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WHICH ANIMALS LIVE LONGEST?

All the Sciences

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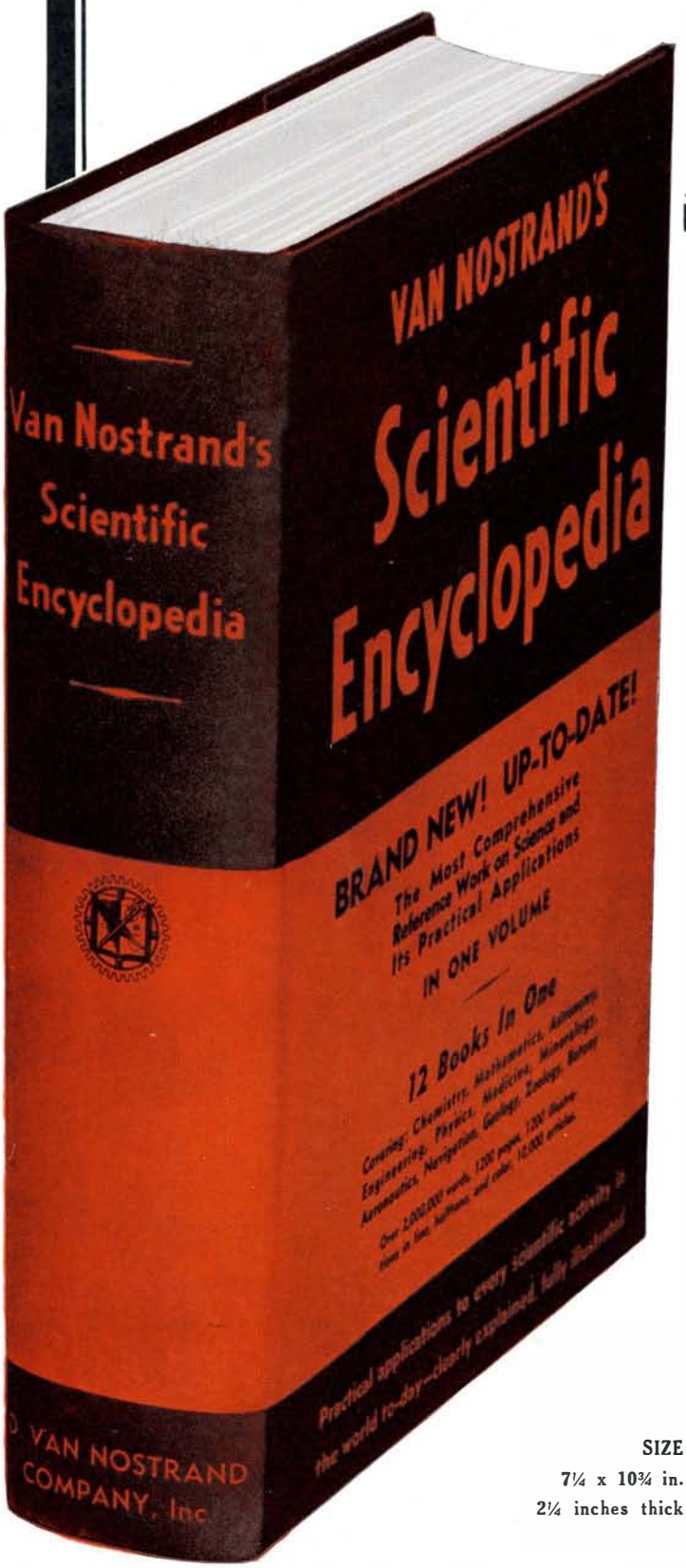
1200 Illustrations



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THIS MONTH'S cover illustration is not a 4th of July display; it is a striking photographic study of what happens during the flash welding of two pieces of steel in the General Electric plant at Schenectady, New York. Two semi-circular pieces of steel are being fused into a magnet frame for a direct current motor. Asbestos curtains restrict the flight of the sparks shooting from the welding machine.

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

JANUARY • 1941

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HOW DO WE RATE?

"OF COURSE, the Old World's scientists are *miles* better than ours."

To a remarkable extent, considering the inaccuracy of their implications, honest beliefs represented by this sample remark heard in conversation appear still to be held in our land. Oddly enough, an opposite type of belief, typified by the assertion "Aren't our scientists the best there are?" appears to exist with them. Just where, then, do these United States of America stand in science, meaning pure science—physics, chemistry, the biologic sciences, and the like?

