of a People of about 2500 Years Ago



Vertical view of two huts comprising three rooms; also the middle rampart

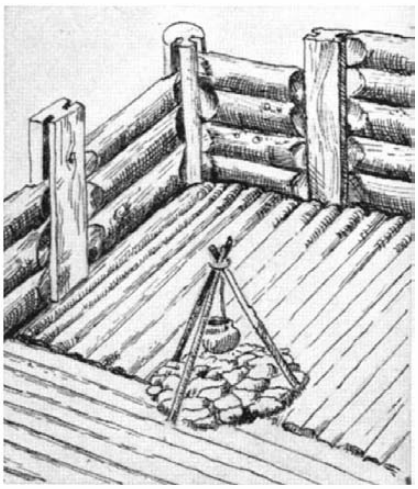
At left center, entrance to a hut; at left top, some of the ramparts and, at the extreme left, part of the circum-peninsular road or street



A reconstruction of the northern part of the village, as drawn by W. Boratyuski

water and earth, have been preserved almost as they were left 2300 years ago.

This protective layer of sand and mud has also preserved a large number of tools, ornaments, and weapons used by the ancient inhabitants, and even a few pieces of furniture such as the lower part of a family plank bed discovered in one of the huts. Pottery especially is very well represented. Besides coarse ware there are some very beautiful, richly ornamented specimens: for example, incised vessels encrusted with white material or painted with red ochre, lumps of which have been found on the site. Two vessels are decorated with very conventional figure-drawings: a few riders, and a hunting scene with several horsemen and two stags. There are numerous bronze objects: 40 pins, some of them swan-necked, a few bracelets and small rings, needles, fishhooks, a razor, tweezers, double cone-shaped beads, buttons, and many other objects. Iron socketed celts, sickles, awls (one of them still in its bone handle), needles, a bridle bit and pins have been found; as well as horn and bone awls, mattocks, large hammers with square holes for the handles, socketed spearheads, tanged arrow-heads with barbs, smoothing tools, and so on. Wooden implements include swirling sticks, pestles, two kneading troughs, pine bark floats for fishing nets. The most interesting wooden objects are a primitive plough, a solid wagon wheel of Mercurago type, made of a single block of wood, with a square hole for the axle and two semicircular openings cut out on either side, strengthened by two strips let into the wood across the grain, an oak axle from a cart, and three wooden gratings, one of them lined with wicker, which were doubtless used as hut doors. Other finds include blue glass beads, most probably imported from Egypt, various stone implements such as pentagonal celts, circular and triangular tools the purpose of which is unknown, but which may have been used to smooth earthenware vessels or to prepare hides, querns and grindstones, clay implements for spinning and weaving, whorls and loom weights, and clay toys. The numerous carbonized grains of corn, wheat, barley, millet, pea, and vetch which have been found, and fibers of flax, point to the agricultural character of the population. The bones of domestic animals found show the importance attached to cattle breeding. Wild creatures are represented mostly by the stag and the hare, more rarely by the bear, and occasionally by the wild boar, the wolf, the fox, the beaver, the wild duck, and the hawk. Fish bones occur but rarely. Other occupations of the people are clearly illustrated by the discovery of clay molds for casting necklaces, pins, and the like. They are all of the so-called *cire-perdue* type, that is to say the clay was plastered around the wax model; and, after casting, the mold had to be broken in order to get at the object. Such models, for this process, have not hitherto been found elsewhere in Poland.



Showing the original method of construction of the huts at Biskupin

The excavations at Biskupin have given us for the first time a conception of the appearance of a complete prehistoric Polish settlement, and have thrown new light on the material and social culture of the Urnfield people of the Lusatian culture. Only a well-disciplined body of men under energetic leadership could establish such a settlement and build it according to a unified and well-thought-out plan. It has sometimes been supposed that the Lusatian culture disappeared as the result of over-refinement and consequent decadence; but the discoveries at Biskupin give us a very different picture. The frequent occurrence of horn and bone implements on a site dating from a period of the highest development of the Lusatian culture, when bronze was beginning to be superseded by iron, offers a perfect analogy with the frequent use of horn and bone implements by the early historic Slavs—between A.D. 600 and 1000—who also raised similar strongholds and showed a similar tendency to settle on low-lying ground exposed to inundation. The most striking fact is that huts of identical construction are in use today over the whole area once occupied by the Lusatian culture, especially in Poland. There are some, indeed, quite close to our site, at Godawy, on the east bank of the lake of Biskupin and at Biskupin itself. A similar hut, dating from the late Middle Ages, was excavated in 1935 at Kcynia in the district of Szubin, and another dating from the 17th or 18th Century, at Ostrowo near Gebice in the district of Mogilno; and it may be therefore supposed that the type has existed in Poland continuously from the Early Iron Age down to the present day; if this is true it supplies one more proof of the Slavonic origin of Lusatian culture.

THE complete examination of Biskupin will take several years, for the site covers over six acres, of which only one third has so far been excavated. The best preserved portion, it is hoped, will be properly protected and kept as an object lesson for future generations. The archeological expedition lives on the spot in a camp of its own, containing a workshop, a dark room for photography, rooms for drawing, and so on. The whole site laid bare is mapped on a scale of 1:10 and several hundred photographs have been taken from ladders and from a balloon. The expedition has reconstructed two huts on the original plan, one of which serves as a museum, where the most interesting finds are exhibited.

●

Coming soon: The inside story of television as it will be presented to the American public in scheduled broadcasts to start this spring.—The Editor.

Factory 'Magic'

Ingenious Factory Process Solves Old Problem . . . Lower Cost . . . Transformer is Significant

NO basic change has occurred in the design of the transformer, inert device for increasing or decreasing voltage of alternating current circuits, for more than 50 years. Back in 1886, at Great Barrington, Massachusetts, William Stanley developed and put into first practical use a transformer which, except for certain refinements, is the same in construction and principle as those in use today.

Now, however, a transformer developed by the General Electric Company, embodying an entirely new construction principle, has been placed on the market. Although the operating advantages of the new type transformer, as well as its lower production cost, are economically significant, the manner in which the device is made is the more intriguing.

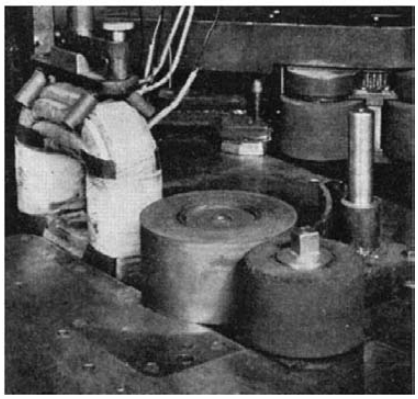
The transformer is known as a "wound-core" type and embodies the solution to a design problem that has stumped the best engineers in the field for years. Its method of construction savors of the magician's stunt of linking together two seamless (?) steel rings and, like the secret to most tricks of legerdemain, is unbelievably simple.

Unlike old-type construction, the two sides of the wound-core's oval-shaped primary and secondary coils are each encircled by a core consisting of a tightly compressed, ribbon-like winding of thin, silicon-content steel. Unless closely inspected, the core and coil assembly might give the impression that two close-fitting iron rings have been miraculously interlinked with the oval coil assembly.

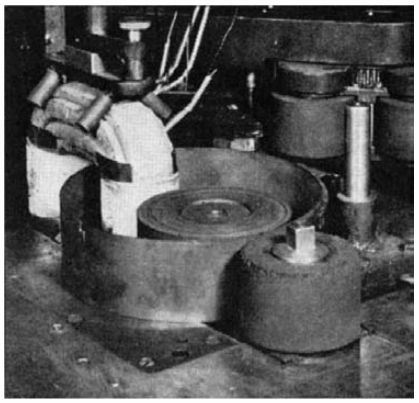
Actually, the steel cores are spirally wound about the copper coils by a specially developed machine which accomplishes the feat efficiently in a matter of a few minutes, as compared with the appreciably longer time required to hand-assemble the L-shaped steel punchings regarded as most efficient for the core construction of old-type transformers.

This accomplishment of winding the cores about the coils seems like a process that should present no great difficulty, and it wouldn't—except for the fact that the pre-wound shape of the core must be retained throughout the process. The outer turn of the core in its pre-wound form must be the outer turn of the core after it has been wound on the coils; and the inner turn must likewise remain the inner turn after the winding process is completed. This precaution is necessary because the spiral cores have been "set" in their pre-wound shape by carefully controlled annealing operations to retain the superior magnetic qualities in the steel. If the form of the core is too greatly disturbed in the winding process, small elastic stresses are caused and may increase the electric losses in the core steel by as much as 15 percent. Reversing the order of the turns might increase these losses as much as 25 percent!

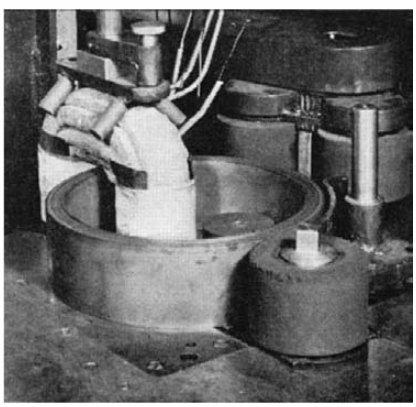
In the winding process, the pre-wound core is placed on a post adjacent to the coil assembly on the special machine. Then the outer turn of the spiral core is passed through the "window" formed by the coil winding, brought around in a fairly large loop, and tack-welded to the next underlying strip of the roll. By means of a series of revolving rollers, both the core and the large loop which has been formed by its outside turn are rotated. In this way the strip is unwound from the post and simultaneously rewound about the coil in its original form. The same operation is repeated on the other leg of the winding, and presto!—the transformer assembly has assumed its misleading semblance of the linked rings of the magician.



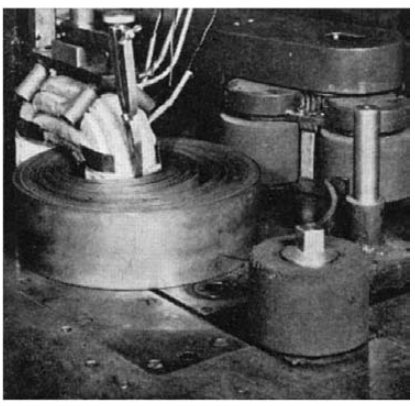
Process begins with pre-wound metal strip core on revolving post



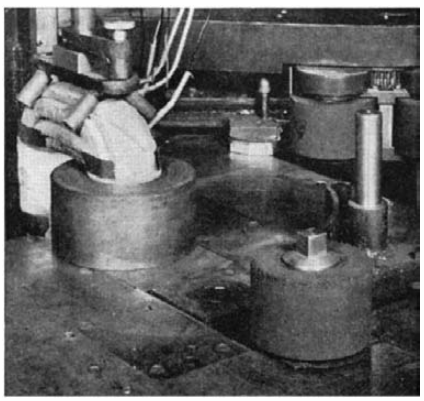
End of strip threaded through coil window and loosely around post



All of strip is unwound from post and is loose loop through window



Post retracted, the inner end of core strip is pulled in around coil

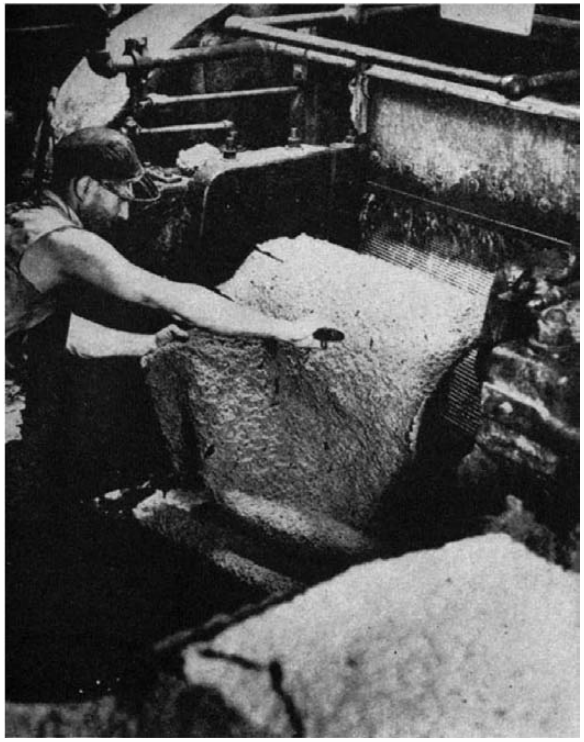


Outside rollers now roll the strip into a tight spiral around the coil

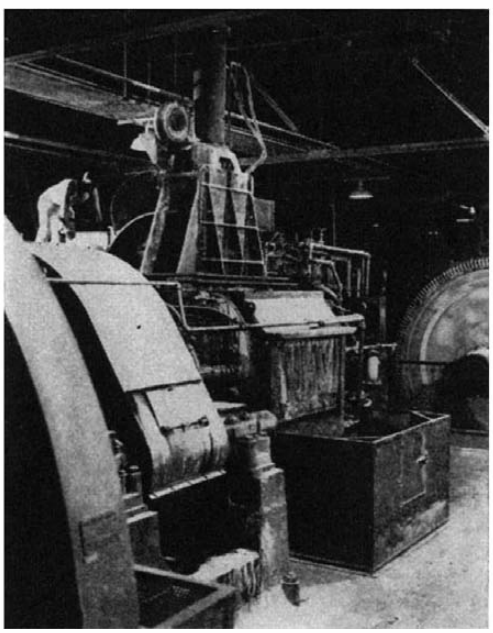
RUBBER TO COTTON

Rubber Thoroughly Cleaned . . . Ingredients Mixed . . . Cotton Cords Individually Coated With Rubber . . . Wire Beads . . . Treads Extruded in Slabs

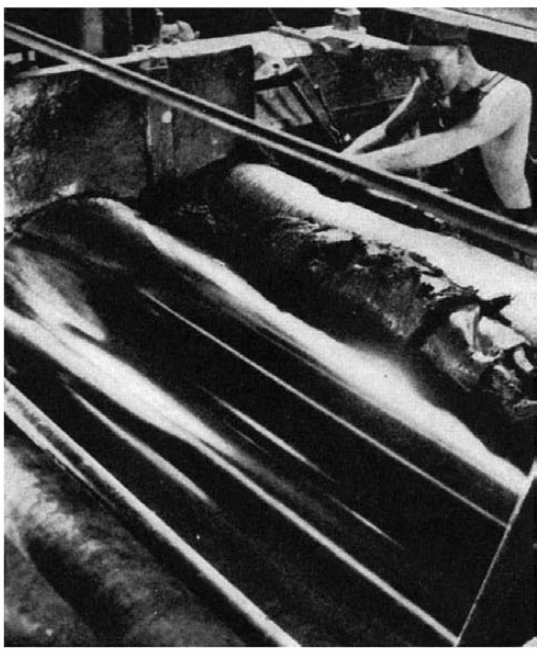
By A. P. PECK



1 Foreign substances are removed from the crude rubber that will eventually become part of one of your automobile tires. In this machine the crude rubber passes through close-set rollers which chew the rubber and expose many surfaces for cleaning by a spray of water

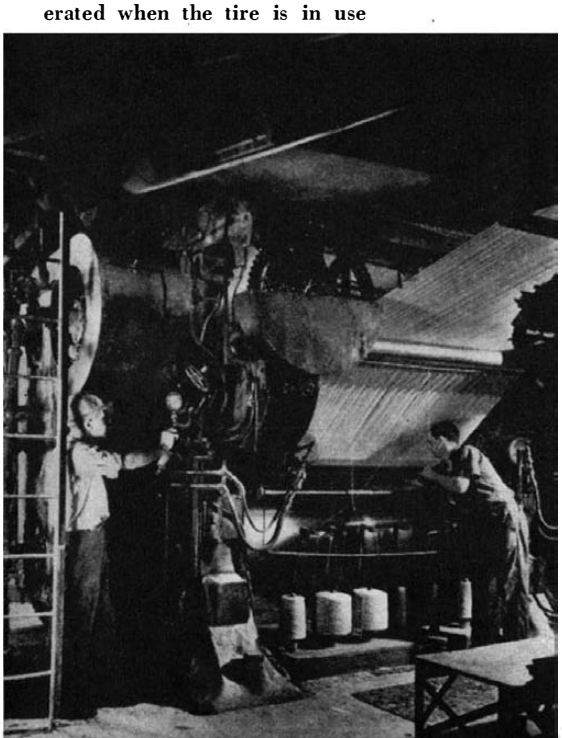


2 *Below:* The cleaned raw rubber is next worked into a plastic condition, after which it is combined with other materials, necessary to tire wearing qualities, in a machine such as that shown

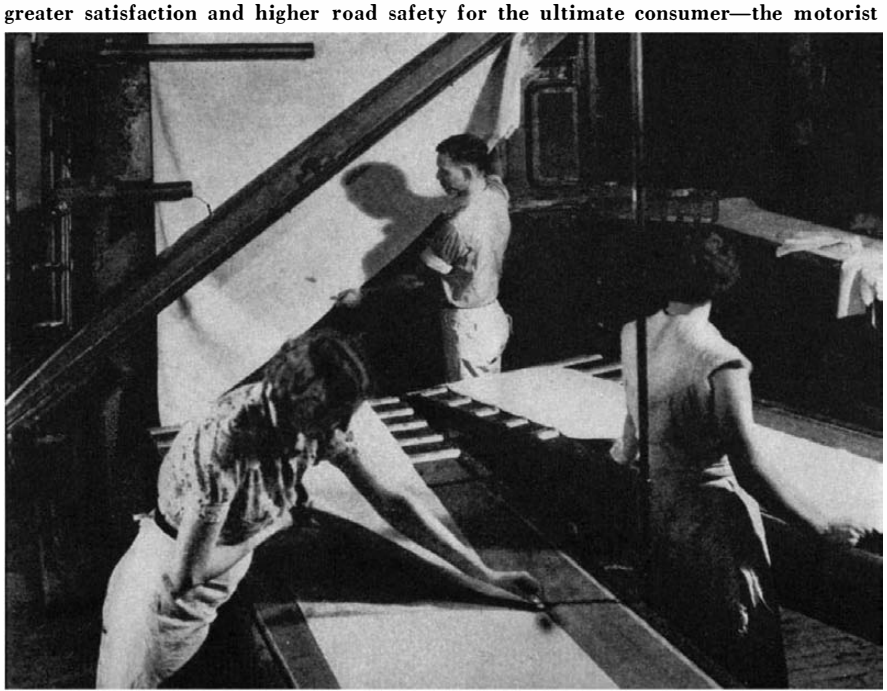


3 Among the basic machines in the tire manufacturing industry is the rubber mill shown above. Here the mixture made in the machine shown at the left is passed between rollers so that the raw rubber and the added ingredients are compounded thoroughly. If this is not carefully done, mixing will be incomplete and the finished tires will not be wholly satisfactory

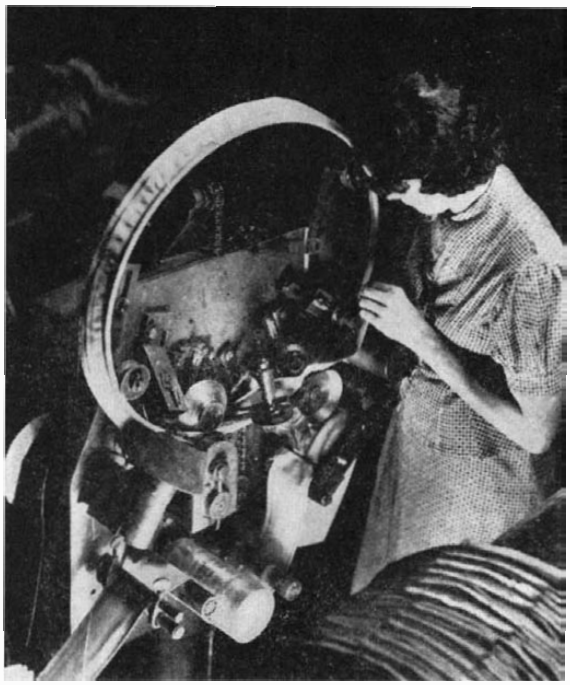
4 Cotton now enters the picture. From it is made the cord which, in the illustration below, is being covered with rubber, each individual strand receiving its coating. Thus cord and rubber are merged to form the tire fabric. This type of construction is considered to be an important safeguard against tire deterioration through heat generated when the tire is in use



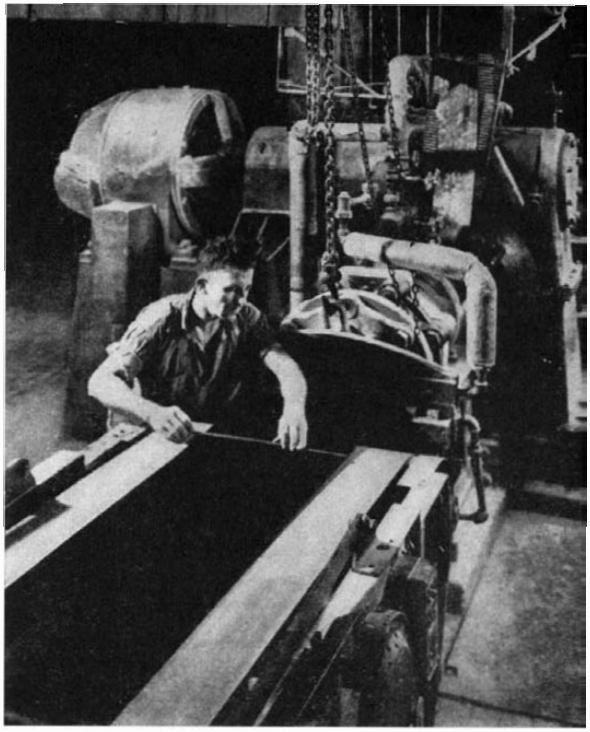
5 Sheets of tire fabric, formed of rubber impregnated cords, are cut to specified widths and angles as shown below. Practically all fabric now u in tire construction is cut on the bias on machines such as this to afford strength and flexibility, and hence greater satisfaction and higher road safety for the ultimate consumer—the motorist



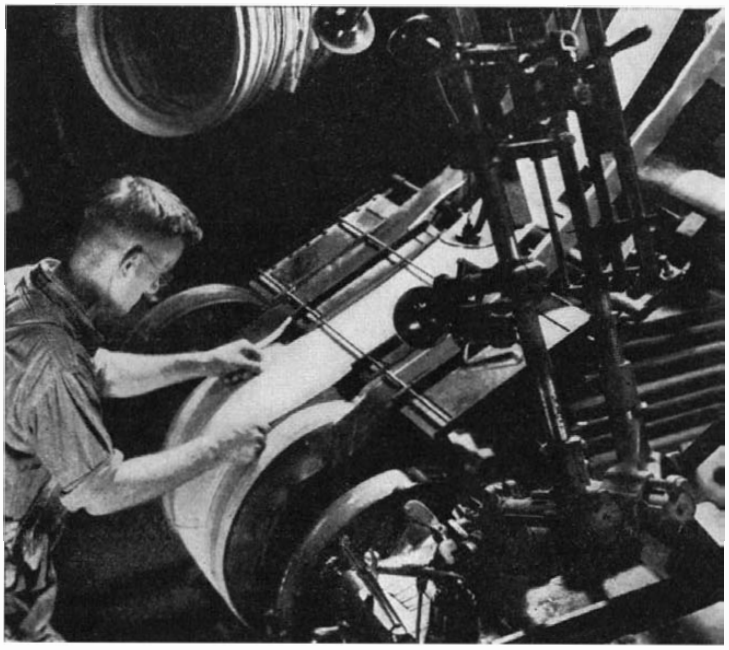
TO TIRES



6 The bead or edge of the tire is formed of woven copper wire, incased in a sheath of rubber and fabric. There are approximately 137 feet of this wire in the bead used in an average size modern passenger car tire



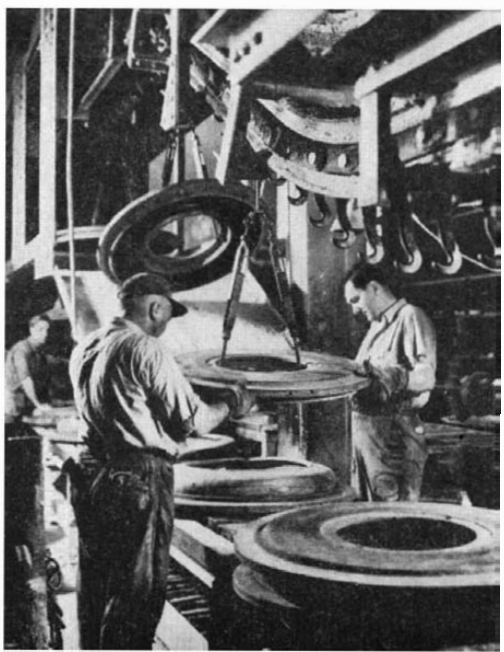
7 *Right:* Preparing the strip of rubber which eventually will become the tread of a finished tire, bearing the distinguishing design of its manufacturer. Here the rubber batch is placed in the machine and extruded as a slab of rubber of the desired width. The tread is then ready for application to the completed tire body



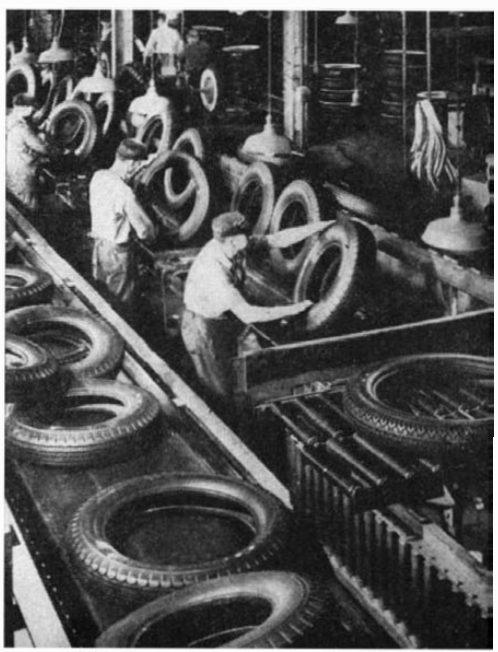
8 *Right:* A skilled workman in one of the plants of the B. F. Goodrich Company is assembling the various parts of a tire built by the "drum" process. The layers of cord are rolled smooth and the beads with their re-inforcing strips are tied into the carcass. After breaker strips, cushion, and tread are applied, the drum is collapsed and the uncured tire is removed

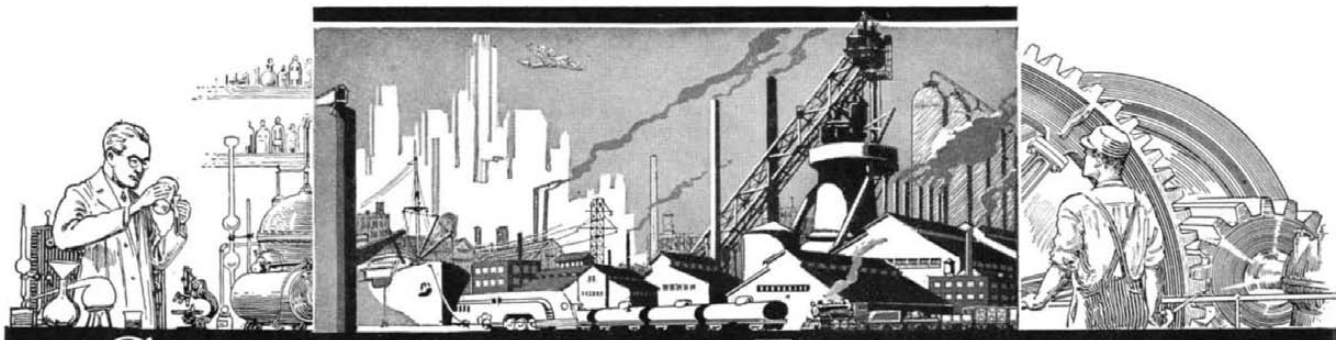
9 *Below:* The forming chamber where the tires built by the drum method are shaped. The casing, as it comes from the assembling drum (see 8, above), is placed in this chamber and a water bag inserted by means of a ram. Pressure built up in this bag forces the tire into the circular shape in which it will be vulcanized

10 *Below:* The shaped but uncured tires are here placed in steel molds where the tread design will be impressed. Still in these molds, the tire is vulcanized by steam and hot water



11 *Below:* Finished tires pass before a group of inspectors whose sharp eyes detect any minor imperfections that might injure the serviceability of the tire





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

Invisible Glass

GLARE from reflected light, which makes it difficult to see pictures framed under glass at certain angles, has been removed by a new process developed in General Electric's research laboratory by Dr. Katharine B. Blodgett. By applying thin chemical films to the surface of glass, Dr. Blodgett has been able to nullify or neutralize reflected light rays with the result that pictures framed with glass so treated appear as though there was no glass at all, regardless of the angle of view. The same is true with clock faces, show cases, display windows; in fact, any place where glare is caused by light reflections on glass.

Dr. Blodgett demonstrating how the anti-glare surface is put on glass

The refractive index of any type glass is easily determined. This known, the process consists of building or attaching to the glass a very thin transparent film of about four millionths of an inch, or exactly one quarter wavelength of light, in thickness. As light falls upon the film, rays are reflected from both the upper and lower surfaces. With the film exactly one quarter wavelength in thickness, those rays coming from the outer or upper surface are equal in intensity and opposite in phase to those rays reflected from the lower surface, and counteract one another; thus no light is reflected.

"The process is still in a laboratory stage," Dr. Blodgett explained. "At present it has not reached such a stage that it can be offered the public. However, we are hopeful that we may soon do so.

"Glass is treated by dipping it into a tank of liquid, on the surface of which is a film of insoluble soap but one molecule thick. As the glass is pushed down one layer of the film becomes attached and as it is pulled up another is applied. Thus each immersion adds two layers of the film, each but one molecule thick. The dippings are continued until we have built up about 44 layers which form a thickness of one quarter wavelength, or about four millionths of an inch. We can measure or determine the exact thickness of the film at any time, although it may be thinner than any substance we know of today, by an optical process.

The clear part of this framed portrait is covered with the new invisible glass, the rest with ordinary glass to show the difference

"The non-glare treatment of glass also promises to have a wide-spread application in the field of camera, telescope, and all other type lenses," Dr. Blodgett pointed out. "It is commonly known that reflection from the surface of any lens causes from 4 to 5 percent loss in the light transmitted. Since this is true to both front and back surfaces, there is a light loss of at least 8 percent in each lens. With some of the better type cameras, using three or four lenses, the loss of light reaching the plate or negative is 25 to 35 percent. With telescopes and submarine periscopes, where a larger number of lenses and prisms are used, the light loss is still greater. In some periscopes it is as much as 75 percent.

"With the exception of the slight loss by absorption in the glass itself, the film-treated lenses would transmit 100 percent of the light. With an actual test in the laboratory, a piece of glass was treated and by doing so we increased the light transmission from 92 percent to 99.2 percent."

Welded Metal Sculpture

A WELDER, and a good one, is F. F. Nichols of David City, Nebraska. During the summer he has little time for hobbies but in the winter months he takes a hand in some unusual creative work of his own.

No soap sculpture or basement workshop

Figures created by welding

carpentry for him. Turning away from repairing castings of massive proportions, Mr. Nichols takes up his oxy-acetylene welding blowpipe, some steel welding rods and some bronze ones, a few additional light sheets of steel, and sets to work fashioning small metal figures depicting life and action in the old West. These figurines have a vitality and vigor that might be found in the work of a craftsman of the Renaissance. Yet the hands and equipment that shape them are the same that each year repair and fabricate tons of heavy industrial equipment.

The solid body portions are built up with a melted steel rod and then given a lustrous coating of bronze with the bronze welding rod. Exact blowpipe control of the direction of the intensely hot flame and skilful manipulation of the welding rod make possible the careful shaping of each figure. The patina, or surface color of the bronze coating, is obtained by varying the flame to get different effects of shading.

AFTER DEATH

ELECTROCARDIOGRAMS have shown that the heart beats for as long as half an hour after a person is, to all appearances, dead. The stethoscope is not reliable as a means of determining whether the heart's action has ceased. Artificial respiration should be continued until rigor mortis sets in.—*Health News*, New York State Department of Health.

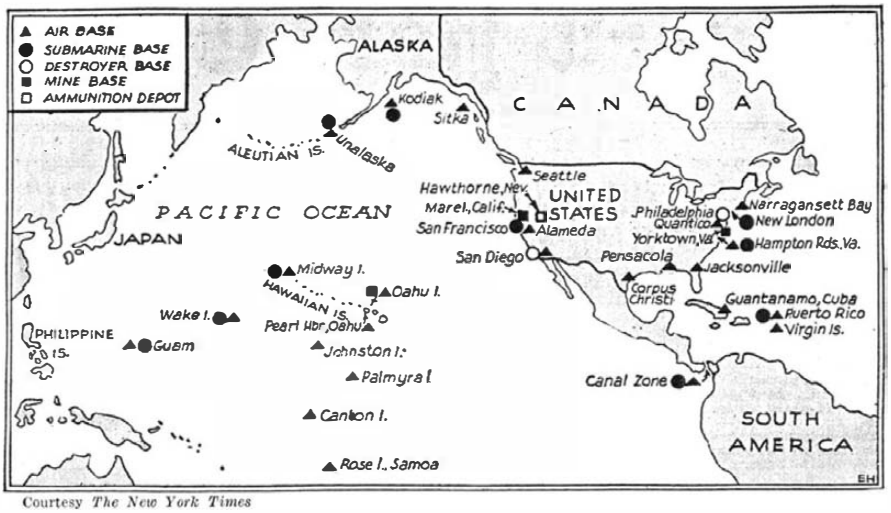
Light-Weight Freight Cars

ANTICIPATING the need for light-weight freight equipment, American Car and Foundry Company has developed two new designs of modern light-weight welded steel freight cars. One is a 50-ton all-welded alloy steel box car and the other a 40-ton welded-riveted refrigerator car.

Low alloy, high-tensile, corrosion-resisting steel has been used to the fullest extent practicable in both types of cars, the thickness of plates and shapes being reduced to a minimum while still providing adequate strength. The light-weight of the box car is 37,500 pounds and that of the refrigerator car 44,200 pounds. This represents a reduction in weight of approximately four tons in each design.

New developments incorporated in the all-welded box car include steel ends with extra long corrugations extending around the body end posts, steel doors of increased rigidity, and a new design of under-frame having integral all-welded construction.

New developments in the welded-riveted refrigerator car, in addition to those mentioned above, include ice bunker, ice hatch, removable steel bulkhead, a unique and very efficient application of insulation, and a new and economical method of using dry ice in combination with water ice.



Courtesy *The New York Times*

Careful study has been made by a Naval Board of the coastlines of the United States and its possessions. This Board recently made its report to Congress. The above map shows the Board's recommendations as to sites and types of bases which are deemed necessary. Because of the desire to unify our defense plans, most of these bases will be approved and construction work will be started without delay. At least the nation can count on a vast extension of our system of air bases

Slag in Glass

IN India, where soda ash is relatively expensive, experiments have been made to show that the slags of iron and steel plants can be used in the manufacture of glass for many common articles. The slag used is supplemented by orthoclase feldspar. Reduction in the cost of common glass, as made in India, of as much as 50 percent is reported. The glass has been used for bottles, jars, tiles, and such articles.—*D. H. K.*

Peru's Good-Will Offer

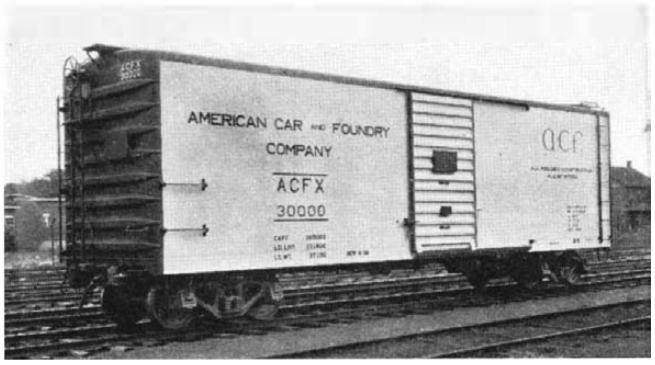
DURING the recent session of the Pan American Conference at Lima, Peru, the New Orleans office of the Pan American Society of Tropical Research received an official communication from the Honorable Pedro Recavarren C., Director of Agriculture of the Peruvian Government to the effect that the people and the government of Peru desired to make a good-will gift offering, to the citizens of North America, substantially as follows:

"In celebration and commemoration of the successful International American Conference (Pan American Conference), at Lima, Peru, South America, the people and government of Peru take great pleasure in offering, through the good offices of the Pan American Society of Tropical Research of New Orleans, Louisiana, United States of America, a free, good-will packet of seeds of a beautiful native flowering plant of Peru. This offering is an expression of the feeling of peace and kindness that exists in South America for the people of North America.

"The seeds offered are those of the Mutuy o' Pacte, which is a small plant, bearing flowers of exquisite fragrance and exotic loveliness, that is native to the mountains and highlands of Peru. It is, therefore, hardy and can be grown throughout the latitudes of North America. The color of the flower is a brilliant shade of yellow and the plant blooms for two or three years.

"In connection with the free seed offering of this beautiful Peruvian flowering plant, a pamphlet will also be sent to applicants that will describe the results attained by the Pan American Powers at the recent International Conference at Lima, Peru, and also will describe the country of Peru and carry the message of good-will from the Peruvian people and government to the people of North America."

This pamphlet and a packet of these seeds



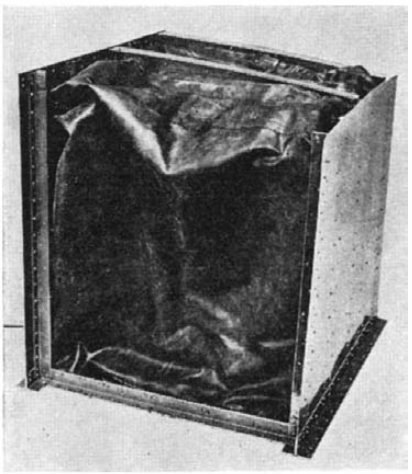
Two new types of freight cars constructed of light-weight alloys

will be sent to every person in the United States and the Dominion of Canada who desires them. There is, of course, no charge and no obligation. Send your name, address and a loose stamp to: The Pan American Society of Tropical Research at New Orleans, Louisiana. Eight hundred thousand seeds of this Peruvian flowering native plant are ready for distribution. Peru invites you to write for your free packet of seeds and message of good-will now.

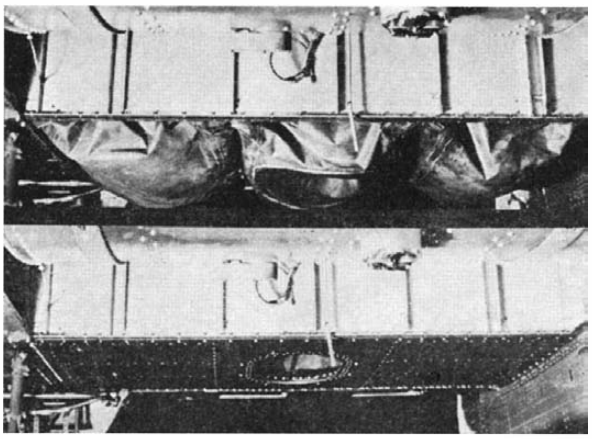
Fuel Tanks of Fabric

THE Glenn L. Martin Company has now developed an aircraft gasoline tank of synthetic fabric which gives definite promise of being vibration-proof and thus insuring higher safety and reliability.

In the "Mareng fuel cell," as it is called, the gas-tight metal fuel tank is eliminated. Bags of treated fabric are designed to the shape of the interior compartments of wings, fuselage, or floats, as the case may be, and are inserted in place somewhat as inner tubes are installed in tire casings. These fabric tanks, instead of being tailored to fit their compartments exactly, are cut to patterns which are slightly larger in each dimension than the surrounding walls against which they rest. This over-sizing is an important factor, as the fabric lining is thus never subject to stretching or twisting. The cell serves solely as a static, vibration-proof container, all strains and stresses being taken by the structure of the wing fuselage or float.



Above: **One of the new fabric fuel tanks for aircraft, showing how it is placed within a metal compartment that serves as a container**



Right: **Fabric fuel tanks installed in a wing, before the bottom plate is fastened in position**

Lower right: **The "shake-table" set-up on which airplane fuel tanks are tested to determine the resistance to vibration**

Government specifications require that airplane gasoline tanks shall be able to withstand not less than 15 hours of destructive vibration on a high-frequency vibrating table, and 25 hours' resistance is the highest requirement in any service. Subjected to this vibration the Mareng fuel cell withstood 700 hours of test unscathed, although to make the ordeal more severe a rocking motion was also imparted to the machine. One of our photographs shows the table to which a high-frequency, low amplitude vibration is imparted while the tank is undergoing test. The arm at the right supplies the rocking motion.

In another photograph is shown one of the fabric cells placed loosely within the metal compartment, which is subsequently placed on the vibrating table. A third picture shows a three-cell fuel tank installed in a plane wing.

Another advantage of the new type of tank is that, if pierced by a bullet in flight, the leakage of gasoline is relatively slow. Piercing treated fabric results in a slit, rather than in a definite hole. Under the pressure of the gasoline the slit tends to close. On a foreign war-front, one of the new Martin fabric tanks was pierced by enemy bullets. Instead of the plane being immediately grounded, as would be the case with conventional metal tanks, it was able to return to its base more than a hundred miles away. Still another advantage, besides the elimination of gas tightness in the structure, is the fact that corrosion of metal by gasoline is no longer to be feared. Gasoline inside the cells is not in contact with metal, and the synthetic fabric is completely unaffected by gasoline.

While the new development is perhaps of more interest in military applications, it should add greater reliability to commercial aircraft likewise.—*A. K.*

Seaplane Terminals

THE Seaplane Flying Association wants the C.A.A. to create a Division of Seaplane Operation to build seaplane terminals and pertinent facilities. If we accept the Division of Private Flying, then a Division of Seaplane Flying is equally logical. The question of costs, and the effect of costs on the national budget, is something which should always be kept in mind, however, when a new federal activity is suggested.

Even today the C.A.A. is not neglecting the seaplane. Thus, its airport section is developing a new floating marker light, for night operation of seaplanes and flying boats. These lights have already been tried out in the vicinity of Baltimore, Maryland, where a 3600-foot landing area was laid out by mooring two rows of twelve lights each, spaced 300 feet apart on the surface of the water. A series of experimental take-offs and landings were successfully carried out within this area with a Douglas Amphibian and two Navy Consolidated Flying boats.

The construction of the light is very simple and effective. It consists of a 39-inch streamlined airplane tire floating on the water, through which a five-foot vertical bronze tube is set in gimbals. A 25-pound battery container is fixed at the bottom of the tube and a mercury-vapor light at the top. An anchor weighing five pounds is made fast to the float with 36 feet of chain, so that it remains relatively stationary in rough water.