Largely, of course, the answer to such questions is a matter of opinion, for there is no exact, perfect way to weigh and assess a scientist or a nation's scientists quantitatively and qualitatively. There is, however, a gage which it is believed most objective persons will accept, and this is the carefully weighed and formulated, combined judgment of the Swedish Royal Academy of Science and Caroline Medical Institute, in selecting scientists for Nobel Prize Awards.

An analysis of the Nobel awards in physics, chemistry, and medicine (including the biological sciences) has recently been made by Professor Harvey C. Brill, of Miami University, Oxford, Ohio. Nobel Prizes have been awarded since 1901. Taking the entire period of years, Germany has won the largest number. The numbers are: Germany 37, Great Britain 21, France and the United States each 15, Holland 9, Sweden and Austria each 6, Switzerland 5, Denmark 4, Italy 3, Canada 2, and Spain 1. Our rating here appears fairly satisfactory.

But, as Professor Brill observes, such ratings do not tell the whole truth, so he works out a rating based on population, giving to each nation what he terms a "percentage attainment." The nations now run as follows: Switzerland 417 percent attainment, Denmark 400, Sweden 300, Germany 185 (less than half as good as Denmark's), Great Britain 175, Austria 120, France 115, Canada 67, Belgium 40, the United States 38, Italy 23, and Spain 13.

Professor Brill next breaks the total figures for 1901 to 1939 into two great groups, the first for the years 1901 to 1930 and the other for the last decade. Taking the early group of years, again the little nations run far ahead of the ticket, Denmark leading with 500 percent attainment, Sweden following with 423, Holland with 400, Switzerland with 300, Germany with 180, Great Britain 167, Canada 87, Austria 81, Belgium 55, Italy 21, the United States 18, and Spain 15. In those early years we did poorly.

Far better are the findings for the most recent decade. Switzerland wins a 465 percent attainment, next comes Holland with 217 percent, then Great Britain with 175, Austria 162, Germany goes down with 135 and the United States goes up with 78; France with 44 and Italy with 22 are below us. Our score of 78, for the years of the last decade, is *more than four times* the 18 we received as an attainment score for the earlier years of the prize awards.

And now, how about quality? Since Nobel Prizes are awarded to individuals and not to nations, it is logical to assume that quality averages approximately the same wherever the prizes are awarded.

In sum, our product, the American pure scientist, has reached standard level in quality, and apparently we are entering on the early stages of mass production in the matter of quantity. Since we already have stood high in inventiveness, railroading, automotive engineering, aviation, telephony, and other aspects of applied science, the signs are auspicious for ultimate high rank in both—especially since, in the past decade or more so many corporations such as Bell Telephone, General Electric, and Westinghouse, have clearly demonstrated their far-sighted and imaginative qualities by going in for pure science wholeheartedly, along with applied science. Even though pure science probably pays big dividends in actual money, and these corporations know it, their attitude in helping lift this nation in pure science is not based wholly on desire for gain.—*A. G. I.*

FLEET GROWTH

ONE day last June, an audience of New Yorkers watched an ungainly, yet enormous and somehow consciously powerful, hull slide down the ways at the New York Navy Yard in Brooklyn. It was the battleship *North Carolina,* far from complete and therefore riding high and cork-like.

More than 15 months, we were told, would be required to complete her and her sister, the *Washington,* which preceded her into the water at another yard. Yet both of these were about 80 percent complete the middle of last November and both are expected to go into service several months ahead of schedule. They will raise our battleship total to 17. (Britain has 14 officially, but has doubtless added five more, secretly, since the war began.) Four more of our battleships, the *Alabama, Indiana, Massachusetts,* and *South Dakota,* will be launched late in 1941 or early in 1942.

In other categories, American construction goes on apace. In 1940, we completed 13 submarines, each of about 1480 tons, and we will add 11 more in 1941. Destroyers have gone into commission at the rate of one a month, and about 15 more will be completed in 1941. Past the half-way mark in construction is an aircraft carrier, the *Hornet.* Light cruisers to the sum of 10 are on the ways or getting their finishing touches, while 15 submarine chasers and 40 motor torpedo boats should all be completed in 1941.

This powerful group of warships, which does not include any units of the 70 percent increase for our "two-ocean" navy, will be a credit to the nation when all are manned by well-trained sailors. Speed in building our "two-ocean" navy is now necessary, for it will take several years for us to complete that remarkable program. Nevertheless, even now, the United States is much nearer the point where she can merely whisper "beware," and have her voice echo thunderously in the ears of all aggressors who would menace this hemisphere.—*F. D. M.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of January, 1891)

CANAL—The Panama Canal is actually a thing of the past, and Nature in her works will soon obliterate all traces of French energy and money expended on the Isthmus. Reports of October 25 say that the late heavy rains have caused vast slides into the canal from the hilltops near Obispo, and the canal excavation at Circaracha is entirely filled up.