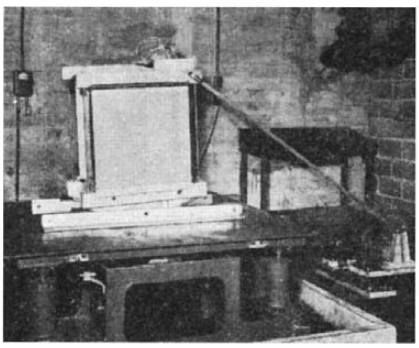
It is believed that the new system of water lighting will reduce surface glare, give the pilot a definite horizon, and indicate the exact surface of the water. It will be interesting to see how the system works out in continued service.—*A. K.*

Our Position in Air Defense

FOREIGN governments are secretive in matters relating to military and naval aircraft—far more secretive than is our own government—and no comparison of foreign air fleets and of our own air fleet is entirely sound. But this is what may be deduced from reports of competent American observers of the European scene, such as Igor Sikorsky, Paul Johnson, and others: In prototype airplanes—that is to say, airplanes which are types and not yet in large production—we can match anything that England, Germany, France, or Italy has to show us. If some single-seater fighters in England and Germany are faster than ours, this is only because our single-seater fighters confront longer distances in service and have to carry much greater fuel supplies. Otherwise, in bombers, multiplace fighters, navy patrol boats, or what not, we are either unsurpassed or definitely ahead. But when it comes to actual airpower, and current production of military aircraft, then it may be said that we lag behind, particularly behind Germany.

Mr. Johnson, with considerable evidence to back up his statement, rates the actual air powers of the great nations as follows: Germany, 10; Italy, 6; Great Britain, 5; the United States, 4; and France, 2. C. G. Grey, in Jane's "All the World's Aircraft," dismisses Russian aviation as negligible, and social experimentation on a vast scale seems to have reduced French strength and current production of aircraft to a very low level.

It is quite apparent, then, that the Administration is fully justified in seeking a great

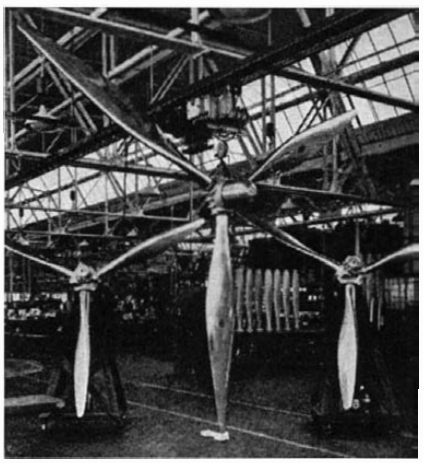


increase in our air forces and the building of 9000 to 12,000 airplanes in the next two or three years. While the program is ambitious, the productive genius of the United States will undoubtedly be equal to the task. Where we may find greater difficulty is in training flight personnel, and in getting enough mechanics for maintenance and other ground duties. Without adequate ground forces, the mightiest air fleet is helpless.—*A. K.*

Propeller Progress

THE year 1938 was remarkable for many aviation achievements such as the "hydromatic" controllable pitch propeller which keeps the engine running at one particular speed, and at the same time allows the constant speed to be set at any desired revolutions per minute; the electrically controllable propeller; the fully feathering propeller in which the blades can be set edgewise when an engine is out of commission; and the development of a system in which an engine drives one airscrew to the right and another to the left so that engine torque effects are eliminated. In addition to all these advances, the propeller engineers are keeping a jump ahead of the game by building airscrews large enough, yet not too heavy, to absorb the power of the 2000 horsepower engines which are just around the corner.

One of our photographs shows a Hamilton



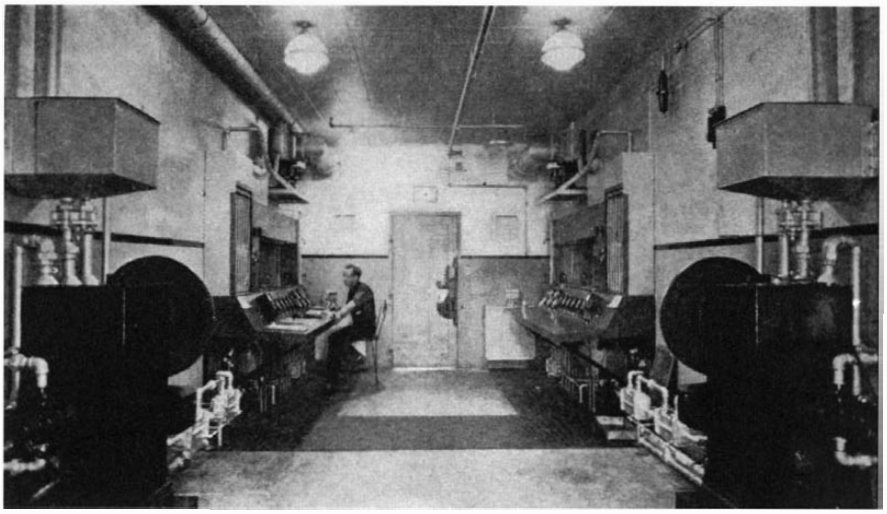
Latest in propeller design

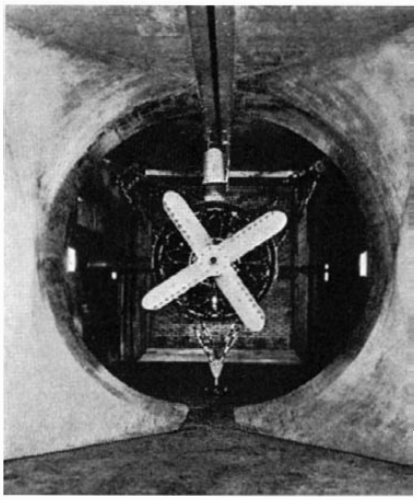
Standard 17-foot hydromatic propeller, the largest propeller ever built, designed for use with airplanes which are still in the drafting-room stage. This 17-foot giant dwarfs the 11½-foot airscrew now in use on the Douglas DC-3 transport. The largest metal propeller actually in use is the 14-foot airscrew employed on the new Boeing 314 flying boat.—*A. K.*

Civil Aeronautics Authority

AFTER some preliminary confusion, unavoidable, in organization, the Civil Aeronautics Authority has got into its stride and is doing good work. Perhaps the most significant innovation of the Authority is the creation of a Division of Private Flying, with Grove Webster as its chief. Mr. Webster will attempt the simplification of air regulations affecting the private flier; develop standardized methods of ground school and flight instruction; maintain contact with private fliers throughout the country; and in general promote popular flying.

One of the most important tasks facing the new chief is to help in the provision of inexpensive flight instruction. College students as a class are excellent flying material, and are just at the right age—old enough to have discretion, young enough to pick up flying quite readily. But they are not at the earning stage, and parents refuse to provide the 200 or 300 dollars necessary to learn to fly. If Mr. Webster can help the formation of clubs, arrange for payments to those who have soloed or otherwise reduce the financial liabilities of a college boy learning to fly, he will undoubtedly increase the number of amateur pilots by thousands. It will be interesting to see what policy is finally evolved.—*A. K.*





One of the sound-proofed control rooms from which engineers observe airplane motors on test. *Left:* The flexible cable mounting or supports of powerful engines in their test cells

Testing Aircraft Engines of 3000 Horsepower

AIRCRAFT engines are constantly increasing in power, and the Wright Aeronautical Corporation is putting into production double-row Cyclone engines rated at 1500 horsepower, the highest ever accorded an aircraft engine of any type by the Civil Aeronautics Authority. And, of course, the engineers and constructors will not stop at even this immense power.

These powerful prime movers are based on the most exhaustive research, and among other problems there is that of testing, particularly of testing many powerful engines simultaneously for long periods of operation. To meet the situation, a building has been constructed, enclosing a battery of 14 test cells, each of which is capable of testing an engine up to 3000 horsepower, swinging huge propellers up to 20 feet in diameter.

One of the most interesting features of the new equipment is the investigation of air effects on the engine under high-speed flight conditions. When air enters the carburetor at 200 miles an hour, there is a powerful "ramming" effect. A blower connected to the carburetor air intake enables the test engineers to simulate this "ramming." The blower is also equipped with controls by means of which the air fed to the carburetor may be "thinned" out to simulate flight at high altitudes. The air may also be heated or cooled to represent varying atmospheric conditions.

The test cells are built in pairs and are separated by control rooms on each side of which are tables on which are mounted the throttles and a variety of instruments for checking power output, fuel and oil consumption, cooling, and so on. A glass window above the instrument board gives the test engineer an unobstructed view of the test cell and the engine.

Soundproofing is another problem. The inhabitants of Paterson, New Jersey, used to complain bitterly of the unendurable noise created by engines undergoing test. The walls of the building are now so massive that no noise can penetrate them, but the inlet and exhaust air must be rendered incapable of spreading sound waves into the surrounding atmosphere. Hence the towers at each end of the test cell, which extend 30 feet above the ground, are provided with a great concentration of sound-absorbing material. The offices of the test engineers are also most carefully sound insulated.

A new method of mounting the engines has also been developed which simulates actual flight conditions much better than the ordinary framework of structural steel bolted to the floor. A steel tube is used instead. This tube is suspended from the ceiling

by four cables and anchored to the floor by two more. Cradled in rubber, these cables provide a flexibility in the engine mount which could not be obtained with a rigid test stand. They also prevent the transmission of vibrations to the walls of the structure.—*A. K.*

X-Ray Tire Inspection

WITH the attention of every safety organization and every safety official in the nation concentrated on ways and means of making street and highway travel safe for America's 30 million motor vehicles, The Firestone Tire & Rubber Company announces the introduction of a new motoring safeguard—the tire X ray.

This new application of the X ray, a bene-

Looking through a tire

factor of man ever since its discovery in 1895, will enable car owners to checkmate most of the 40 million flats that are now occurring annually. With this equipment only a few minutes are necessary to X ray a set of tires. The operation is simple. No pictures are taken. The owner looks directly through his tires without removing them from the wheels.

In an experimental test, engineers X rayed the tires on 100 automobiles. The tire X ray revealed that 99 percent of these cars carried one or more hidden tire dangers. A further investigation of 2000 worn tires produced 2049 nails and tacks, 2099 pieces of glass, and 2197 pieces of rock and small stones which had become lodged either in the tread or deeper in the body of the tire. In addition, a considerable number of tires showed breaks in the cords as well as other defects that would have eventually resulted in a flat, or possibly a blowout.

Detection of these under-cover hazards with the Firestone tire X ray is a simple procedure. The automobile is elevated several inches above the floor and the tire X ray is rolled under one wheel. Protective flaps are adjusted to confine the rays to the section of the tire that is being inspected. The operator turns a crank which rotates the entire wheel. When any foreign object or defective section of cord is revealed, it is immediately spotted, automatically marked, and the inspection continues. Once located, the foreign objects are quickly extracted with special tools after the tire X-ray inspection has been completed.

In addition to its value as a safety factor, the use of the tire X ray adds mileage life well beyond the normal expectancy of a tire that does not receive X-ray inspection. Glass and nails in the tire body, agitated by every revolution of the wheel, weaken the body structure. After miles of travel in this condition the tire is permanently injured, even though the tube itself may have remained intact. Thus tire X ray is not only a life saver. It is a money saver.

RESEARCH

ON industrial and engineering research there was expended during 1938 about $180,000,000, according to an estimate by Dr. W. A. Hamor, of the Mellon Institute.

Peeling Potatoes By Flame

DRUDGERY and waste are being taken out of peeling potatoes by a new process in which the tubers are exposed for a few seconds to a flame temperature of 1750 degrees, Fahrenheit. This almost instantaneous heating of the peel blisters and chars it so that a high-pressure water spray can remove it completely from the potato. Eyes and blemishes must be removed by hand subsequent to peeling. This process is being applied to potatoes and other vegetables for hotels and restaurants using large quantities.—*D. H. K.*

Wireless Record Player for Radios

DEVELOPMENT of a wireless record player which combines in compact form the virtues of a fine phonograph and the flexibility and control advantages of the modern radio receiver has been announced by the radio division of the General Electric Company.

The new record player was designed to meet the demands of the modern home for a musical instrument which will play with-

Self-contained wireless record player for use with any radio receiver

out interruption the outstanding recordings of the day. No sound issues from the cabinet of the record player itself during its operation; the automatic electric sound reproduction and control devices of an existing radio receiver are employed, thus utilizing the owner's previous investment to greater advantage. Despite this use of the home radio receiver, however, there is no wired connection between radio and record player, a fact which makes the performance of the device almost uncanny to the observer.

This accounts also for the flexibility of the record player since in practice it can be used effectively with any radio within hearing distance. From a single location in the home, where it is plugged into the household circuit, the music from records being played can be heard from a receiver in the central living room, or from small sets in a play-

With no connecting wires

room, or in upstairs bedrooms, or on an outside terrace.

Most radio receivers built by General Electric for 1939 are equipped with a special key, or button, which is pressed when the record player is in operation. This makes available an unoccupied section of the broadcast band. On other sets, however, it is only necessary to set the dial at a "dead" spot in the broadcast band, with the power on. The record player acts as a small broadcasting station, transmitting the electric impulses represented by the record to the radio receiver, whence they emerge as sound. Provision is also made in the new record player for the attachment of a small microphone, enabling users to "broadcast" to their own radio, from which their voices emerge.

Inexpensive Air Filter

DESIGNED primarily for removing pollen from air, but equally effective for removing dust, soot, and lint particles, is a new low-priced air filter offered for home and office by Norris Industries, Inc. Tests in a hospital room show a pollen count of 1159 outside to be reduced to three per cubic yard inside.

The purifier comprises a weatherproof casing with two Burgess filters, and fittings to make it adjustable to all but casement windows. By using any ordinary 10-inch household fan, which is placed inside the casing, 200 cubic feet of air per minute are driven through the filters. Through a unique arrangement of louvres in the sides of the casing, air from the room is re-circulated and cleaned. Thus 125 cubic feet of fresh air are drawn from the outside and filtered, while 75 cubic feet are being re-filtered to maintain dust- and pollen-free surroundings. Unless operating in very dirty surroundings, filters may last a season, but can be replaced economically.

Temperature Controlling Metal

A NEW alloy of iron, nickel, chromium, and silicon developed at the Battelle Memorial Institute has the remarkable prop-

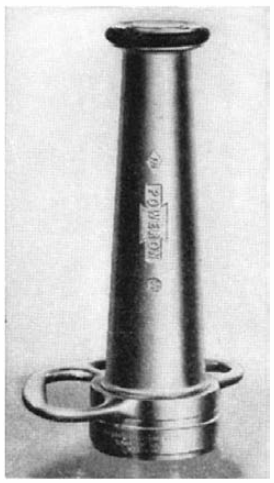
erty of losing its magnetism at a definite temperature which can be predetermined between 1100 degrees, Fahrenheit and —150 degrees, Fahrenheit. At the critical point, where the metal loses its magnetic properties, it goes through a phenomenon to which the word "shivering" has been applied; when this occurs it can be utilized to control electric circuits or operate other temperature controlling devices. The temperature at which this change occurs in the metal is established by the proportion of the various constituents in the alloy.—*D. H. K.*

Nozzle for All Classes of Fires

A NEW type of nozzle that is especially desirable for general use on fire-hose lines because it permits the use of water in large quantities for extinguishing all classes of fires, including fires in oils and in live, high-voltage electrical equipment, has been developed by American-LaFrance-Foamite Corporation, manufacturers of fire protection equipment, Elmira, New York.

This new device, which is known as the Poweron nozzle, discharges water in a discontinuous spray that is especially effective for fire-fighting purposes and does not conduct electricity. It cannot be adjusted to throw a solid stream of water. Tests conducted by the Underwriters' Laboratories showed that the nozzle is suitable for use on equipment carrying current at voltages as high as 250,000.

The Poweron nozzle is similar in size and appearance to the ordinary fire-hose nozzle and can be attached to any standard fire hose. Its special form of discharge, besides being more effective than a solid stream of water, forms a water curtain between the operator and the blaze. The nozzle is non-adjustable.



Left: **The new spray nozzle that holds great advantages for fighting any fire.** *Above:* **A demonstration that shows the type of spray**

Tunnel Lining

THE Chain Belt Company, of Milwaukee, recently shipped one of two Rex Tunnel Lining Machines for concreting operations on the Gunpowder Falls-Montebello Tunnel which is part of the water supply system for the city of Baltimore. This tunnel will extend a total length of seven miles with an inside diameter of 12 feet and will require about 70,000 cubic yards of concrete. There will be two principal shafts from the surface through solid rock to the tunnel, each about 200 feet deep and spaced at two-mile intervals from Baltimore.

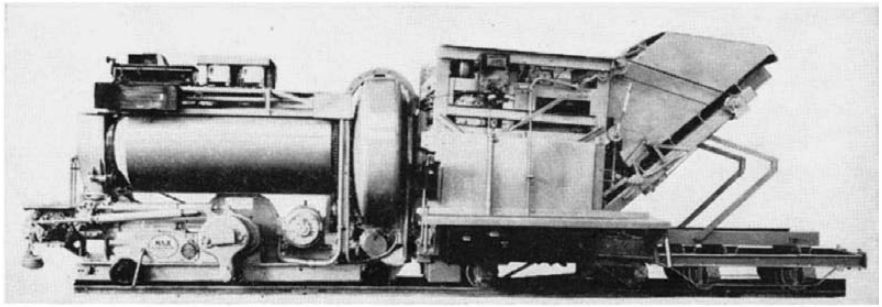
To handle this concreting job, the company designed and constructed two tunnel lining machines. These units are modeled along the general line of the Rex tunnel machines used on the Metropolitan Water District project in Southern California, with, however, some very definite modifications to adapt the equipment to work in a 12-foot tunnel.

There are two separate cars—a mixer car weighing approximately 18,000 pounds and a Pumpcrete car weighing approximately 16,000 pounds. Each car is on flanged wheels with individual traction drive to operate on 36-inch gage tracks. The two cars are designed to work close-coupled as shown in our illustration.

At the extreme right is one of the batch cars which will be used to charge the mixer. The batch body has a capacity of two 1¼-cubic yard batches. As the car is backed up to the mixer, two arms from the mixer car engage the body and hoist it into charging position. The body is lifted from the batch car through a lever and cable arrangement which is part of the mixer car.

The machine is powered for D.C. operation, and all of the controls are conveniently placed to operate from a platform on the mixer car.

The two complete tunnel lining units will be operated independently of each other inside the tunnel and each unit will have a fleet of 15 batch cars serving it. The contractor plans to dry-batch his aggregate and cement on the surface, and drop the batch down a pipe through the shaft and through a transfer bin into the batch cars.



The tunnel lining unit is made up of two separate cars as described

MILK

MORE than 100 billion pounds of milk are produced and consumed in the United States each year. The average in recent years has been 106 billion pounds.

Eighty-One Cents' Worth of Dirty Business

BECAUSE a user with a laudable curiosity complex wanted to know how much it cost to operate a vacuum cleaner for a year, approximately 200 housewives were called upon to answer her and the figures were recently revealed by R. F. Sambleson, commercial engineer of General Electric's vacuum cleaner section at Bridgeport, Connecticut.

The average cost of power in the United States is roughly five cents per kilowatt-hour. A regular floor type cleaner uses .325 kilowatts, and a hand type only .200 kilowatts. The G-E engineers figured 50 hours of actual cleaning a year as a reasonable basis for their computation, which makes the operating cost of the floor type 81 cents a year, and that of the hand type 50 cents.

Then, just to check their usage figures, 200 cleaners were put into actual home use for a year, with timeclocks on them to measure the time during which the motor

Above: **Cherry trees, growing in incubator bottles under aseptic conditions, will later be transferred to pots.** *Below:* **Incubated peach seedlings after transplanting**

was running. The average figure turned out to be only 33 hours, which would make the annual operating cost a third lower than previously supposed. Either this is a tribute to the efficiency of the cleaner, in Sambleson's opinion, or husbands should begin checking up on the time-honored statement that "woman's work is never done." In either case, 81 cents is the top figure, and that wouldn't even buy a good broom.

Shrinkproof Woolens

WOOLEN blankets made proof against shrinkage by treatment with a solution of sulfuryl chloride in dry cleaning solvent have been recently put on the American market. The treating process is English and is known as the Hall process.

Conducted under rigid control, the simple treatment of woolen goods by immersion in a sulfuryl chloride solution of proper concentration acts on the serrations of the individual fibers and makes the fabric permanently non-shrinkable. After treatment, the fibers are stronger, slightly whiter, and somewhat softer than untreated wool. Several manufacturers are offering woolen goods which can be guaranteed against shrinkage so long as the treatment given the fabric does not destroy the fibers themselves.—*D. H. K.*

Grows Fruit Trees In "Incubators"

DIFFICULTIES encountered in the course of the fruit-breeding work in progress at the State Experiment Station at Geneva, New York, particularly with respect to developing early ripening varieties of the stone fruits, have given rise to a so-called "incubator" method of handling the embryos of fruits that would otherwise be lost. "Incubator" fruit trees have reached maturity and are now bearing fruit on the Station grounds.

A brief popular description of the incubator method of growing fruit trees was given by Dr. H. B. Tukey in a recent issue of *Farm Research*, the Station's quarterly magazine. "Breeding fruit trees by 'incubator methods,' as it has been called," he says, "consists in removing the embryo from the mother fruit during the growing season and placing it in an 'incubator' bottle under aseptic conditions, properly nourished with various salts and a sugar supply, with the result that a new seedling fruit tree is produced which is a potential new variety." By this method the Station fruit breeders have saved many seedlings which might otherwise have died.

The method has proved most valuable in saving seedlings from crosses of early ripening peaches, cherries, plums, and apricots. Heretofore, most of the embryos of crosses of very early ripening varieties of these fruits have failed to develop properly and much or all of the cross has been lost. By removing the embryos at the correct stage of development and nursing them along in the incubator bottles, the Station now has a number of potential new varieties of these fruits well along the road to maturity, while some few of them are actually beginning to bear fruit.

The method has found another unexpected but very useful application in the nursery industry, as a germination test of fruit tree and forest tree seeds. By this method the percentage germination of the seed can be determined within seven to ten days as compared with a period of several months under ordinary conditions. It is also supplying much valuable information on the growth habits of fruit embryos which will doubtless prove helpful to plant scientists.

Alcohol In Ice Caps

TO simplify nursing routine by eliminating numerous time-consuming operations, one large hospital is standardizing on the use in ice caps and collars of a 10 percent alcohol solution in place of the conventional cracked ice, according to the *American Journal of Nursing*. The solution freezes at minus 4 degrees, Centigrade.

Each cap is filled with 500 cubic centimeters of a 10 percent alcohol solution and, the article states, takes from 60 to 90 minutes to freeze in electric units employed by the hospital. Used ice caps are washed with soap and water, dried and then returned to the freezer. It is not necessary to remove the solution, according to the article.

Tests over a five-year period in an 18-story surgical building, with an average census of 250 patients and a five-room operating suite, are said to have convinced authorities of the economy of the measure.

The mixture produced by the freezing of the solution is described as firm but easily broken up by hand to make the cap conform more readily to body contours.

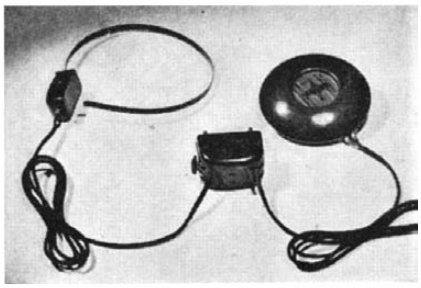
LAMPS

FOUR fifths of a billion—800,000,000—incandescent lamps were sold in the United States during the year 1938. Of these, 485 million were of the everyday kind.

Miniature Telephones Aid Hearing

AS a result of many years of research and development work in artificially reproducing speech, Bell Telephone Laboratories have perfected a new type of hearing aid, known as the Ortho-Technic Audiphone. The newly perfected device, so small it can be concealed on the person, is actually a miniature telephone of the most improved type.

After the sound waves are picked up by the efficient "transmitter," they are amplified



A typical Audiphone combination using a bone conduction receiver. *Below:* **Ear pieces for air conduction receivers are supplied in universal types or may be molded to order to suit the individual ear**

to a suitable strength and led into a miniature "receiver," which repeats them at the point where they may best actuate the organs of the inner ear. For this purpose, it may be advisable to locate a diminutive receiver in the outer ear, or it may be more advantageous to locate it against the head immediately behind the ear, where it will transmit the sound vibrations through the bony structure to activate the hearing organs within. This, and selection of the proper units to comprise the most effective Ortho-Technic

Audiphone combination, is decided after an analysis of the subject's hearing acuity by means of the Audiometer test.

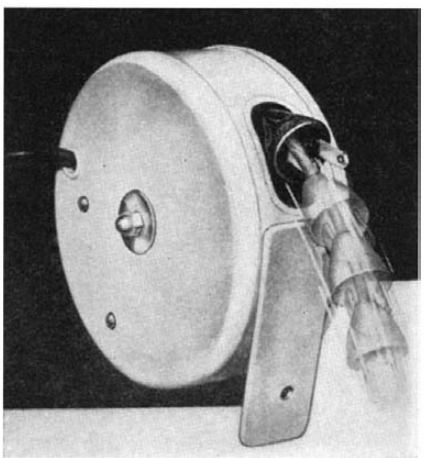
The Audiometer is an instrument specially designed and built to analyze an individual's hearing acuity. Through a test by this instrument, comprehensive information is obtained regarding the relative response of the individual's hearing organs through air conduction and bone conduction.

The new Ortho-Technic Audiphone operates efficiently in any position, regardless of whether the wearer is reclining, sitting, or standing. The user need not be confined to conversations with an individual, for he may participate freely in group conversations. By manipulating the convenient "volume" control, he may enjoy the loud music of a brass band close at hand or he may understand completely what is being said by a person speaking in normal tones on the opposite side of an ordinary sized room. Because it consumes less power than previous designs, the new device does not require replacement of batteries as often, which makes it more economical in operation.

Automatic Reels for Electric Cords

A MODERN and inexpensive solution to the old problem of dangling, unsightly extension cords on electric appliances and electric equipment is made possible in the new Cordomatic—automatic cord control reel—just announced by The Cordomatic Division of the Vacuum Cleaner Corporation of America.

Made in a variety of sizes and designs for either external or concealed mounting, Cordomatic reels are complete, fully enclosed,



No more twisted electrical cords

self-contained units, ready for installation. They maintain the exact needed cord length at all times, eliminate cord wear, keep castors from damaging the cord, stop kinking and tangling and avoid danger of accidents from dangling coils. The cord is paid out as required and then is retrieved automatically and wound inside the metal container where it is out of sight, out of the way.

Basement Greenhouse

A BASEMENT, glass-less greenhouse which holds interesting possibilities for profitably utilizing basement space in homes in congested areas, has been designed by Professor Alex Laurie, of Ohio State University. It is not intended to supplant the familiar greenhouse, but merely to serve as a propagating house and for "finishing off" plants which have been brought almost to the blooming state in pots. A series of tests were made to determine its fitness as a propagating house and cuttings of carnations, geraniums, chrysanthemums, and many other varieties

In a basement

were successfully grown in clean, sharp propagating sand.

For those who might wish to build a basement greenhouse as a propagating house, the construction is of the simplest: Walls of pressed wall board are nailed on each side of two by four partitions, the dead space between the double walls acting as an insulating area against both heat and cold. The inside walls of this simple greenhouse are painted white to reflect the maximum of light from the 100-watt Mazda lamps which are installed two feet apart and suspended two feet six inches above the propagating bench. These are operated 12 hours a day by automatic clock. Electric soil-heating cable is installed on the benches and is thermostatically controlled to maintain the soil temperature at 73 degrees, Fahrenheit.

A fresh-air inlet from outdoors is installed at floor level with an exhaust fan at the ceiling. A thermostat control actuates the fan when the temperature rises above the desired level and stops it when the temperature drops to normal. Frequent syringing of the plants is necessary in order to maintain humidity at a desirable dew point and, in addition, trays of water are kept for this reason under the benches.—*C. F. Greeves-Carpenter.*

Threshold Treatment of Water

RECENT investigations initiated to prevent caking in valves and distributing lines of irrigation systems, caused by the addition of small amounts of ammonia to hard water, have proved the high value of minute doses of sodium hexametaphosphate as a preventive. This treatment, called threshold treatment because so little water softener is used, has not only permitted the economical distribution of ammonia as fertilizer in irrigation water supplies but has shown the way to prevent incrustation in other water systems.

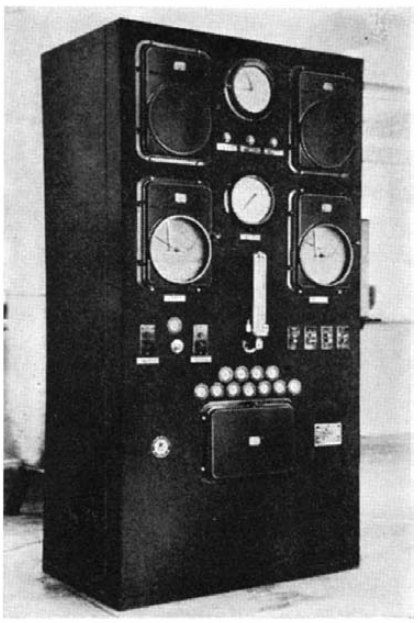
As little as one or two parts of the metaphosphate in a million parts of water effectively prevents the precipitation of calcium carbonate and other salts in water systems. The development of the threshold treatment is so recent that new applications are being found daily. In Ohio, the water supply of a city is being treated to prevent incrustation of the filters in the softening plant and of the distribution system throughout the city. In Illinois, a river which flows continuously through the condensers of a large commercial distillery is subjected to threshold treatment so that the condensers will not scale up. In Texas, where the condensers on the cracking stills used to plug up solid in one month, the use of metaphosphate has prevented scale, allowing the units to run indefinitely. In state after state where hard water supplies are encountered, the railroads and the steam power plants are using this phosphate glass in what seem like ridiculously small amounts to avoid operating difficulties resulting from calcium carbonate.

The development of the uses of sodium hexametaphosphate in the conditioning of water is purely an American achievement, although this substance was first studied by the British chemist, Thomas Graham, over a century ago.—*D. H. K.*

Co-ordinated Process Control

INDUSTRIAL instruments give close control for carefully planned processes. Bristol's system of co-ordinated process control is an automatic machine which controls process operations, where instruments—individually operating to control such process variables as temperature, pressure, liquid level, flow, humidity, and motor or machine speed—are co-ordinated and interlocked into a single control unit so that they perform operations in successive steps and proceed in the proper sequence as required by the process.

The system is exceedingly flexible and is, therefore, used to control a number of dif-



For co-ordinated process control

ferent types of manufacturing processes. Those already in operation may be placed under supervised control or those newly developed and previously perfected in the laboratory and pilot plant may be put into automatic production on a full-scale basis. Such control prevents deviation from the original plan and eliminates the chance for error resulting from manual supervision.

This new system of co-ordinated process control consists essentially of a multiple cam cycle controller, or "Mechanical Brain," which controls through the medium of compressed air and by means of leakless pilot valves and cams. Around this cycle controller, standard recording and controlling instruments are built to operate valves (all sizes up to large gate valves), pumps, blowers, dampers, and electrical equipment. By means of the cycle controller, the operation of these instruments is controlled to a time program, so that the devices to control such variables as time, pressure, liquid level, flow, humidity, speed, and mechanical motion, may be operated automatically, according to the schedule found to be responsible for the best over-all results. In this way the system provides for a carefully planned machine, built in the form of a suitable panel board, to control, automatically, involved processes where the human element in supervision may best be eliminated.

Molasses as Fertilizer

WASTE molasses is being used as a source of nitrogen for fertilizing Hindu soils. Good results have been obtained using dosages as high as 30 to 40 tons per acre.—*D. H. K.*

HYDROGEN

BECAUSE it is only about a tenth as heavy as air, hydrogen, used inside the casings of great electric generators to cool them, reduces the windage, or friction, of their giant rotating shafts to one tenth that of air. Hydrogen is thus a vital factor in increasing power efficiency.

Old Age Can Walk—Can't Sprint

THE inability of an old man to sprint 100 yards although he may be able to walk all day as well as in his youth is due in part to loss of capacity to accumulate lactic acid in exercise, according to Dr. David Bruce Dill of the Fatigue Laboratory of Harvard University.

Lactic acid in the body, Dr. Dill explains, is a fuel for muscular contraction which has sometimes mistakenly been spoken of as a "fatigue substance."

"It may be that the heart has a greater capacity for work in severe exercise than ordinarily because of the high concentration of lactic acid in the blood pouring through it," Dr. Dill continued. "Dr. Robert Johnson in the Harvard Fatigue Laboratory has found that lactic acid, however rapidly it passes out of muscle cells, enters the red cells of the blood very slowly; so slowly that after one or two minutes of severe exercise nine tenths of the blood

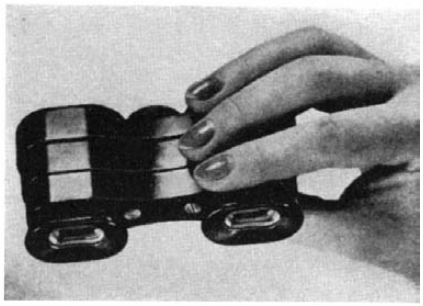
lactic acid remains in the plasma, or fluid part of the blood.

"The capacity to accumulate lactic acid in exercise is lost in old age. A man of 70 may have one half the capacity for carrying on work in a steady state which he had in his prime, but his capacity for work carried on after the supply of free oxygen in the blood is depleted is almost lost. There are many illustrations of this—many men of advanced years can walk all day as well as in their youth, but sprinting for 100 yards would be impossible. De Mar at 49 ran the marathon as well as at 22, and Cunningham runs the mile at 29 better than at 22, but who knows a successful sprinter as old as 29?"

Vest Pocket Sport Glass

A NEW vest pocket sport glass, as easy to carry as a cigarette case, has been designed by Bausch & Lomb Optical Company for use at all outdoor sports or at the opera.

The new glass is of 3-power and rectangular in shape, designed to afford an exceptionally wide view rather than a high one. This makes it particularly suitable for all sports, since the width of the field is 452 feet at 1000 yards. It weighs but six ounces.



Synthetic Wool Vulnerable

THE enthusiasm that has been shown in various countries for synthetic wool made from the casein of milk has been dampened by the discovery that certain bacteria will destroy casein even after it has been woven into a garment. Synthetic wool garments require no moth balls to protect them, since moths do not attack casein. Synthetic wool, however, may be destroyed by bacteria, against which moth balls are no protection. Obviously the present fabrics used in Italy which are made up of half wool and half synthetic wool are vulnerable to both attacks.—*D. H. K.*

"Everything Flows"

NEW clues to the underground mechanism causing earthquakes, mountain formation, and other geological phenomena have been found by a Harvard physicist in the action of rocks under tremendous laboratory pressures.

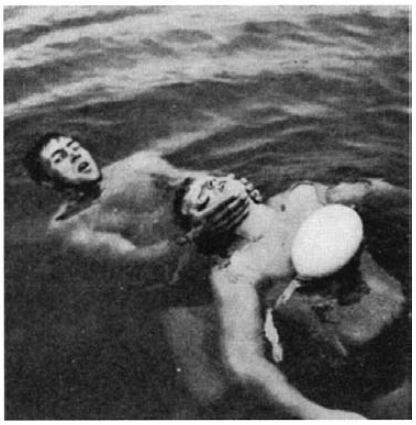
David Griggs, junior fellow in geophysics, has utilized the high-pressure equipment of Prof. P. W. Bridgman to duplicate the pressure conditions in the earth's outer crust—a granitic layer extending down 30 to 50 miles.

Under the high confining pressures, which

reached a maximum of about 300,000 pounds per square inch, it was found that limestone could be made to flow. A small block of it was compressed 35 percent in length without shattering. Contrary to past geologic beliefs it was found that, under high pressure, rocks will not flow indefinitely but will break if deformation is carried far enough.—*Science Service.*

Life-Saving Belt

AN inflatable, chemically-operated rescue belt has been developed by Lyf-Boy Corporation. This consists of a belt, a part of which may be inflated with a gas from a self-contained chemical. In use, the belt



Life-saving belt that is fastened around chest and quickly inflated

is fastened around the chest of the drowning person by the lifeguard, who then squeezes the belt to start the inflation. Buoyancy is thus provided for the victim so that the lifeguard may tow his charge ashore by means of a hair-carry or a chin-carry.

Squeezing the belt causes a weak acid solution to be sprayed on a small quantity of bicarbonate of soda, resulting in the evolution of the inflating gas.

Ozone-Resistant Rubber Insulation

FAILURE of rubber-insulated electric wires and cables frequently results from the attack of ozone in the atmosphere. To prevent this, a layer of rubber free from sulfur, and hence unvulcanizable, is being placed on the outside of the ordinary rubber sheet and is said to protect it from ozone damage. Electric discharge, due to leakage, forms ozone in the air; apparently by preventing this, the new method prolongs the life of rubber insulation.—*D. H. K.*

Can Traffic Lights Be Improved?

THE excellence of the type of traffic signals adopted in The Hague is recommended for consideration outside of Holland. The signal consists of a large circular surface protected by a hood. On this surface are 12 concentric vacuum lights—six neon tubes for red and six mercury vapor tubes for green. When all six red rings are lighted, traffic is stationary. As time passes, one ring after another becomes extinguished, and as the last disappears the green rings flash on and traffic moves. The six green rings then

successively disappear and the cycle is repeated.

Such a system possesses this very important feature: both automobile and pedestrian traffic can judge the time during which a particular signal will operate. Motorists see when to prepare to go, and the pedestrian sees how much opportunity remains for crossing. There is only one illuminated area instead of three, and there is no amber light to be abused.—*Highways and Bridges Magazine,* London.

* * *

A traffic light of similar principle was recently demonstrated in Massachusetts. This signal consists of an aluminum encased circle of 16 bulbs, 15 white and one red. The lights indicate the number of seconds before the light is to change. It is reported that the signal "circle" may be attached to any ordinary traffic signal.

ELECTRICAL POULTRY FARM

ON the chicken farm of Charles F. Wendig, near a swank colony of artists and writers at New Hope, Pennsylvania, electricity is now at work waking chickens in the morning, keeping the young warm, heating their drinking water, providing them with a 12-hour-light day, mixing their feed, sterilizing their air, cleaning their eggs and grading them, and putting them to bed at night. This is but a partial inventory of electric "wired helpers" which have transformed the Wendig enterprise into the first Westinghouse Electric Poultry Proving Farm.

DYEING WITH GOLD

A NEW process of depositing gold on fabrics, which resembles the ordinary dyeing process, has recently been developed. The fabric is dipped in a solution containing a complex organic compound of gold (trialkylphosphine aurous chloride) and on heating becomes coated with a thin, even deposit of gold left by decomposition of the dye.—*D. H. K.*

THE ENGINEER: A DEFINITION

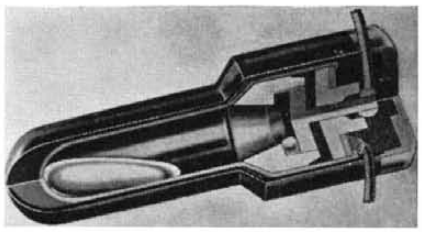
"AN engineer is one who, through application of his knowledge of mathematics, the physical and biological sciences, and economics, and with aid, further, from results obtained through observation, experiences, scientific discovery, and invention, so utilizes the materials and directs the forces of nature that they are made to operate to the benefit of society. An engineer differs from the technologist in that he must concern himself with the organizational, economic, and managerial aspects as well as the technical aspects of his work."—*Dr. Karl T. Compton.*

BETTER SWITCHES

ENGINEERS have long recognized the unsatisfactory operation of switches with breaking points exposed to the air. Circuits carrying heavy loads are difficult to open because the arc and high temperature causes pitting of the contact points. On circuits carrying lighter loads, dust and cor-

rosion are the enemies of the points. When the first mercury switch appeared, it seemed to be the solution of these problems. In principle, it controlled circuits with sealed contact points preventing exposed arcing. Also, since each contact was made through fresh points of mercury that was sealed to prevent corrosion and dirtying, such a switch should last indefinitely.

However, ordinary mercury switches had many faults that prevented their general use. The use of a metallic envelope together with a non-flammable and non-explosive liquid



Metal shell mercury switch

fill in the Durakool metal mercury switch overcomes the faults of the usual mercury switch.

Durakools are perfectly cylindrical so that they may be turned through a full 360 degrees on their long axis without changing their operating characteristics. That is to say, any side up is the right side up. This is not true with ordinary mercury switches. Also, the principles in these new mercury switches allow them to be built and used in sizes up to 200 amperes. This is by far the largest mercury switch ever commercially available so far. They are being rapidly applied to an astonishing variety of mechanical equipment ranging from tiny humidity controls to gigantic concrete mixers used on the Conchas Dam. There are at present about 5500 known applications where Durakool mercury switches will serve satisfactorily, including control of many kinds of machines, pumps, clocks, scales, coin-operated machines, and many other devices.

FIRE-WALKING

(*Continued from page* 138)

fairly quickly, and stepped off at the side, stating that the fire was too shallow.

Afterward, however, he walked the same fire three more times, but with fewer and quicker steps. His feet were again examined and found uninjured. Thirty minutes later there was likewise no sign of blistering. He refused to walk again, the fire being "not to his liking."

At the suggestion of one of the physicists the "cotton test" was applied. Human flesh scorches at a lower temperature than cotton fabric, so some calico was wrapped around a wooden shoe last. This imitation foot was "walked" upon the embers and in a second the calico was scorched, while in two and one half seconds the cotton was burned through in several places.

Digby Moynagh, editor of *St. Bartholomew's Hospital Journal*, who was present, decided to try the feat and momentarily placed one bare foot in contact with the embers. "His foot tingled for a considerable time afterward," Harry Price states. Next he walked two paces on the embers but jumped out, said it was "hot" (!) and that his feet tingled. For some time he felt noth-

ing further, but in 30 minutes blisters had formed on the soles of his feet. He had walked more quickly than Kuda Bux. As will be seen later, undue haste in walking on embers may result in unnecessary burns. Moynagh's weight was 168 pounds, that of Kuda Bux, 120. There is a suspicion that weight has some bearing on fire-walking and that a very heavy person should not attempt it.

For a second test of Kuda Bux, one ton of firewood, seven tons of oak logs, and a load of charcoal were provided. The trench was reduced to nine inches in depth, widened to six feet and, at the request of Kuda Bux, its 25-foot length was broken in the middle by a platform of earth, thus altering it to two 11-foot trenches in line, with a three-foot space between.

Eight days after the previous tests the second were undertaken. The wood was ignited and after a few hours the glowing embers just filled the trenches flush with the ground. "We spent the morning feeding the flames," Price states, "and by one o'clock the pits were a mass of red embers, radiating a heat sufficient to be distinctly felt at a distance of 65 feet on the leeward side of the trenches. The assistants and rakers were compelled to wear goggles and the rakers used shields constructed from the sides of packing-cases. "It was blowing half a gale and, as the wind swept across the fires, they were fanned almost to white heat; ash in the form of powder being blown in clouds from the surface of the fires."

The load of charcoal was then added and in 20 minutes was cherry red. Kuda Bux was examined by Prof. C. A. Pannett, also by the three physicists who were present, Dr. T. E. Banks, G. Smith of the London School of Hygiene and Tropical Medicine, and C. R. Darling who was recommended by the Institute of Physics. A number of other scientists were present, some from the University Council. Prof. Pannett, after examining the feet of Kuda Bux, stated that the soles presented no unusual features. The skin was not callous, but soft. The feet felt cold to the hand, and a skin thermometer applied to the soles registered 93.2 degrees, Fahrenheit. The skin was very dry. The feet were then washed and well dried and a small square of zinc oxide plaster was attached to the sole near the arch, to permit observation of any possible effects on its fabric due to the fire.