PIKE'S PEAK—The Manitou and Pike's Peak Railway is now a reality. The trial trip over the entire line was made October 20 last, and subsequent operation of passenger trains over a large portion of the road has proved the full success of the undertaking. . . The road is operated by the

Abt cogwheel system. The maximum degree of curvature is 16, or a curve with a radius of 359 feet. The length of the road is a few feet less than nine miles, of which two and three-quarters miles are above timber line. The elevation of the station at Manitou is 6,563.3 feet, the summit of Pike's Peak 14,115.3 feet, the elevation overcome between the points being 7,652 feet.

DEATH VALLEY—Secretary of Agriculture Rusk has been for some time engaged in organizing an expedition to explore the famous Death Valley in Colorado. . . There is reason to believe that there are rich gold and silver mines in the region named. . . The scientific men with the expedition will map the country and procure specimens of such animals and insects as exist there, if any do exist.

POWER—A company is organized for utilizing the enormous water power of Lake Superior and constructing very extensive works in the vicinity of Sault Ste. Marie. The waters of Lake Superior fall at the Sault about 30 feet to the level of Lake Huron, the velocity being recorded by Gen. Powell of the United States service as a little more than 90,000 cubic feet a second. Careful and accurate measurements and calculations show the actual velocity and volume of water to be 122,000 feet per second, equivalent to 236,000 horse power.

TUNNEL—Since our last account . . . about 470 feet have been added to the Hudson River tunnel, which brings the total completed length up to 2,720 feet. This indicates a progress at the rate of about 7 feet per day.

RECLAMATION—Antelope Valley, in San Bernardino and Los Angeles Counties, a high intermountain plain or basin stretching between the Mojave Desert and the upper part of the great Colorado Desert, has been considered, until recently, almost irreclaimable. There are now upon it several great fruit colonies. . . The land now irrigated amounts to 10,000 acres, and will be increased to 25,000 acres. . . This is the beginning of what is believed will result in the reclamation of the whole valley, and even of the Mojave Desert.

NECKTIE—Where will the progress of instantaneous photography end?. . . We have already made known the photographic opera glasses and hat; but now we have something cleverer, and designed to meet with great success among practicians: it is a question of a necktie provided with a pin. The latter is an objective, and the necktie is a camera. When any one approaches you and speaks to you at a distance of 2 or even 3 ft., you press a rubber bulb concealed in your pocket, and you have the portrait of your interlocutor.

STEAMER—On the steamship *City of Paris* there are sixty firemen, who feed the fiery maws of fifty-four furnaces, that create steam in nine steel boilers. Fifty coal passers shovel the fuel from the bunkers to the furnace doors, and the firemen toss it in.

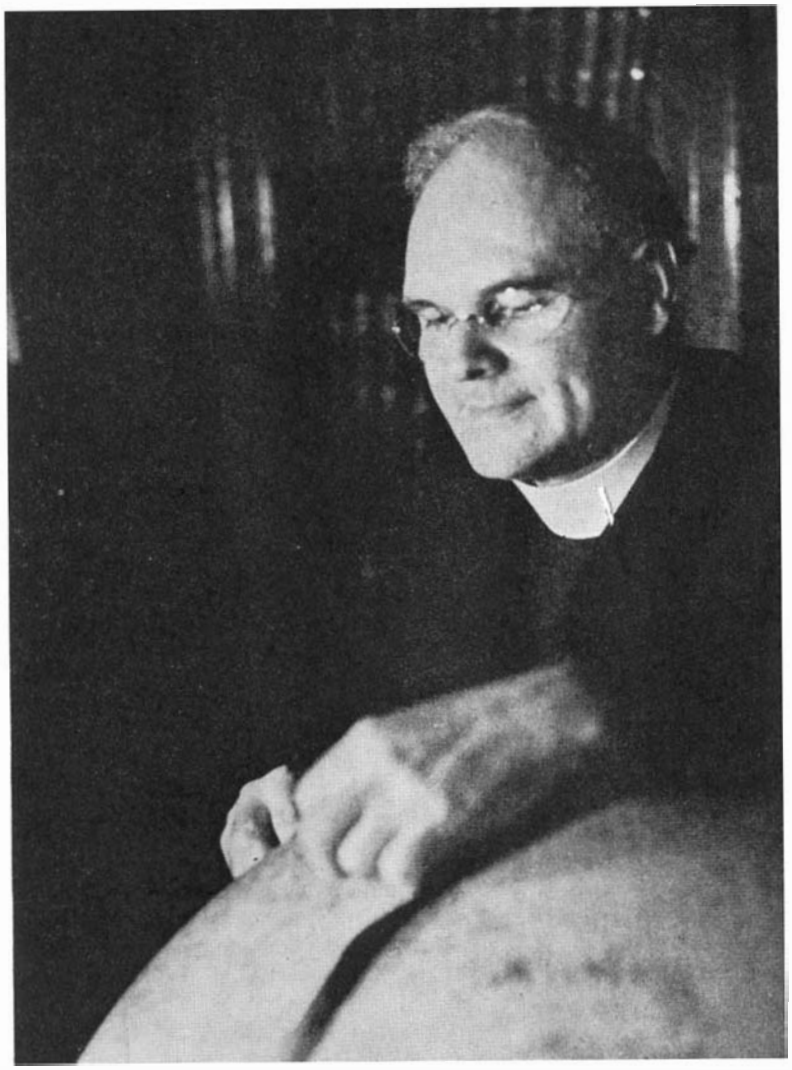
STAR MAPPING—Upon various mountain peaks in the heart of the Andes, from 4,500 to 14,000 feet above the sea, there have been in use for nearly two years past two portable houses, built in Boston in the fall of 1888, and forming the home of a corps of scientists from Harvard University. They are making a map of the southern heavens, after a plan similar to that of mapping the northern heavens, which has been in progress at the university observatory for some years.