Seven hours after the eight tons of wood had been lighted Kuda Bux made the first walk, covering only the first 11-foot section of the divided trench. This he did in 4.5 seconds by stop-watch and in four strides—deliberately, steadily, fairly quickly. The records taken by the physicists give approximately one half second during which each foot was in contact with the embers.

Afterward, Kuda Bux's feet were found to have a temperature of 93 degrees, slightly lower than before the fire-walk, probably because he had taken a few steps on the cool grass outside the trench, after walking the fire. His feet were in no way injured and the plaster patch was untouched except at the edges where loose fluff was lightly scorched. He then took four more strides on the fire but no injury was found either immediately or 48 minutes later when his feet were re-examined.

How hot was the fire over which Kuda Bux walked? The physicists responsible for the measurements used a thermo-couple and

the temperatures were as follows: Surface, 430 degrees, centigrade, or 806 degrees, Fahrenheit. Body of the fire, 1400 degrees, centigrade, or 2552 degrees, Fahrenheit—which is a white heat temperature; in fact, steel melts at slightly lower temperature than this. It was owing to the high wind on the day of these tests that the embers reached so intense a heat. In fact, Kuda Bux, after preparing to walk a third time, asked for five minutes' grace, and then said he could not do it again. "Something inside me has broken. I have lost my faith and if I do it again I shall burn myself." He looked worried and nervous and Price did not press him to do the walk a third time. And, at that, Kuda Bux no doubt was using excellent judgment. For Dr. E. H. Hunt, who was present, and had seen ceremonial fire-walking in India, stated that the test was made under unusually severe conditions, such as the high wind making the heat intense, which would have deterred most fire-walkers.

Digby Moynagh, the novice who had tried the feat on the occasion eight days before, next took two steps on the fire but stepped off the trench. He was examined by Prof. Pannett who reports that "the soles of his feet had numerous healing blisters on them. He acquired some more at the second attempt. His skin was moister than the Indian's and this may have had some influence, because afterward a small piece of charcoal was found stuck to the skin, and on its removal a blister was found underneath." He had also walked at a quicker pace than Kuda Bux. The last two points are worthy of note, for other instances of each turned up in the course of the subsequent experiments. The first point, with regard to dampness causing hot embers to adhere to the soles, disposes of the "spheroidal state" question, discussed earlier. The second, regarding undue haste, seems to imply possibly that this haste leads to uneven pressure of the feet on the fire. As will be seen, the amateur who finally learned to do fire-walking without self-injury avoided frantic haste and kept cool. No doubt he discovered an ideal balance between the extremes of haste and its opposite.

Next, Maurice Chapeen tried fire-walking, taking two short, quick steps. His feet were badly blistered and also were bleeding at three points, the latter due possibly to the burnt skin rubbing off the soles of his feet as he hurried out of the trench. His weight was 163 pounds.

Harry Price states that he took a slow-motion picture of the performance and ascertained from it that Kuda Bux had walked much more slowly than the amateurs.

Summing up, Price states that "the poor thermal conductivity of wood ash is not a factor necessary for success; the ash was carefully removed before each walk." And that no one portion of the skin is in contact with the hot embers for as long as half a second. Subsequent observations modified this.

In the more recent of the two London fire-walking reports, named earlier in a footnote, G. Burniston Brown, Ph.D., describes three further fire-walks performed within the past year. Another Moslem magician from India, Ahmed Hussain who had walked the fire on many occasions in India, was tested, together with several English volunteers, since Hussain claimed to be able to convey his alleged immunity from burn-

ing to others. The Englishmen of the investigating Council evidently had deep-dyed designs for breaking up the foreign monopoly on fire-walking and planned to build up as early as possible a home industry. They had advertised for volunteers and 40 people volunteered to walk the fire. Those selected, presumably from ordinary walks of life, were Messrs. Craigie, Marshall, Bould, Chesney, and Adcock, weighing respectively 143, 145, 124, 177, and 157 pounds. Hussain weighed 126 pounds.

Professors C. A. Pannett and W. D. Newcomb tested their feet for possible chemical treatment and washed them in cold water, drying them carefully. Hussain had requested a trench 15 inches deep, four feet wide and 12½ feet long. This was provided and the fire was laid as before.

The surface temperature of the fire, taken by the physicists with a contact couple, was 575 degrees, centigrade, or 1067 degrees, Fahrenheit, and in the interior it was 700 degrees, centigrade, or 1292 degrees, Fahrenheit, as taken with a standard portable indicator lent by the Cambridge Scientific Instrument Company, Limited.

Hussain, after reciting prayers from the Koran, stepped into the fire and took three quick strides in 1.3 seconds (Frodsham stopwatch reading to one hundredth second) and was not burned.

Hussain had claimed that he could convey his immunity to others, so the experiment shown in one of the illustrations was made. Messrs. Craigie, Marshall, and Bould lined up behind him, holding hands, and the foremost clutching his belt. They crossed the trench in about 1.5 seconds. (What are the feelings of a novice as he is about to plant his naked foot for the first time on red-hot embers?) "All were burned to a varying, but slight, degree," the Report states, "but only one (to whose foot a piece of ash had adhered) complained of any feeling of pain."

Adcock then walked across alone, taking three steps in 1.4 seconds, followed by Chesney. "They were also slightly burned," the Report states, "and it was found that where the number of steps had been uneven, the foot that had been down the more often was the more affected. This indicated that the injurious effect was cumulative."

Hussain then declared that *he* could walk any distance without being burned. He was therefore asked to walk continuously around the fire but discovered that he must always walk forward in a straight line!

On another day, the trench, now increased to 20 feet long and with the surface temperature of its fire 740 degrees, centigrade (1364 degrees, Fahrenheit), "Hussain, after muttering the usual prayers, crossed the trench in 2.3 seconds, taking six steps, and complained at once of being burned: he was found to have five blisters on one foot and marked erythema (reddening) on the other, a condition closely resembling that of the amateurs after four steps. He refused to walk again, attributing his failure to lack of faith."

Adcock then walked the trench, taking only four steps, and showed slight signs of burning. Later he crossed in dry rope-soled shoes, taking seven steps, and the soles were not burned at all. Bould and Russell next walked the trench and both were slightly burned.

One of the rope-soled shoes was then wetted and held in contact with the fire.

OBLONG ROOTS?

This is an algebraic square:
$(u-3)^2=(u-3)\ (u-3)=u^2-6u+9$

This is an algebraic square root:
$\sqrt{u^2-6u+9}=\sqrt[2]{[+(u-3)]^2}$ or $\sqrt[2]{[-(u-3)]^2}=+(u-3)$ or $-(u-3)$

This is an algebraic oblong:
$(u-3)\ (u-2)=u^2-5u+6$

This is an hypothetical algebraic oblong root:
$\sqrt[\wedge]{u^2-5u+6}=\sqrt[\wedge]{(u-3)\ (u-2)}=(u-3)$ or $(u-2)$

That hypothetical formula merely illustrates the analogy of the idea "oblong root" to the idea "square root"; the formula does not define a determinate algebraic operation.

* * *

Squares and square roots are equivalent to algebraic rotations in the plane of complex numbers.

The plane of complex numbers floats in the space of bifoliate numbers.

Oblong powers and oblong roots, which are indeterminate operations in complex numbers, become determinate operations in bifoliate numbers and are equivalent to polyarithmic (nonalgebraic) rotations in the space of bifoliate numbers.

* * *

This is a polyarithmic oblong power:
$(u-3\&2)\,?=(u-3\&2)\ \ (u-2\&3)=u^2-5u+6$

This is a polyarithmic oblong root:
$\sqrt[\wedge]{u^2-5u+6}=\sqrt[\wedge]{(u-3\&2)\,?}$ or $\sqrt[\wedge]{(u-2\&3)\,?}=(u-3\&2)$ or $(u-2\&3)$

* * *

This simple application of polyarithmic roots to the formal solution of quadratic algebraic equations may be extended to equations of higher degrees which are incapable of solution by means of the usual algebraic roots. This thesis is developed by Robert A. Philip in three monographs:

MULTIFOLIATE NUMBERS.....Price one dollar
MULTIFOLIATE SUBSTITUTIONS.....Price one dollar
MULTIFOLIATE RADICALS.....Price one dollar

THE MONOGRAPHIC PRESS
106 Washington St. Fairhaven, Mass.

Several seconds elapsed before any sign of steam appeared, showing that the spheroidal state—the sudden formation of an insulating layer of vapor—does not occur under the conditions obtaining in the fire-walk.

It was very noticeable that the feet sank into the embers, the Report continues, to a depth of between two and three inches, so that the upper part of the feet were covered. It is very evident that the very low thermal conductivity of smouldering wood prevents damage to normal skin and other objects, if the time of contact is below about half a second and the number of consecutive contacts is not too great.

In a third and final experiment, with a nine-inch, twelve-foot trench, and a stiff breeze which raised the surface temperature of the fire to 800 degrees, centigrade, or 1472 degrees, Fahrenheit, Hussain crossed taking four steps and was uninjured. Then Reginald Adcock walked the trench in 1.8 seconds, taking three steps. He was not burned in any way and he made a statement that, no doubt, has immediate bearing on success in fire-walking; he said that former attempts had given him confidence to walk steadily.

The Report then shows a comparison that is of interest, since it makes clear that in three trials the English novice—an average man such as the present reader is likely to be—had easily equalled the Oriental "professionals" (Kuda Bux had stated that for several consecutive years he daily performed the feat at an annual religious festival which lasted a week). Kuda Bux, Hussain, and Adcock, weighing respectively 120, 126, and 160 pounds, walked distances of 11, 12, and 12 feet, taking 4, 4, and 3 steps, in 2.2, 1.6, and 1.8 seconds, in minimum time of contact per step of .55, .40, and .60 seconds, over surface temperatures of 806, 1472, and 1472 degrees, Fahrenheit. "It will be seen," the Report points out, "that both Hussain and Adcock exceeded Kuda Bux's performance by walking on a fire of nearly twice the surface temperature. Further it is remarkable that Adcock should have survived, without injury to his feet, the greatest minimum mean time of contact."

What, then, in sum, is the secret of fire-walking? Dr. G. Burniston Brown, the author of the Report, sums it up as follows (slightly condensed):

"The fire-walk is in no sense a trick: the walk is performed in the normal manner with bare and chemically unprepared feet.

"Owing to the fact that the surface of the fire is a very unstable one and the feet may sink in several inches, it is impossible to walk so that a constantly changing portion of the foot is in contact with the hot embers (this would be possible on a firm plane surface) and skill of this kind is not a factor necessary for success. Nevertheless, steadiness in walking is an advantage in order to avoid remaining with the weight on one foot for too long an interval.

"Moisture on the feet is a disadvantage.

"The spheroidal state does not occur.

"No abnormal degree of callosity of the feet is required.

"Fasting or other initial preparation is not necessary.

"No evidence was shown that immunity from burning can be conveyed to other persons.

"The fall in the temperature of the surface of the soles of the feet during the experiment was possibly due to a number of

steps being taken on the grass after leaving the fire, before the place of examination was reached.

"Immunity is not due to contact with layers of relatively cold ash in which combustion has ceased, since in experiments with Kuda Bux the ash was removed; and, in any case, the feet sink in sufficiently far to be in contact with the burning embers and small flames below the surface.

"The equivalence of the performance of one of the amateurs with that of the professional fire-walkers, and the small difference between their performance and that of the other amateurs (the professionals could not take more than two steps with each foot without injury), together with the fact that the immunity could not be transferred, indicates that the slight immunity shown is not sufficiently abnormal to require the hypothesis of a specially induced mental state; for example, 'faith.' The fact that no signs of burning were found on the dry rope-soled shoes (which can hardly be supposed to be affected by the mental state of the wearer) leads to the view that the secret of the fire-walk lies in the low thermal conductivity of the burning wood. The thermal conductivity of copper, for example, is about 1000 times greater than that of oak wood.

"In order that damage may be caused to the skin or other substance by contact with a body hotter than itself, it is necessary that a certain quantity of heat should enter the colder body, and that the time during which this transfer takes place should not be too long, otherwise the heat may be conducted or radiated away before the temperature has risen sufficiently. Consequently, in spite of a large temperature difference such as exists in the fire-walk, the quantity of heat transferred may remain small if either the thermal conductivity is very low or the time of contact is very short. In the case of the fire-walk, burning wood and its ash are very poor conductors of heat; and, furthermore, the time of contact is not above about half a second in normal quick walking. Even so, successive contacts of this period cause an accumulation of heat sufficient to cause injury, and the experiments have shown that with fires whose temperature is 500 degrees, centigrade, or more, only two such contacts can be made with each foot without erythema or blistering."

Dr. Brown, in clearing up lesser details, remarks that "it is to be expected that a people who normally walk with bare feet, especially on the hot ground in tropical countries, will exhibit a greater resistance to injury than the volunteers in the experiments in England, and hence it may occur that, in India for instance, the fire-walker's limited immunity is in no way unusual." He also alludes to the hypothesis of hypnotism and refers to some side experiments that were made at Maudsley Hill Mental Hospital showing that, although subjective feeling of pain may be considerably lessened by hypnotism, any inhibition of normal skin reactions to burning can be only slight. With regard to things of this kind, or to things physiological such as the possible power of inhibiting the activity of the sweat glands of the feet, it may be said simply that these crutches are not necessary, for the facts of a purely physical nature—namely, brief contact, few contacts and a poor conductor of heat—seem sufficient to account for the ability to do fire-walking.

Conducted by JACOB DESCHIN

Photographic Party

FOR those parties with a purpose—aside from the purpose of sheer pleasure-making—such as raising money for a worthy charity or some other noble cause, this department has positive proof that photographic "bait" is well worth consideration.

Faced with the problem of devising an attractive method of raising money, at the same time giving the donors something for their contribution that was worth what they paid for it, this department was approached on the subject of how to attain this end by giving the party a photographic flavor.

The plan finally approved was to set up a kind of "studio" in one of the rooms of the house in which the affair was to be held. A main light, diffused, was set up at the conventional 45 degrees in relation to the background and a spotlight was employed for an emphasis light. These were made ready before the guests arrived and a camera was set up on a tripod so that picture-making could commence with the least fuss and danger of possible interference. The camera used was a 9- by 12-cm filmpack-plate type, equipped with a telephoto lens of double normal focal length. The background consisted of drawn window curtains which were fuzzed out by the large diaphragm opening—*f*/5.5. Subjects sat on a backless bench.

The names of the victims were gathered

Party portraits with a purpose. These four are examples of the type of work that can be done rapidly if you follow the suggestions given in the note above

in advance, permitting a steady progression after picture-making began. For the sake of the sitter and to facilitate the making of pictures, the door of the "studio" was closed each time. This helped both the sitter and the photographer, and as a result matters went along very smoothly.

While the lighting was, in the main, the same for all, the spotlight as well as the general illuminant had to be shifted occasionally to suit different personalities. Also, of course, focusing was arranged for each individual in view of the shallow depth of the long-focus lens, but inasmuch as the ground glass had to be inspected for subject composition anyway, the frequent focusing was not unduly bothersome.

Off-hand, it would seem that the best camera for the purpose would have been a miniature and the pictures made one after another with little interruption between each one. But in view of the fact that the number of persons involved was not great and the desire of the photographer and the sponsors of the event was to give the best possible performance for the money, the larger camera was chosen and an attempt made to compose each picture carefully. Your money's worth, was the keynote of the enterprise.

The price of one dollar for single portraits and one dollar and fifty cents for portraits of couples was found to receive practically universal acceptance. Out of a relatively small group, a total of 20 dollars was collected. Enlargements, a sample of which was shown to prospects before picture-making began, were made on 8- by 10-inch double weight stock, semi-matte surface.

In addition to the picture-making, three 11- by 14-inch enlargements of favorite negatives taken from the files were mounted on 16- by 20-inch exhibition mounts and sold by lottery.

It is needless to say, of course, that the photographer engaged in such a strenuous venture as this may make up his mind that he will see practically nothing of the party!

Leica Import Certificate

DIFFICULTIES ordinarily encountered with U. S. Customs officials by Leica owners who want to bring their camera back into the United States upon returning from a trip abroad may now be avoided. An "Import Certificate" is being issued with each new Leica camera, lens, or Leitz binocular which has been imported through regular channels. This consists of a small card on which is stamped essential identification information concerning the camera, and assurance that full duty has been paid on the particular camera.

Secret Camera Note from Asia

NEWS of bustling activity in the manufacture of photographic equipment and materials in China and Japan has come to us by way of a friend of a friend who recently received a letter from Shanghai. In part, this letter discloses:

"It may interest you to know that the Japanese are now making the most extensive photographic products imaginable. They include: films for Leica, the 'Canon'; an amphibious Leica-Contax, called the 'Baika', Leica-type with 'Lausar' *f*/3.5 lens, 127 film size; and a score of 620 roll-film cameras with Japanese-made Compur shutters and lenses. . . . For the first time, a Chinese company is making cameras; box-type, lens ground in Shanghai, first batch of 10,000 destined for India."

Making Pictures of the Picture Makers

TRAIN your camera on the camera shooters the next time you go strolling in search of picture material. It's lots of fun. The important thing, as in all candid shooting, is to make sure you are not observed by the victim. This is comparatively simple as he, or she, is probably so engrossed in focusing and viewing his own subject that he or she pays little heed to anything else that may be going on around.

Picturing a picture maker

Contests

NEWS of photographic contests comes to us this month from two fronts.

Commemorating the 100th anniversary of the birth of photography, the manufacturers of Rolleiflex and Rolleicord cameras are sponsoring the First International Rollei Competition, with prizes totaling 500 cash awards headed by a first prize of $200. In addition, many of the winners will be represented in a Rollei picture book tentatively titled "The Magic of Light."

"Anything that makes a good picture" is the sponsors' only requirement, with "no restrictions as to subject or quantity of pictures to be entered." Artistic merit and general interest are to be the bases of judgment. Prints must be enlarged to at least 5 by 5 inches, though original color transparencies are acceptable. All entries must be mailed before August 31, 1939 and prizes will be announced December 1, 1939. American entries may be mailed to Burleigh Brooks, Inc., 127 West 42nd Street, New York, New York. Rules and entry blanks may be obtained from the latter or from the local Rollei dealer.

Increased prizes and decreased entry fees are the features of the Second Annual Competition in News and Pictorial Photography at Kent State University, Kent, Ohio, under the auspices of the Department of Journalism. The closing date for submission of entries is March 1, 1939. The prizes this year will consist of a first prize of $40 and

(*Please turn to page* 184)

Prize Winners

IN THE

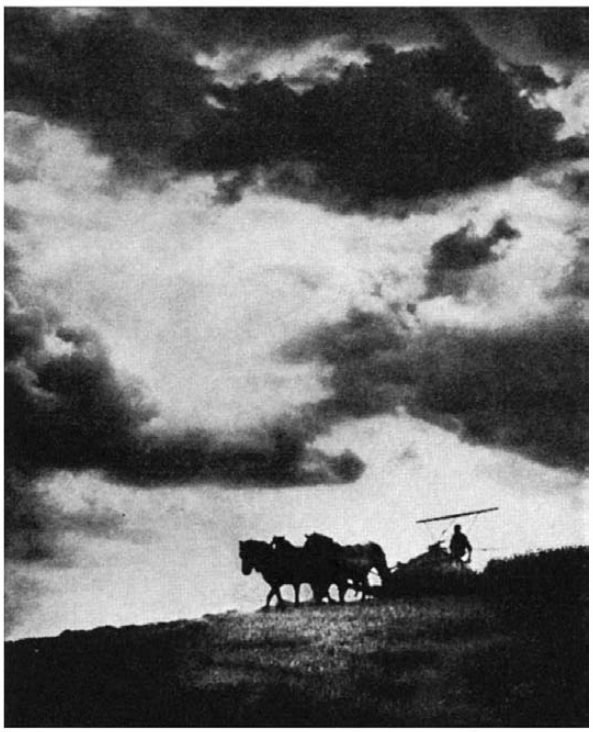
Third Annual

Scientific American

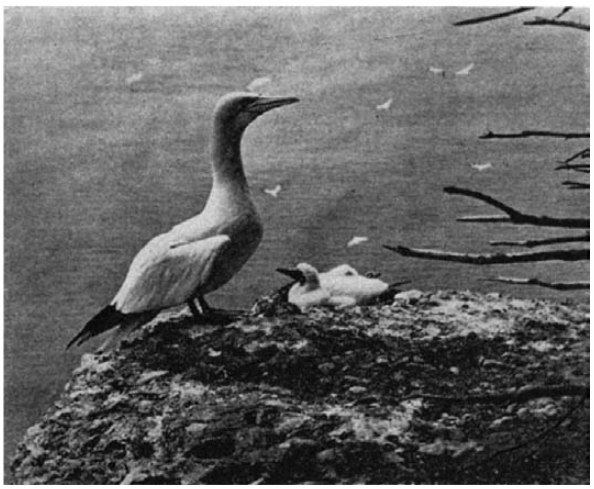
Photography Contest

The judges—*left to right*: McClelland Barclay, Robert Yarnall Richie, and Ivan Dmitri—eliminating, in the semi-finals, pictures from this group of more than 100 which had previously been selected from the large number of excellent prints that were submitted in our photo contest

1st PRIZE in Division 1, Human Interest. Submitted by Allen Brooks Howard, Jr., Staten Island, New York. This striking character study was taken with a Rolleicord camera, the exposure being made on Eastman S. S. Pan film



1st PRIZE in Division 2, Landscapes. Entered by H. Lou Gibson, Rochester, New York. Taken with a Recomar camera on Eastman Panatomic film. No filter was employed



1st PRIZE in Division 3, Science and Industry, including Natural History. Photographed by Ruth M. E. Hennig, Boston, Massachusetts. This unusual bird photograph was taken with a Kodak on Eastman S. S. Pan film

HONORABLE MENTION AWARDS

DIVISION 1

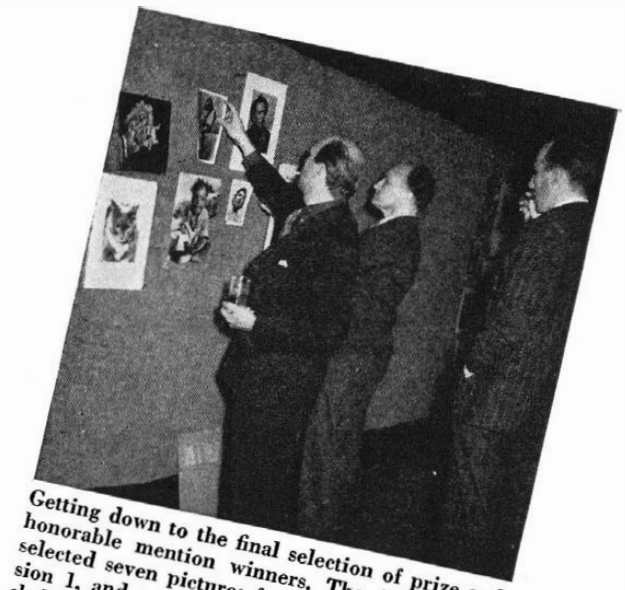
William A. Baker, Quincy, Massachusetts
Francis J. Wilson, Saskatoon, Saskatchewan, Canada
Lau Wai Kwong, Hong Kong, China
Carl Bakule, Minneapolis, Minnesota
Mrs. Harry N. Aldrich, Chicago, Illinois

DIVISION 2

J. B. Guss, Fort Lewis, Washington
Georg Halasz, Budapest, Hungary
G. L. Osmanson, Morris, Illinois
Elise Voysey, Bayville, Long Island, New York
H. Farkas, Budapest, Hungary

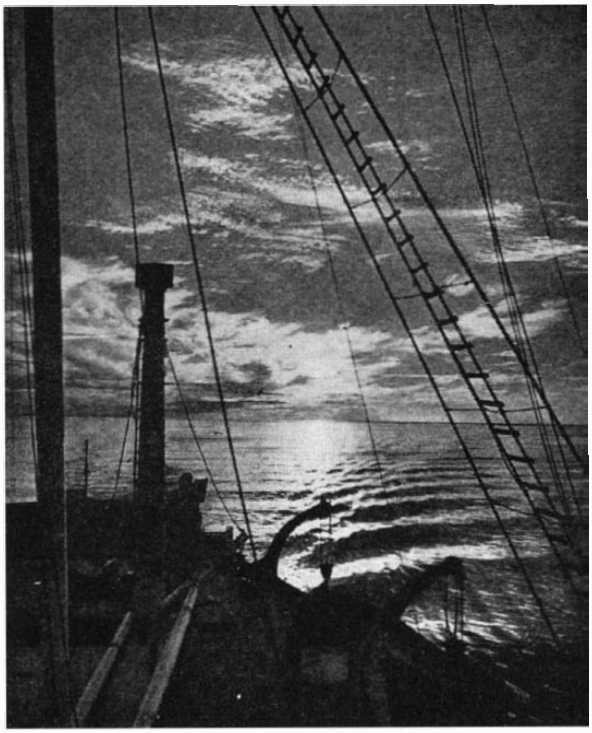
DIVISION 3

George F. Watson, Beloit, Wisconsin
Thomas E. Benner, Urbana, Illinois
Don Laskey, Grand Rapids, Michigan
Anthony Pulitano, Brooklyn, New York
Adolph W. Dreyer, St. Louis, Missouri

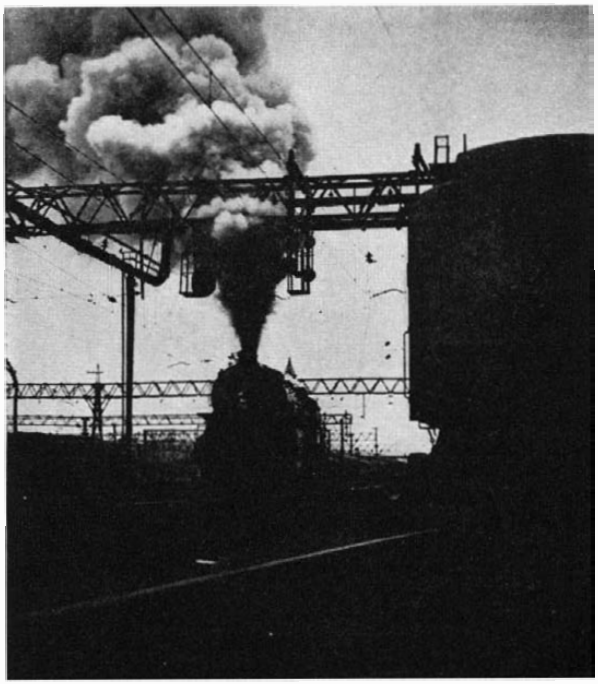


Getting down to the final selection of prize and honorable mention winners. The judges have selected seven pictures from the group in Division 1, and are now deciding on the two that shall be awarded cash prizes. The 1st Prize winner is hidden behind Mr. Dmitri's right shoulder

2nd PRIZE, Division 1. "Curly-Head" was submitted by Stephen F. Harris, Dover, Massachusetts. The picture was taken on Eastman S. S. Pan with an Auto-Graflex camera



2nd PRIZE, Division 2. Entered by E. Haeberle, Elmhurst, Long Island, New York. An unusually fine sunset, taken with a Rolleiflex camera on Agfa S. S. Panchromatic film



2nd PRIZE, Division 3. Taken by Kenneth Carlisle Marthey, Brooklyn, New York. The spirit of railroading was caught with a Rolleicord on Eastman S. S. Pan film

a second prize of $10 in each of the two divisions. Judges of the news photography competition will be members of the program advisory committee for the Short Course, while Frank R. Fraprie, F.R.P.S., editor of *American Photography*, and members of his staff, will judge the pictorial division.

All newspaper workers and students and instructors in schools and departments of journalism are eligible to compete in the news section. The pictorial contest is open to everyone. Entry fee in either section is $1 for four prints or less, with a charge of 25 cents for each additional print.

Rules include preference for 8 by 10 or 11 by 14-inch print sizes, and not smaller than 5 by 7. Regulation 16 by 20-inch mounts suggested, but larger or smaller mounts, if used effectively, will not be barred. Name and address of photographer should appear on back of each print, accompanied by exposure data. If desired, name may be placed on front of print with title.

Flash and Flood Guide

YOURS for the asking is a handy little pocket guide containing a wealth of useful exposure data on flash and flood photography just announced by the Wabash Photolamp Corporation, of Brooklyn, New York. This little pocket guide lists over 120 different films in 35-mm, cut- and roll-film and film-pack, made by Agfa, Defender, DuPont, Eastman, Gevaert, Hammer, Ilford, Perutz, Univex, and other film manufacturers, together with data and exposure tables for correct use in making flash and flood pictures. Complete data and exposure tables are also included for the various 8-mm and 16-mm films for home movies, as well as tables for Kodachrome and Dufaycolor films. The Wabash people, as you know, make Superflash and Superflood bulbs.

Protecting the Sponge

ONE of the most frequently heard complaints concerning the viscose sponge is that it gathers dust easily, thus endangering the delicate emulsion surface when swabbing negatives to get rid of excess moisture before hanging up to dry. A very satisfactory and convenient method of protecting the sponge is to have a glass container such as the one illustrated (only 10 cents at the five-and-ten). This not only

In a glass dish

keeps the sponge always ready for use but it may thus be left moist. A viscose sponge protected in this way will always remain free of dirt and grit provided any dirt accumulated during use is immediately washed and the sponge squeezed of excess water, never wrung.

Traveling Camera Exhibit

IF you live in or near Philadelphia or Reading, Pennsylvania; New Haven or Hartford, Connecticut; Providence, Rhode Island; Boston, Massachusetts; Syracuse, Rochester, or Buffalo, New York, you will soon have an opportunity of attending the Universal Camera Exhibit, which is taking to the road under the auspices of the Leica people. Consisting of working set-ups of specialized Leica camera accessories, such as the photomicrographic, photomacrographic, copying and reproduction devices, and so on, in addition to the complete line of Leica cameras and more than 500 accessories, the exhibit will be in charge of Anton F. Baumann, Leica expert, lecturer, and photographer. In addition, Mr. Baumann will demonstrate his methods of making giant enlargements and will lecture on color photography.

The exhibit will be on display for three days in each city from 1 to 10 P.M. Exact dates are available from local Leica dealers.

In Praise of the Changing Bag

RECENTLY we had occasion to use a film changing bag under circumstances which did not easily permit the unloading and reloading of cut-film holders. Since we chiefly employ the miniature type of camera if shooting when away from the studio, the need of a changing bag does not often arise, but when it is needed, it plays its rôle admirably. A word of caution to those who are using the changing bag for the first time: Do not attempt to unload the holders and reload them during the same "session." Introduce a box and a protective opaque material such as black paper into the changing bag with the holders to be unloaded. Unload the holders, wrap the film with the opaque sheet of paper and place in the box; after tightly closing the box, end that particular chapter of the session. For reloading, return the empty holders to the bag, accompanied by a new box of cut film—and load in comfort.

Why Is a Prize Picture?

WITH Norris W. Harkness, columnist for *The Camera* (Philadelphia) and *Nature Magazine,* we recently collaborated in the judging of photographic prints submitted in a club competition. We could select only two prints in each of three classes, a First Award and a Second Award.

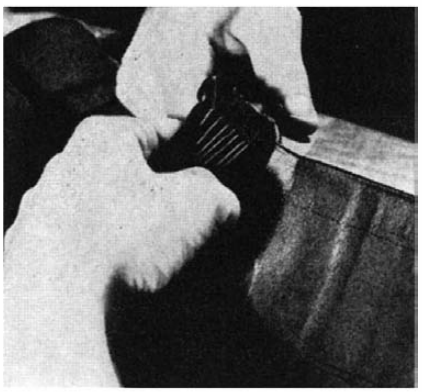
Those finally chosen were picked out because they were well or satisfactorily composed, the printing quality was good, the subject matter interesting. Those that fell by the wayside had in several instances sinned chiefly because they lacked but one of these three qualities. If the subject matter of one was good, it lost out because the negative was under- or over-printed; in another the printing was satisfactory but the

picture content was presented without imagination. One fault that was particularly noticeable was the evident misunderstanding of the type of picture suitable for submission in a competition of this sort. For example, a dish of fruit that was remarkably well printed had to be discarded because of the commercial type of lighting employed in making the picture: an even light from both sides. Another picture of this type was one showing a bowl of flowers on a table and a woman's hands engaged in arranging them.

A prize picture, therefore, would seem to be that one which possesses all those good qualities which combine to make the print that stands above the crowd. Interesting subject-matter probably comes first, followed by proper selection of viewpoint and good composition, selection of the proper paper contrast for the negative employed and a printing depth sufficient to record the tones of the negative within the capacity of the paper. One careful worker has made it a rule never to enter the dark-room with more than one negative and to work with that negative for all it was worth. Sounds worth while.

THE BELLOWS MAKER

TO those in the know, bellows-making is considered one of the most skilful of the arts dealing with the manufacture of photographic equipment. The illustration shows



Bellows making

the method by which the bellows are folded in the familiar "accordion" fashion. The hands you see were taught their cunning by a master in the craft as they, in turn, will demonstrate the art to another in the future.

TREATISE ON EXPOSURE

A COMPREHENSIVE and rather extensive treatment on the subject of exposure, exposure meters, and their proper usage, discussion of the meaning and importance of the various film-speed rating systems now in use, plus much other useful information on the subject, is now under way. The guide, as it is intended to be, accompanied by a compilation of the latest film-speed ratings for the various emulsions now available, is being compiled under the direction of Joseph M. Bing, F.R.P.S.

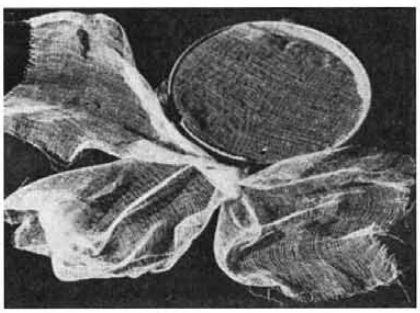
STRAIGHTENING PRINTS

MANY workers experience difficulty in flattening out prints after they have dried. The knack of straightening prints by

the method of passing the backs of the prints over the table edge or under a rule, is not always successfully employed, sometimes resulting in unpleasant cracking. One very effective method is to moisten the backs of the dried prints with cotton, cloth, or a sponge, insert the prints between blotters either in a print press or under a weight, such as a number of books, and leave them overnight. The next morning the prints will be found to be perfectly flat, and will stay that way.

Variable Diffusion Screen

FOUR different diffusion degrees are possible with the home-made diffuser shown in the illustration. The device consists of a pair of knitting or embroidery hoops, four



Diffusion screen

pieces of cheese cloth and a bit of scotch tape to hold the ends of the cloth to one of the hoops. In use, a piece of cloth is inserted in the hoop, while the others hang free out of the way. For greater diffusion, more of the cloths are added.

Success With the Wire Finder

SOME camera users appear to have difficulty in employing the wire or frame finder on their cameras. They complain that the picture they get is different from the one they saw in the finder. The fault probably lies in the method of using the finder. This finder is accurate for all practical purposes if the eye is held close to the small opening at the back of the finder and an effort is made to see the outline of the frame and to enclose the view within this outline. Unless these two precautions are observed, the picture will differ from the view.

See Yourself as the Camera Sees You

PLACING a large mirror behind the camera to permit the sitter to see him or herself approximately as the cameraman has arranged matters on the ground-glass or in the view finder, has been suggested as a possible aid in making portraits. The contention seems to be that if the sitter can see himself in the mirror, he has a feeling that he is taking a real part in the actual making of the picture and can more easily assume a natural pose and expression. Since the suggestion was made by several persons independently of each other, perhaps there is something to it after all. At least, there is no harm in trying it.

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.

UNIVERSAL SAFELIGHT OUTFIT ($1.95): With interchangeable safelight filters. Complete set includes black enameled safelight lamp; A-3 green safelight filter; A-7 red safelight filter; and 10-watt yellow bulb. Used in lamp without filter, yellow bulb provides safelight illumination for contact printing papers. With red filter may be used for orthochromatic films; with panchromatic, except those requiring development in total darkness, yellow bulb and green filter are used. Lamp fits any standard electric outlet.

ZENOPRINT KIT ($1.00): Contains materials for making contact prints without use of dark-room. Process utilizes newly introduced Safelyte Paper, with orange repellent dye. Dye disappears in fixing bath, leaving ordinary black and white print. Kit includes, besides paper, special developer containing red light-repellent dye, standard hypo solution and special flexible printing frame. In operation negative and paper are placed in frame, latter bent for perfect contact, in front of ordinary electric light bulb and exposure of several seconds is given, followed by development and fixing in the usual way. Additional supplies of paper may be purchased separately, sizes ranging from 2¾ by 4½ inches to 5 by 7 inches.

IMPERIAL PRECISION EASEL ($9.95): All-metal, plan-parallel paper surface; silver-blast focusing surface. Margin masks, with controls at both ends, and adjustable white border control for squaring up paper with easel and masking bands and giving measured white border to prints. Makes up to full 11 by 14-inch prints.

LOCK-SHARP ($3.00): Light-tight self-closing box for protection of photographic paper while working in dark-room. Automatically locks out all light, giving positive paper protection when cover is released. Cover drops into light trap which prevents possibility of fogging paper. Strips supplied with box permit separating different contrasts or types of paper. Type now available for 8 by 10 paper can be used for smaller sizes. Larger sizes will follow later.

UTILO FILTERS, COMBINATION LENS SHADES (filters $1.35 to $2.50 each; shades $1.20 to $2.00 each). Filters, available in three yellow densities, orange, red, green, and blue, furnished in sizes 22 mm to 42 mm. Metal-mounted, slip-on type filters of solid glass dyed in the mass. Featherweight metal mounts fitted with three adjustable prongs to provide firm and uniform grip on lens.

Each filter supplied with leather purse case without extra charge. Combination lens shade furnished in sizes 24 mm to 42 mm. Made of lightweight, strong metal finished in dull, anti-reflection black. Metal ring built inside Utilo shade to take Utilo filter of same diameter. Leather case available for shade at 50 cents extra.

PERUTZ ULTRA FINE GRAIN DEVELOPER: May be used below or above its optimum temperature without noticeable ill effect on negative. In addition to grainless silver image, a stain image is produced.

COMBINATION TABLE TRIPOD AND TILT TOP (Complete, $2.00; tripod or tilt top separately, $1.00): Measures 7½ inches, solidly built. Has three removable legs furnished with rubber tips. Tilt top of solid brass with swivel ball socket permitting forward or backward tilt of 180 degrees and swing in any direction.

PERDURO: Hardener for use in any ordinary developer. Has mild tanning action and increases resistance of emulsion to mechanical damage and differences in temperature between processing baths.

MENDELSOHN SPEEDGUNS: Both Universal model and Model C (for Speed Graphic) now feature adjustable aplanatic reflector for accommodating differences in bulb sizes. New bulb socket, with improved method of making contact. All wires removed from battery case.

New model for 2¼ by 3¼ Speed Graphic: Provides leads and connectors for focal-plane shutter synchronization in addition to standard front shutter synchronization. Normal operating condition with two cells in battery case; for using more than one bulb, or in other cases affecting greater drain on the circuit, extension tube is provided. With this tube, case holds three cells.

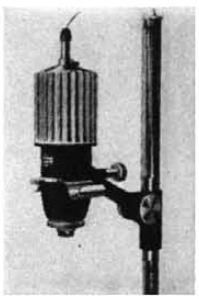
PERUTZ PERGRANO: "Only single layer panchromatic film in America." Inherently fine grain, is claim, obviates use of ultra fine grain development. Very short developing and fixing time claimed for it due to single layer of emulsion.

LABORANT 5 by 7 ENLARGER ($289.00): For negatives up to 5 by 7 inches (13 by 18 cm). Has double condenser; counterbalanced head; tripod suspension post for vibrationless manipulation; friction drive for micromatic focusing; horizontal projection; large lamphouse, and other features. Double extension bellows permitting reducing as well as enlarging. Complete with Betar *f*/4.5, 21 cm lens.

MAZDA PHOTOFLASH LAMP No. 21 (20 cents): Same size as standard 60-watt Mazda lamp; smaller than present No. 20 Mazda Photoflash lamp, yet gives more light. Lumen second output 50,000 to 60,000, compared with 45,000 lumen second rating of No. 20. Light spread over longer time. Peak of flash accurately timed. Lamps filled with foil which allow flashing by contact. "Quick break" filament burns out almost instantaneously after igniting flash material, thus reducing drain on dry-cell power. Manufacturers claim "satisfactory pictures can be

taken with aid of new lamp at distances up to 15 feet, using fast panchromatic film, *f*/11 lens opening, and 1/200th second shutter setting. Substituting ultra-speed panchromatic film, distances can be increased to 30 feet."

MASKING PRINT-FRAME ($1.50): For negatives ranging from 1 by 1½ inches to 4 by 6 inches. Equipped with adjustable masks. Permits quick cropping of negatives. Lengths marked off in inches along each side so that print may be made accurately to desired dimensions.



OPTILITE PHOTO ENLARGER: Said to combine scientifically controlled enlarging facilities with tilting arrangement making unit adaptable for projection. Enlarger has special patented scratch-and dust-proof film holder, scientifically designed cooling system, and separate precision focusing adjustments for lens and projection bulb. Negatives receive illumination by means of 50-candle power low-voltage bulb and double condensers. Enlarger available in Junior and Standard De Luxe models, both taking negative sizes from 35 mm to 2¼ by 2¼ inches.

DE LUXE DARKROOM OUTFIT ($9.75): Packaged in substantial wooden box with dark walnut finish. Includes: New masking print-frame; new safelight with bulb and filters for use when handling paper or film; three 5 by 7-inch steel trays finished with white, acid-resisting enamel; one dozen-sheet package of four by six-inch Convira paper; one two-ounce bottle Rodinal developer; five M-Q developer tubes; one ½-gallon size can of acid hypo; one eight-ounce footed glass graduate; one 10-inch stirring rod; one stainless steel thermometer; two stainless steel film clips; one four-inch print roller; four 12 by 12-inch blotters for drying dull-surfaced prints; one 10 by 12-inch ferrotype tin for drying glossy prints; one copy of 60-page, illustrated handbook, "Developing and Printing Made Easy."

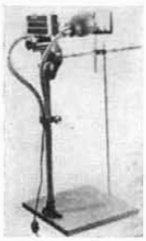
FEDCO ADJUSTABLE DEVELOPING TANK ($3.75): Snap-lock cover makes tank light-proof. Tank made of Bakelite; will not warp. Has wide funnel for filling and side vent for pouring. Complete with agitator rod. Center core hollow to permit insertion of thermometer. Spiral feed reel adjustable to all sizes from 35-mm, 36-exposure rolls, to No. 116, inclusive. Distinguished by red cover.

KODACHROME, PROFESSIONAL, DAYLIGHT TYPE: Now available in following sizes: 2¼ by 3¼ inches; 6.5 by 9 cm.; 9 by 12 cm.; 3¼ by 4¼ inches; 4 by 5 inches; 5 by 7 inches, and 8 by 10 inches. Can be used in ordinary cut-film holders, with any good anastigmatic lens giving critically sharp definition. Weston rating 5; average exposure in sunlight for average subject is 1/25th second at *f*/6.3. Color balance adjusted to produce correct rendering with average noon sun-

light, though certain filters are called for to compensate for variations in daylight color with different conditions of weather or subject. Moderate contrast and fair latitude. Packaged in boxes of six films each, box also containing envelope for returning films for processing.