SUBMARINE—The French submarine boat *Gymnote* was recently tried at Toulon, and demonstrated its ability to pass through a blockaded line and escape attention in spite of systematic efforts to watch, trace, or discover its course.

CHICAGO FAIR—The last act necessary to start into booming activity the gigantic works pertaining to the great fair has been performed. The presidential proclamation has been issued, and soon we shall see holes in the ground and structures in the air.

CRUISER—On the 22d of December the new U. S. steel cruiser *Newark* had her official trial trip, and proved a great success, the contract requirements being exceeded by about five hundred horse power. . . It is confidently expected that the final figures will show that 9,000 horse power was developed. . . The armament of the *Newark* will be twelve six-inch breech loading rifles; four rapid fire guns, two three-pounders and two one-pounders; four revolving cannon and four Gatling guns. There are also six torpedo launching tubes. Three steel masts are adapted to carry fore and aft sails, and the fore and main mast have military tops.

Personalities In Science



REV. JAMES B. MACELWANE, S. J.

ONE of the most prominent and active personalities among those contributing to the growth of the science of geophysics is Rev. James B. Macelwane, S.J., director of the Department of Geophysics at St. Louis University, St. Louis, Missouri.

He was born in 1883 near Port Clinton, Ohio, and there he spent his boyhood days getting his education and helping his father conduct a fishing business and grow fruit.

In 1903, James Macelwane became a member of the Society of Jesus, and in 1910 he began his studies in seismology, a basic branch of geophysics, at St. Louis University. In 1911 he received his M.A. degree, and in 1923 he received his Ph.D in physics from the University of California.

In 1925 he was called back to St. Louis University to inaugurate its department of geophysics, the first department of its kind to find its way into an institution of learning in this country.

Father Macelwane, as director of the central station of the Jesuit Seismological Association at St. Louis, is at the head of 18 seismological stations located in different parts of the country. By an arrangement with Science Service, data of important earthquakes are telegraphed at once to its offices in Washington, also to the University of St. Louis, from the more important of these stations, from the stations of the United States Coast and Geodetic Survey, and from many other stations in the United States and Canada. This information is interpreted and the location of the epicenter of the earthquake is tentatively determined by the United States Coast and Geodetic Survey in Washington and by the central station in St. Louis. If the two independent determinations agree, the result is immediately released for publication. All these reports, together with many others received by mail, are then published in a preliminary bulletin from St. Louis and sent to more than 350 institutions in all parts of the world. Father Macelwane has worked out a table of travel times for earthquake waves that is now widely used for routine location of earthquake epicenters.

Besides his extensive work as a teacher and organizer in university education, Father Macelwane does a great deal of research in seismology, having made some notable contributions to our knowledge of the paths of elastic waves. Seismology is an exact science which makes use of mathematics to solve the problems connected with the travel of elastic earthquake waves. In his book, "Geodynamics," Father Macelwane has mathematically established the basic principles for interpreting the data of seismological observation. As a result of his research on seismographs he has devised a number of new instruments for special purposes.

He is joint author with Father F. W. Sohon, S. J., of the textbook, "Theoretical Seismology," editor and joint author of Bulletin 90, "Seismology," of the National Research Council, joint author of "Internal Constitution of the Earth," and the author of over 120 published articles on geophysics and other subjects. He is now writing a semi-popular book which he will entitle "Seismology."