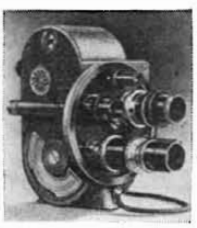
LAFAYETTE TWIN-LITE: Provides means for mounting lamp reflectors of clamp-on type. Extended to full height, tubular steel stand elevates lamps to more than six feet; telescopes to any intermediate length and when folded measures only 21 inches overall. Tripod base locked automatically when open for use. Each section of telescoping column equipped with pressure clip to lock it in position after adjustment for height. Reflectors clamp on 20½-inch cross-arm; one or two lamps may be used as desired. Weight of stand slightly over one pound.

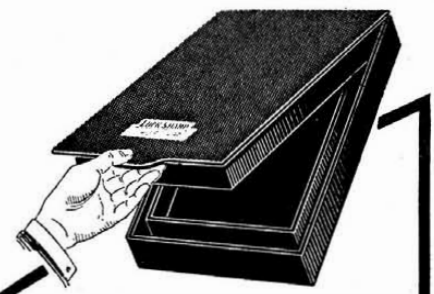
TECHNISCOPE: For micro- and macro-photography. Combination unit comprises equipment for taking pictures through the microscope; making or copying stereopticon slides; making close-up photographs of small objects; copying letters, manuscripts, and book pages. Said to be particularly useful in reducing projection slides of old standard sizes and X-ray films to the 35-mm miniature standard size. Sliding focus "head" can be adjusted to vertical or horizontal position. May also be removed and taken into the field for use with tripod in photographing small objects.



JIFFY SLIDE BINDERS ($1.50 box of 18): Metal binder for framing 35-mm color and monochrome slides. Slide is placed between two masks and two cover glasses and put inside binder; edges of binder are then simply bent down with fingers or pencil. Kit contains 18 aluminum binders, 36 silvered masks, and 36 thin cover glasses.

TURRET MODEL 8-MM FILMO MOVIE CAMERA: Featured is a lens turret accommodating three photographic lenses and carrying three positive view-finder objectives. As turret is rotated, bringing a photographic lens into position before the aperture, the correct view-finder objective is automatically positioned. Permanent critical focuser located horizontally opposite photographic aperture. Positive type view-finder projects picture area in such a way that it cannot vary with angle at which eye looks into eyepiece. Two models of the Turret 8 offer two speed ranges of four speeds each: Model 134-K—8, 16, 24, and 32 frames per second; Model 134-J—16, 32, 48, and 64 frames per second. Each model furnished with one lens: 12½-mm *f*/2.5 U. F. Myal Anastigmat, and corresponding view-finder objective, as regular equipment. Additional lenses are offered as supplementary equipment.





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. What are the advantages and disadvantages of hypersensitizing film in order to increase its speed?—J. C.

A. The fact made public by Agfa Ansco Research Laboratories that film emulsion subjected to the action of mercury vapor can be increased in sensitivity from 50 to as high as 150 percent of the original speed, is obviously a boon where great film sensitivity is required. This is the great advantage of the process. Another is the fact that if a roll of film is known to have been underexposed, the hypersensitizing treatment can be applied after exposure to "add" the required speed up to as much as 100 percent or double the speed of the film when exposed. Also, the maximum effect of the process is obtained by treatment both before and after exposure of the film, bringing additional speed up to 150 percent. The disadvantages, if so they may be called, include the length of the hypersensitizing period, 30 hours for loosely rolled, uncovered film, and from 6 to 8 days for paper backed spools or 35-mm magazines; and that if there is too great a lapse of time (three to four weeks) between the completion of hypersensitization and actual exposure of the film, the added speed wears off.

Q. Our high school is planning to purchase a camera suitable for taking all pictures needed in their year book. We take most of the pictures indoors. The camera should be one that will take both group pictures and portraits. I should appreciate it if you would give the approximate cost of such a camera and the names and addresses of dealers handling these cameras.—R. F.

A. A proper reply to your inquiry can be made only with a knowledge of several factors not included in your inquiry; namely, the amount of money you are willing to spend on this equipment, the size negative you desire and whether you wish to print by contact from relatively large negatives or to make enlargements from smaller negatives. In the latter case, of course, you will require an enlarger unless you intend to have the processing done by a photo finisher. Quite a number of camera types are suited to the sort of work you have in mind, from the 35-mm miniature up to the professional 8 by 10. Generally speaking, for group and single portraits, a view camera affording negatives 4 by 5 or 5 by 7 inches, or a film-pack camera exposing negatives 3¼ by 4¼ or 4 by 5 inches, either camera equipped with a lens of at least *f*/4.5 maximum aperture, should be most suitable and least expensive for the kind of work you indicate. We are assuming that the negatives are to be printed by contact. We refer you to the advertising columns of this magazine for dealers who handle various types of cameras.

Q. When using glossy bromide paper, I find it has a bad curling tendency which makes it difficult, after exposure, to immerse it properly in the developing solution; that is, to insure the developer covering the paper evenly to the edges from the start. Can you suggest how the paper may be straightened to avoid this inconvenience?—D. C. K.

A. One of the surest ways, of course, is to make up a generous volume of developer solution (which is rather wasteful), so that even if the edges of the paper do curl considerably they will be submerged by the depth of the bath, aided by quick manual immersion. The problem is to flatten out the paper before the developer has a chance to do its work. What's wrong with immersing the exposed paper in a tray of plain water and when the paper has become water-soaked and, as a consequence, straightened out, slipping it into the developer? Make sure, of course, to drain the excess water from the paper as thoroughly as possible, before immersion in the developer, to prevent undue dilution of the latter.

Q. In copying articles from journals I have used contact paper to make a negative from which I make a copy of the article which I want to keep. In making my negative I place a piece of sensitive paper (Velox No. 5 single weight) sensitive side toward the printed matter and have the light pass through the sensitive paper; thus the black of the printed matter absorbs the light and the paper remains light on being developed. Where there is no printed matter the light is reflected and the sensitive paper becomes black when developed. Is single weight the thinnest

paper available, as the paper I now use is bulky to go into files? Is there a sensitive paper made which will fold without cracking, which I can use for this purpose?—W. A. R.

A. Papers of the folding-without-cracking, thinner-than-single-weight type are Eastman's Solar Bromide or Line Solar Bromide (for contact printing), with dead matte surface; and Agfa's Nokoline and Defender's Document, both the latter in semi-matte surface. We notice that the sample print which you sent with your letter is on glossy, single weight paper, ferrotyped. Unless you have a special reason for using a glossy paper, you will find the matte and semi-matte papers more suitable and possibly easier to read. Besides, these are the only surfaces in which the paper you prescribe is available. We observe in your print, also, numerous out-of-focus areas which were probably caused by improper contact between the magazine page and the "negative" paper. We would suggest the use of glass to hold paper and subject in contact and weights or pressure of some sort on all four sides, in addition to a flat surface on which to rest the magazine. Since you appear to be doing copying by this method right along, we believe you would find it advantageous to construct a printing frame of the conventional type but with an opening at the side for the pages on the other half of the binding as well as the bulky and interfering binding back.

***Q.* Enclosed are three photographs taken with a photoflash bulb at *f*/11, bulb exposure, and all taken within a few minutes apart. You will note that in one print the candles are correctly registered and on the other two there appear streaks as though the candles were blazing away but the effect does not register as coming from the candles; in fact it looks as though there were more than the actual number of four. The candles were just lighted and were burning very low. The suggestion that the camera was moved during exposure does not seem to fit the occasion as the other objects are all sharp. Can you offer any explanation?—F. K.**

A. From the streaky appearance of the flames and the fact that the flames seem to be "disengaged" from the candles themselves, our guess is that you held the camera in the hand, using an ordinary hand flash. The shutter being open for some time before you actually set off the flash, the candle flames were registered on the film and since you moved the camera, this registration appears as a streak. The other objects, as you say, are all sharp because the only illumination they had was that of the flash.

Q.* Can you suggest a suitable material other than galvanized iron with which to line a dark-room sink?—*P. R. F.

A. Several workers we know have had eminently good success with sheet lead for this purpose. This material being practically inert to acids, other than turning black where the acid is spilled upon it accidentally, no protective coating is required as in the case of such metals as galvanized iron. Lead lining is easily worked because it is relatively soft. However, because of the hazard of cutting holes in it by accidental dropping of sharp or hard objects, some consider the material to be unsuitable for the purpose. On the other hand, since most sinks of the dark-room type are usually provided with wooden racks upon which trays are rested, the danger mentioned is largely minimized. A suitable thickness for dark-room sink lining is 1/32nd of an inch.

***Q.* I am considering the purchase of an enlarger for my camera and would appreciate it if you could give me some information as to where, what, and the prices of some enlargers. My camera takes a 2½ by 4¼ negative, and I would like to have an enlarger to take this and smaller, if possible.—R. J. C.**

A. We do not know of any enlarger specifically designed to take the negative size accommodated by your camera. In selecting an enlarger, therefore, it will be necessary for you to make a compromise and to purchase an enlarger taking negatives up to the longest dimension of the negative made by your camera, which would mean a short dimension of 3¼ inches. In that case, of course, you will need a special mask for your negatives. Since 2½ by 4¼ inches is a rather odd size these days, you may find that in enlarging you habitually crop a portion of the long side anyway. If that is the case, perhaps an enlarger of the 2¼ by 3¼ or 2½ by 3½ inch size might do. This is not an unreasonable assumption, by the way; witness the numerous instances in which the popular 2¼ by 2¼-inch negatives are enlarged, not square, but to a vertical or horizontal rectangle. Any of the photographic supply houses whose advertisements appear in our columns will be glad to furnish literature and prices on request.

***Q.* In ordering from a glass company a large sheet of photographic ground glass for a special purpose I have in mind, how shall I specify my requirements?—L. A. S.**

A. Ground glass is prepared in several grades of fineness; the finer it is, the more expensive. For best results, when used for photographic purposes, it is necessary to specify "mudground" glass. This is the most expensive and is not kept in stock but must be prepared on special order, except in the ordinary sizes used in conventional cameras. However, it is well worth the extra cost.

***Q.* In taking pictures of small animals and birds by remote control or otherwise on the sly, I find that the subject is frightened away after the first shot. It seems that the noise caused by the reflex mirror flying up against the ground glass is a little too much for them. Is there any way I can muffle this noise?—C. S. K.**

A. You probably know that an eveready leather case, with its felt lining, is fairly effective in softening the noise to a moderate extent. But if you do considerable work along these lines, we would suggest a device something on the following order: Construct a box just big enough to take your camera, and line the box well with some noise-absorbing material. Provide openings for the lens and the cable release, making your focusing arrangements in advance. Of course, the design should also include some such arrangement as hinged doors to provide for inserting and removing the camera.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

CONTRARY to the kind of opinion that might be offered by the average person having no background about telescopes, if you wanted to design the one single telescope that would make visible at one single view the greatest number of stars, you would not employ high magnification but low. Taking several governing data as the basis of the design, it is possible to figure out the exact characteristics of such a telescope, and this is just what one of the authors of "Amateur Telescope Making—Advanced," the companion volume to the beginner's book "Amateur Telescope Making," has done in that book. This telescope is named the "RFT," or "Richest-Field Telescope."

The beginner usually tends to crave high magnification and, when the RFT with its low magnification was first described, some amateurs hesitated to make it, knowing perhaps that their neighbors and friends would rate them low when they heard the answer to the inevitable question, "How much does it magnify?" However, the RFT, magnifying 15 or so diameters, becomes popular and is used usually as an adjunct to the "regular" Newtonian magnifying 50 to 100 diameters—its complement, in fact.

S. L. Walkden, of London, has described here in previous numbers several modifications of the RFT, and now comes his Herschelian RFT. The Herschelian type of telescope has had a bad reputation; perhaps it can partly reform. Walkden writes:

"Regarding RFT's: These instruments need not be of only the refractor and Newtonian types; there is another class of instrument, the Herschelian reflector, which very much claims attention. It does so chiefly on account of its brilliancy, due to the absence of losses of light by flat obstruction and by flat reflection. In the small sizes it is nearly as brilliant as a refractor, and in large sizes more brilliant. Because it needs only a mirror and eyepiece its construction is easy; and is further made easy, compared with the Newtonian, because the mirrors of long focus have only shallow spherical curves to be ground, and need not be parabolized like the deep, short-focus mirrors and mirrors made for high magnifications. Of course, the notable weakness of the Herschelian has always been its defective definition, due to the oblique view and the use of ordinary astronomical magnifying powers, but that can be minimized by giving the mirror a proper focal length. Then, with the *very lowest* possible powers (which are precisely those of the RFT's, only 3.5 per inch of aperture), the defect in definition—an occasional trace of cocked-hat shape in the star images—must, in many opinions, be considered sufficiently unobtrusive.

"In Figure 1, a graph of focal lengths for different apertures, a curve marked GDH (standing for "good-definition Herschelian") tells the focal length considered necessary for good definition, because it makes the oblique angle, like α, or EJX in the corner squat diagram of Figure 2, not more than about 6°. This angle has been judged in tests to be the best criterion of definition. [The squat diagram is not to scale. —*Ed.*] The formula used for the curve in Figure 1 is $F=(7.5a^2+15a)/(a-1.5)$, but the curve, read to within a few inches, serves as well as the formula. If with this focal length the instrument is thought too long to manage, less focal length can be used—with less, however, to be expected in the way of definition; but less length than the PDH (poorer-definition Herschelian) curve of the same figure is not recommended. The formula for that curve is $F=(4.5a^2+9a)/(a-0.9)$, allowing the oblique angle α to be as great as about 10°.

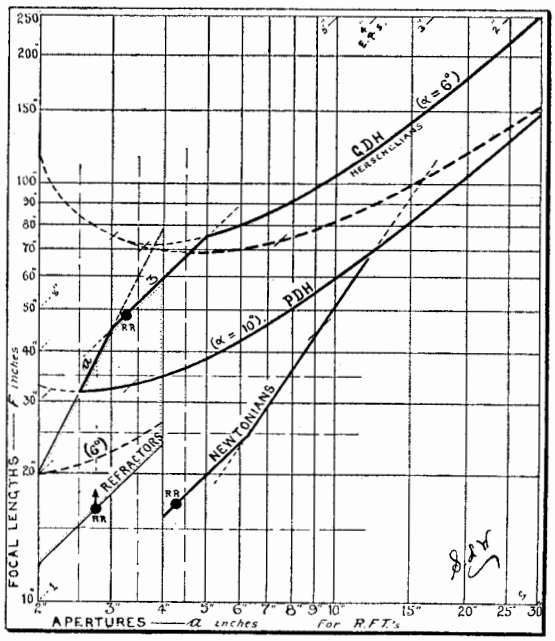


Figure 1: Design data

"From 5″ down to 3″ aperture, the upper limit of focal length is at the thick straight line marked *3*, unless an eyepiece wider than about 3″ is not minded. From 3″ down to 2½″ aperture the upper limit of focal length is at the thick straight line marked *a*—unless an eyepiece wider than the aperture is not minded! Actually, at less than 4″ aperture, and certainly at less than 3″ aperture, the refractor, for which focal lengths are also indicated, is the preferable type of RFT. For it, $F=6a$ is assumed, but $F=5a^2/(a-1)$, shown in the 6° dotted curve, may help the realization of finer definition in these small instruments. Newtonians of greater than 4″ aperture are rivals both for shortness and definition, but fade out in both these advantages at over 10″ to 15″ aperture, and of course are harder to construct.

"When the F inches of focal length of the Herschelian of a inches aperture is settled, the focal ratio $c=F/a$ and the width EK across the top of the instrument (see the squat diagram) may be calculated as $0.3c+a+3$ inches. The top diameter of the main tube at the focal distance, or diameter DK, is then $a+c/5$ inches, and the diameter of the focal image, EL, is $c/5$ inches. The mirror has to be tilted toward the little cross, midway between the points A and B, which points are at the centers of the main tube and the eyepiece tube. The distance AD, which will be found 3″ after using the above rules, allows room for the side of the observer's head, as he observes with his back to the sky and with the starlight coming into the main tube over his shoulder.

"The three black dots of Figure 1 are for general-purpose RFT's of the different types of telescope.

"The eyepiece is to be calculated by the simple rules already given in 'ATMA' for the other RFT's of the same aperture and

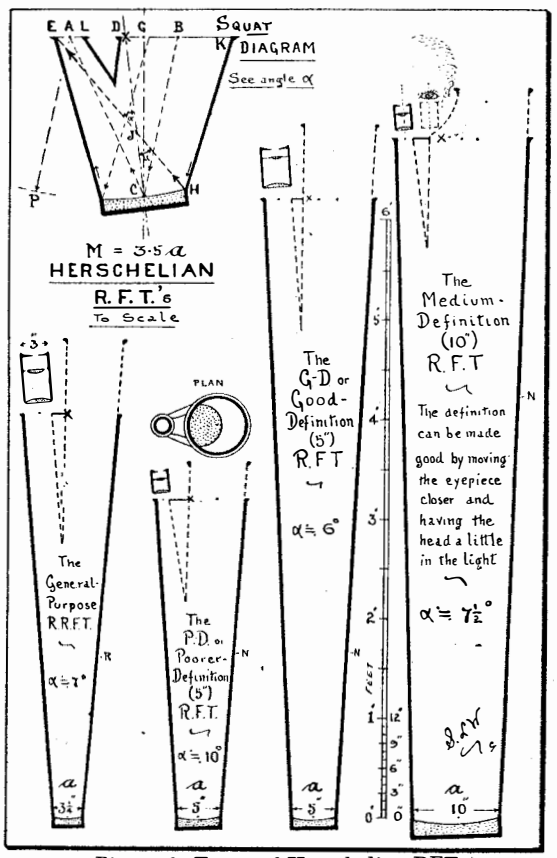


Figure 2: Types of Herschelian RFT

focal length. The little diagonal lines at the very top of Figure 1 indicate some eyepiece sizes, the abbreviation 'e.p.s.' meaning, as will be quite obvious, eyepiece size. For similarly good definition all over the field the eyepiece really needs directing at a point about half way from *C* to *P* (squat diagram) but its best direction is easily found on test.

"It is a good plan to give a Herschelian, especially a large one, a focal length according to the heavy dashed curve for medium definition (drawn freehand in Figure 1, not calculated, but formula is $F=(5a^2+15a)/(a-2)$ inches); as, for example, like the 10″ instrument illustrated in Figure 2; and then, if the definition is not quite all that is wanted, move the eyepiece closer, so that the head intercepts a *little* light. The better definition may be considered ample compensation for the little loss of light not exceeding, perhaps, 10 percent. In larger and larger instruments, more and more of the observer may in this way intrude into the main tube till, at some aperture, perhaps about 100″, the observer may entirely enter the tube. After that he may go to the center, to observe from there, just as already planned for the 200″, and then have no obliquity of view to cause loss of definition.

"The two 5″ RFT's illustrated in Figure 2 show how small instruments of identical aperture compare in length and size of eyepiece, one telescope made according to the *GDH* curve and the other according to the *PDH* curve. The 3¼″ represents the important little general-purpose Herschelian RRFT—superior, at least in illumination, to the Newtonian general-purpose RRFT. It is not according to the *GDH* curve, but it cannot be made longer without becoming unwieldy and requiring a dreadfully large eyepiece. A small number may prefer this Herschelian to a refractor of half its length, on account of the comfortable downward view, and some may like to bring the eyepiece closer to the main tube, even though the head does then intercept a little light. One idea for keeping the head out of the light when the eyepiece is thus put closer, is to incorporate with the eyepiece a compound achromatic prism, bending the light outward through about a dozen degrees and itself absorbing very little light. Some such prism can be balsamed to the eyepiece lens. A more drastic plan is to use a total-reflection right-angled prism or a diagonal, but that may have more drawbacks; besides, it half turns the instrument back into a Newtonian, although one superior in illumination. There is much scope here for experimentalists to find the arrangements they prefer.

"Shorter Herschelians of good definition may possibly be made by those who specially figure the mirrors, but since parabolization has apparently to be done eccentrically, with reference to an axis nearer *AP* than to *XC* (in the squat diagram), only the heroic few, like the makers of Schmidt cameras, may ever attempt that figuring—or perhaps devise ingenious correcting plates.

"So long as the insides of the instruments are of the shapes indicated, allowing free passage for the light, the outside shapes may of course be different, according to fancy or convenience. In the limit nothing is absolutely necessary, except a beam or structure rigidly holding the mirror and the eyepiece in their proper relationship, but it seems better to have something like a tube.

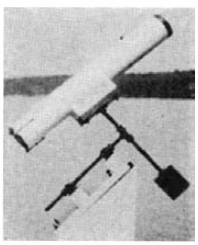
"This is written with the awareness that there are some who can never be indulgent

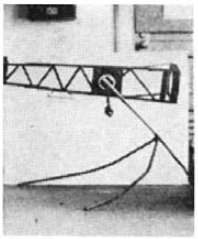
THE BEGINNER'S CORNER

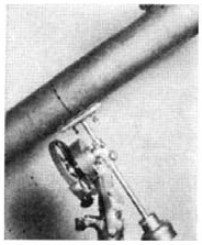
ALTHOUGH "ATM" emphasizes the desirability of mountings that are rugged and heavy—what the machine designer calls "brutal"—a percentage of beginners build telescopes that are far too lightly mounted. Without wishing in any way to reflect on those who built the first three telescopes shown below—for they by now have doubtless sensed the fault if fault it .be—these photographs are reproduced in a group in order to re-emphasize this point. In every case, it will be noted, the telescope itself is excellent, and it is only the mounting, or parts of it, which seem light. In each instance the tubing employed might to good advantage be at least two inches in outside diameter and, if still more, then the more the merrier. Then the star images will not dance about whenever a breeze blows or someone approaches.

The fourth illustration shows a contrast in a telescope made at a cost of $11.60 by Frank W. Dresser, 5208 Larchwood Ave., Philadelphia, Pa. It has a 6″ mirror and, though the mounting is wood (white pine, cypress, and even hemlock), this mounting doubtless is very much steadier. One of the telescopes originally made in 1920, at Springfield, Vermont, by a member of the Telescope Makers of Springfield, was of wood—pedestal, mounting, even the axes—and it was a success.

A way to make sure that a mounting is heavy enough is to design it as would seem to be correct and then double the dimensions of the axes.







TELESCOPTICS

(*Continued from preceding page*)

toward the definition of a telescope, and who would want to boil in oil one who persuaded them to make a Herschelian, but many more will consider they have found the very thing for brilliantly *joy-riding* with low powers around the glorious celestial scenery of the Milky Way. The first kind are recommended to solace themselves by converting their instruments to high-power Newtonians, for the more sober joys of planetary and double-star observation, for which purpose the long-focus mirrors are very suitable."

IN advance of publication of the above has come a testimonial on the Herschelian RFT, part of a letter from Clyde W. Tombaugh of Lowell Observatory—the amateur telescope maker who discovered the first tangible evidence of the planet Pluto. He writes:

"Some time ago, Mr. Walkden suggested to me that I try out my *f*/15 long-focus 5″ reflector [the one shown in 'ATMA' at page 639.—*Ed.*] in Herschelian form as an RFT. So I remounted the mirror on a wooden beam, offsetting the incident pencil 2½″ from the principal axis on one side and the center of the eyepiece 2½″ on the opposite side, and used an eyepiece of 3½″ *e.f.l.* and 1⅞″ field lens diameter. This gives 33X—still too high. Nevertheless, the star clouds and dark holes in Cygnus, Sagittarius, and so on were very beautiful. The definition is good over the whole field, 75′ of arc in diameter. The off-axis effect is only slightly noticeable on the far side of the field."

Tombaugh adds that his eyepiece was a 45-cent, mail-order catalog 3X hand magnifier 1⅞″ in net aperture, plus a simple lens of 2″ *f.l.* taken from another eyepiece, the two separated 2.43″ as a compromise on field and power. This gave an *e.f.l.* of 2.3″. As no out-size eyepieces, like some of those shown by Walkden, are known to be purchasable, the amateur may have to design his own, in the meantime possibly experimenting with some simple makeshift like Tombaugh's. For a 3″ (focal length) eyepiece, Walkden offers the following specifications: *f.l.* of each lens, 4″. Distance of lenses apart, 2.67″. Diameter of field lens, 2.31″, of eye lens, 1.31″.

IN a private communication bearing on the Herschelian RFT, Walkden remarks that "perhaps some of the detail improvers will now get to work on special figurings of the RFT, eccentric and the like, to equip it for high-power magnification and a little less length." Well, that is just what two American amateurs have been doing already—making an offside paraboloid. But we'll tell about this in a later number.

THE telescope shown in Figure 3 is a 4″ *f*/5 RFT, ordinary Newtonian type, made by R. B. Rice, 17 Maple St., Saugus, Mass., who says "the results with this telescope are very fine." But when it comes to enthusing over the RFT, as many have, George E. Dunn, 6906 Bingham Ave., Dearborn, Mich., whose 8″ *f*/4.5 RFT is shown at the left in Figure 4, says: "Mine was disappointing at first and continued to be so until perfect optical line-up was attained. Everest's 'diagonalology' published in your September 1938 number, brings out this matter but it cannot be stressed too strongly for these short-focus telescopes. I found it necessary to redesign the diagonal holder to get closer adjustment and more rigid construction before calling it a job. Even then it was not particularly impressive until one night when it was chucked into the rear of the car and taken into the country. That was my first view of the heavens away from the city haze. My vocabulary does not include much in the way of poetic expression, but no one can describe those clouds in Cygnus as seen through an RFT. This goes also for the double cluster near Perseus and count-

Figure 3: Rice and his RFT

less other regions. Diffraction effects are bad when first or second magnitude stars are viewed, and the RFT is useless on planets. On the other hand it out-performs anything I have looked through for terrestrial work."

NO sooner does the telescope owner begin studying the Moon's map than his curiosity is aroused by the odd names given its formations, mostly names of persons. "Who's Who in the Moon" is a newly published, 130-page memoir of the British Astronomical Association in which these names are explained—some 600 of them—and their owners' personal histories told.

TIME budget of the average TN, as worked out by a telescope widow, Mrs. Howard Morehouse, Dearborn, Mich., assisted by a very accurate stopwatch and two checkers:

Making telescopes..... 90 percent
Talking about them.....9.9 percent
Using them.....You figure it out

INNOCENT literary agent in New York asks: "Would you people be interested in an article on 'How to Make a Telescope'"?

CUSSEGRAIN is what S. S. Weisiger, one of the Pittsburgh amateurs, calls a Cassegrain, no doubt after collimating one.

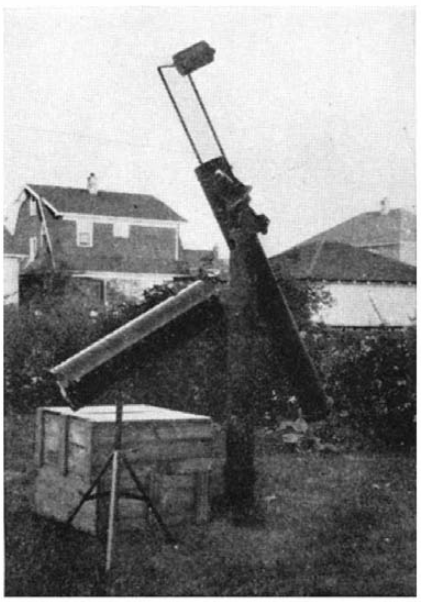


Figure 4: Dunn's two telescopes

CURRENT BULLETIN BRIEFS

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

A MIRACLE BEGINS, by Dr. W. R. G. Baker, is an eight-page pamphlet that gives the straight facts about television—unsolved problems, programs, consumer problems, size of pictures, cost, and future prospects. *General Electric Company, 570 Lexington Avenue, New York, New York.—Gratis.*

VOIGHTLANDER EXPOSURE CALCULATOR is a pocket-size chart of the "slide-rule" type which is adaptable to all parts of the world, all light conditions, and all film-speed ratings. *Willoughbys, 110 West 32nd Street, New York, New York.—15 cents.*

PROTECTING PUBLIC CONFIDENCE IN PERIODICAL ADVERTISING is a 16-page booklet that tells of the work which is being done to insure that the advertising columns of periodicals be kept free from objectionable copy. It is of particular interest to executives and department heads in all concerns which use any form of periodical advertising. *National Better Business Bureau, Inc., 405 Lexington Avenue, New York, New York.—Gratis, as long as supply lasts.*

INDUSTRIAL PRICE POLICIES is a 32-page booklet based upon a research study made by the Brookings Institution, answering such questions as: "What would lower prices mean to business?—to profits? How are prices set in our modern industrial system? How can they be reduced without loss to stockholders or workers? What can the industrial executive do about prices?" Public Affairs Pamphlet No. 23. *Public Affairs Committee, Inc., 8 West 40th Street, New York, New York.—10 cents.*

HATCH-O-DATE is a chart designed to be used by poultry raisers and is especially helpful when several hatches of eggs are placed in the incubator at different times. The chart is designed for eggs having 21 day incubation, but a correction table is furnished for other eggs. The chart includes a monthly calendar. *Pope Brooks Foundation, Inc., Avon, Conn.—10 cents.*

LIGHTNIN PORTABLE MIXERS is a lavishly illustrated eight-page pamphlet that shows various types of gear-driven and direct drive mixers for use in many process industries where small or large scale mixing of batches is a regular part of the procedure. The mixers described are adaptable to use in all types of tanks and cookers. *Mixing Equipment Company, Inc., Rochester, New York.—Gratis.*

VISCOSITY TUBES is an eight-page pamphlet which describes the air bubble method for determining the viscosity or body of varnishes and lacquers, as well as the equipment necessary for this test. Also listed are a number of other devices of interest to chemists in general as well as to paint and varnish workers. *R. P. Cargille, 118 Liberty Street, New York, New York.—Gratis.*

TEGO-BONDED CONSTRUCTION is a 32-page illustrated booklet which describes a modern method of producing plywood and related materials. This type of construction offers the user a panel that is durable, economical, and of practical utility. The method is based on a hot-bonding process wherein the component layers are permanently fused together with dry sheets of a synthetic resin. The manufacture of the panels is described, as are also many of the uses which it finds in diversified fields. *The Resinous Products & Chemical Co., Inc., 222 West Washington Square, Philadelphia, Pennsylvania.—Gratis.*

THE RAILWAY HANDBOOK, 1938—1939, is a paper-covered book which is designed to provide students and other interested parties with a collection of useful statistics and information, particularly regarding the railroads of Great Britain and Ireland. A number of the tables give international comparisons. In the statement regarding the electrification of steam railways it was deemed necessary to cover the whole world in order to present a complete picture of this increasingly important development. Of wide general interest is a ten-page chronology of railroad history. *The Railway Magazine, 33 Tothill Street, Westminster, London, S. W. 1, England.—2 shillings and sixpence.*

HANDLE THE LEICA is a small booklet that is essentially a straightforward sales talk for one particular type of miniature camera, but it contains considerable information which will be of value to any amateur photographer. Request Pamphlet No. 7784. *E. Leitz, Inc., 730 Fifth Avenue, New York, New York.—Gratis.*

THE TIME LAG IN GAS-FILLED PHOTOELECTRIC CELLS, by A.M. Skellett, is a 10-page pamphlet, illustrated, which describes time lag measurements as made with a light chopper on a gas-filled cell of special design. *Bell Telephone Laboratories, 463 West Street, New York City.—Limited free distribution.*

WIRE ROPE FOR MINING AND CONTRACTING is a 96-page catalog which contains not only the usual price list but also has many pages of data as to stresses in suspended cables, stresses in hoist and incline ropes, and specific recommendations as to grades and constructions of rope for various types of power shovels, cranes, and other equipment; as well as a paragraph on the causes necessitating the premature discard of rope. *Broderick & Bascom Rope Company, 4203 North Union Boulevard, St. Louis, Missouri.—Gratis.*

TELEVISION RECEIVERS FOR THE HOME is an illustrated catalogue which describes a table and a console model television receiver, both of which provide a full 8 by 10 inch screen image as well as synchronized sound for complete sight-and-sound radio programs. *Allen B. DuMont Labs., Inc., 2 Main Avenue, Passaic, New Jersey.—Gratis.*

LEGAL HIGH-LIGHTS

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

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

Ice Hockey

A CASE packed with the thrills and interest of one of the fastest sports in the world and involving a well known sporting arena, has recently come before the New York State Courts.

The owner of Madison Square Garden filed suit against a moving picture producer and distributor, charging unfair competition arising out of a motion picture involving ice hockey. In the complaint, the plaintiff pointed out that Madison Square Garden was a sporting arena constructed at great expense, and that it was designed so as to have a large ice hockey arena in which professional and amateur games could be played. The plaintiff also pointed out that he controlled one of the best-known professional hockey teams, the New York Rangers, who were members of the National Hockey League. In order to take moving pictures of hockey games played in the arena it was necessary to obtain plaintiff's permission. The plaintiff then charged that the defendant, knowing these facts, and knowing further that he would have to pay a valuable consideration in order to obtain permission to take moving pictures for use in a feature moving picture play, had produced a moving picture which, while it actually did not have any pictures of games in Madison Square Garden, contained scenes purporting to show professional ice hockey games in New York City, and that many people were misled into believing that they were viewing games being played in Madison Square Garden. In order to encourage this impression on the part of the public it was also charged that the defendant incorporated in the moving picture, photographs taken in a Detroit arena during the Stanley Cup Series of the year 1936-1937, particularly showing plaintiff's team, the New York Rangers.

In its advertising circulars and literature, the defendant repeatedly referred to Madison Square Garden, and it was charged by the plaintiff that when these statements and references were read by the general public they believed that they were viewing professional ice hockey games played in Madison Square Garden.

The defendant made a motion to dismiss the suit on the grounds that the general charges made by the plaintiff in the bill of complaint, as summarized above, did not state a good cause of action. The trial court agreed with the defendant and dismissed the suit. However, on appeal the decision of the trial court was reversed and the appellate court held that the complaint stated a good cause of action. The appellate court pointed out that the plaintiff had built up a substantial good will in the name Madison Square Garden, and that it had also built up valuable property rights in the granting of licenses to take moving pictures of hockey games in Madison Square Garden.

Referring to defendant's moving picture the appellate court stated:

"The public would suppose, and actually did, that the background of the film was an authentic background presenting scenes of actual games in which the plaintiff's team participated in New York. Defendant's circulars referred to the arena as 'Madison Square Garden.' Even in a story that is obviously fiction so far as its plot is concerned, defendants should not be permitted, by the unfair practices alleged, to violate and appropriate to themselves plaintiff's valuable property rights."

Belated Technicality

TECHNICAL defenses are looked upon with disfavor by the courts. This is equally as true in suits for patent infringement as in other types of cases. In a recent suit for patent infringement, brought by a German corporation and citizen in the Federal Court in New Jersey, the patent in suit was held to be valid and infringed. The issues had been thoroughly considered both by the trial court and by the Circuit Court of Appeals on an appeal taken from the decision of the trial court. Thereafter the case was referred to a special master to determine the amount of damages and profits. At this stage of the proceedings for the first time the defendant raised the defense that the German corporation and individual had never actually appeared in the case and accordingly had not subjected themselves to the jurisdiction of the court. Plaintiffs had appeared in the case only by counsel.

The Court pointed out that where an attorney appears for a party in a legal proceeding it is presumed that he has authority from the party to so appear. It also pointed out that this is purely a technical defense and that the defendant should have raised it prior to the trial instead of waiting until after the case had been decided by the Trial Court and reviewed on appeal.

Baby Bath

IN our complex civilization even babies become involved in patent litigation.

In a recent case one of the courts upheld the validity of a patent covering a popular type of collapsible infant's bathtub identified by the name "Bathinette." The patented bathtub consisted of a collapsible support, a tub made of flexible material mounted on the support, and a dressing table pivotally connected to the support so that it could fold from a position overlying the tub to a vertical position exposing the tub. The defendant in the suit was originally licensed to manufacture bathtubs under the patent. However, prior to the institution of the suit the defendant had cancelled the license agreement and had continued to manufacture the bathtubs without the patentees' permission. The patentees filed suit for patent infringement and in the decision referred to above the court held that the patent was valid and that the bathtub manufactured by the defendant constituted an infringement.

Photo Electric

A RECENT decision of scientific interest, involving the most widely used television system, has been handed down by the Federal Court for the District of Delaware. This decision holds that the well-known television pioneer Vladimir K. Zworykin is the inventor of the system. Aside from the fact that the court credits Mr. Zworykin with the invention of this system, the decision is of interest to inventors and to industry because it illustrates two important points. The first point is that applications are frequently kept pending in the Patent Office for protracted periods of time without any fault on the part of the inventor or on the part of the Patent Office. Mr. Zworykin's patent application was filed in 1923 and was still pending at the time of the decision due to the fact that it became involved in a series of interferences with the applications of other inventors claiming to have conceived the whole or part of the system described in the application.

The second point illustrated by the decision is that while no new matter may be added to a patent application after it has been filed the patent application may be amplified so as to include matter which is obviously necessary and well known.

The photo-electric cell employed in the television system involved in the dispute consisted of a layer of aluminum foil, an intermediate layer of an insulator, such as aluminum oxide, and a layer of potassium hydride. In order to make the cell effective for television purposes it is necessary that the layer of potassium be formed of discrete particles electrically separated from each other. As originally filed, the Zworykin application did not specifically state that the layer of potassium was formed of discrete particles. However, it was subsequently amended so as to include a statement of this character. It was contended by Mr. Zworykin's opponent that the amendment constituted the insertion of new matter into the patent application and accordingly was improper. The Patent Office sustained this contention and suit was filed in the Federal Court in behalf of Zworykin. The Federal Court took a different viewpoint from the Patent Office. The Court found that at the time that the Zworykin application was filed the current literature showed that it was well known by those skilled in the art that the layer of potassium had to be formed of discrete particles. The Court also found that the current literature of the time showed that the only way known for making a photo-electric element of this character was by the process of depositing potassium from a vapor and that the potassium when thus deposited could exist only in the form of separate and discrete particles or globules. Under the circumstances it was held that the amendment did not insert any matter in the application but merely amplified it by including a statement of what was obviously necessary and also well known in the art at the time.

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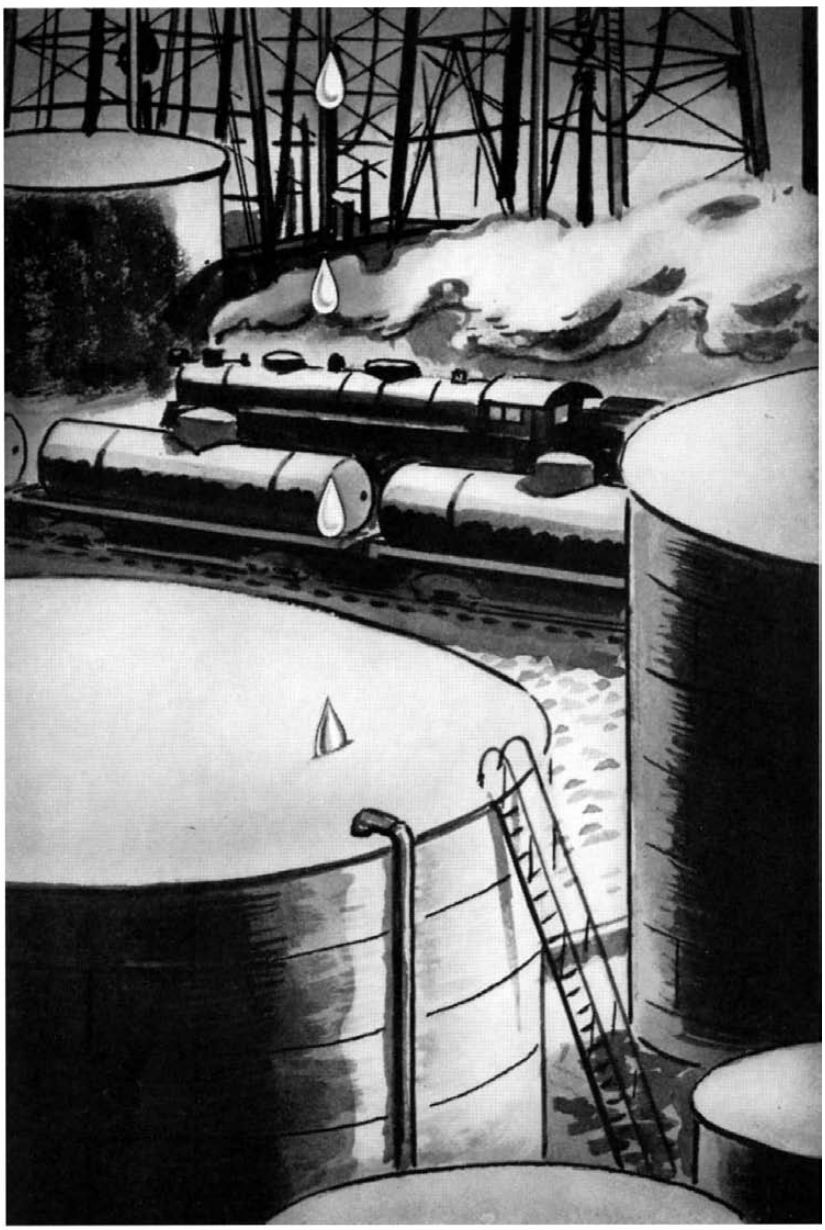

LIQUID... volatile ... powerful ... tetraethyl lead has a mysterious and valuable effect upon gasoline. Just a small quantity added to a gallon of gas improves its anti-knock value. It acts to prevent the power-wasting "knock" or "ping" that years ago might well have throttled the development of the modern automobile's high compression engine.

Today tetraethyl lead is the active ingredient of the anti-knock fluids used by oil companies the world over to improve the anti-knock quality of their gasolines. This enables car owners to take advantage of the high compression engines built by the automobile industry in recent years.

Today every car has 3 grades of performance

Because there are different grades of gasoline sold today, your car has different grades of performance, depending on the gas you buy and your spark setting. Use the chart below to help you make your choice:

BEST PERFORMANCE—with gasoline marked "Ethyl" on the pump or globe. It is highest in anti-knock and all-around quality. Contains enough tetraethyl lead so that your engine's spark can be *fully advanced* for maximum power and economy without "knock" or "ping."

GOOD PERFORMANCE— with "regular" gasoline which permits the spark to be considerably advanced without "knock" or "ping." Most "regular" gasolines now contain tetraethyl lead, as shown by the "Lead" signs on the pumps.

POOR PERFORMANCE — with low-grade gasoline, poor in anti-knock quality. With low-grade gasoline in a modern car, the engine's spark must be *retarded*—which means *loss* of power and economy.

TUNE IN ON "TUNE-UP TIME"

featuring Walter O'Keefe, Andre Kostelanetz' Orchestra... Kay Thompson and Rhythm Singers ... Thursdays ... Columbia Broadcasting System, 10 p. m., Eastern Standard Time

ETHYL GASOLINE CORPORATION, *sole manufacturer of anti-knock fluids containing tetraethyl lead*

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That is why five out of six American families own radios, why four out of five have automobiles, why one out of three owns an electric refrigerator. That is why America has today the highest standard of living the world has ever known. And General Electric scientists, engineers, and workmen, by applying electric power to the machines of industry, have done much to make this progress possible. Their efforts today are directed to the task of bringing about still higher living standards.

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