Father Macelwane has more than a reading acquaintance with many languages—English, German, Italian, French, Spanish, Latin, and Greek.

Although he is extremely busy in his work of teaching, administration, and research, he faithfully performs his duties as a Catholic priest and member of the Society of Jesus. He is soft spoken, charmingly modest, and lavish with his time to those who seek his advice and direction—qualities that have endeared him to his students and fellow scientists the world over.

THE OUTER MUMMY CASE OF EGYPT'S KING PSUSENNES

THOUGH the war in Egypt finally put a stop to the archeologist's labors there, one enterprising archeologist, Professor Montet, was able, before it interfered with him too greatly, to excavate the recently discovered tomb of King Psusennes, dating roughly 1000 B.C. Nested within two outer and larger sarcophagi was this magnificent one of solid silver, seven feet long, carved and engraved and in almost perfect condition. The discovery is more fully described on page 27, and would have received far more public attention—probably comparable with that given the tomb of Tutenkhamon in 1922—had the world not been preoccupied with current events of vaster moment.

ANIMAL METHUSELAHS

Which Animals Live the Longest?

BARCLAY MOON NEWMAN

A MAN springs from longevous stock. None surpasses him in ruggedness of constitution. Throughout his life he receives the most expert medical care, which he heeds in regard to both hygiene and diet. He is blessed with health that endures—until he is stricken, lethally, apparently by the mere accumulation of years. His span of life is at an end.

When he dies, seemingly of "old age," this man—or any man—could not have lived much longer than a century. All available, trustworthy records indicate that, invariably, even under the most favorable conditions of heredity and environment, a centenarian soon reaches the maximum limit of duration of human life.

The life span of an animal species is the maximum potential longevity—under the most favorable conditions of inherited constitution and of environment. The average length of life of an animal group is the average number of years accumulated at death—no matter how the individuals die, from "old age" or not. Because of the discoveries of medical science, the average length of life of civilized populations has increased a score of years within the century. On the other hand, it is claimed that the maximum potential longevity—the life span—has decreased slightly within the past century or two. Thus, there are more older persons, but fewer old gaffers of extreme age.

From observations and experiments on other animals, light is thrown on the factors in the aging of man. How does man's life span compare with the life spans of other animals? What are the striking facts concerning animal longevity? What form is the Methuselah among animals?

Of course, in a sense, certain simple types of animals are immortal, at least potentially so—until accidental death, including disease, strikes them down. For instance, by extensive laboratory studies it has been shown that individuals of some species of one-celled, microscopic animals can maintain their

MEDICAL SCIENCE

vitality undiminished indefinitely, and, in fact, may have remained youthful from time immemorial. How old was the living animalcule model which, under the lens, posed for the drawing of our example Eudorina? There is no way of finding out. Perhaps it was swimming in some forgotten pond millions of years ago.

Here, however, a problem in philosophy is involved. As a general rule, an animalcule does not long maintain its individuality. It may multiply frequently within the day, by dividing itself each time into two separate cells, and continuing to repeat the reproduction, until its personality—if we can use the term—is split into numerous new individuals. In the case of the first division alone, which one of the two new organisms is to be called the original personality? They are twins. It would seem logical to conclude that eventually the original individuality is lost. Immortality of this variety is, from man's viewpoint, unsatisfactory. Such immortality is racial, not individual in the full sense. Man, capable of reproduction, appears to have a similar, racial immortality. Still, in Eudorina, as in man, we do meet with cells that never age; bits of human tissue can be cultured in glassware as long as there are technicians to care for them.

Rejuvenation raises another problem. The slipper-shaped animalcule, Paramecium, may undergo periodic internal reorganization, visible under the lens. The chief change is in the nuclear material, believed to be the main center of control of the little creature's life processes. The nuclear material is present in the form of a large nucleus and a small one. In the reorganization, the larger nucleus breaks up and disappears, while a new large nucleus is produced from substances in the small nucleus. Following this manifestation, which takes place when the animalcule is senescent, there is a striking increase in vitality—a return to youth. But youthfulness is—here at least—demonstrated by reproductiveness. The cell becomes a split personality. Individuality, again, appears lost. And yet, we do see that rejuvenation can occur on earth.

THE intervention of man in the life of these tiny creatures is another interesting consideration. By surgery on a microscopic scale, with delicate needles, an ameba can be operated on at regular intervals. Each time, a minute portion of the shapeless animalcule is amputated. Results indicate that, for some unknown reason, the ameba can thus be kept from growing old. Here, verily, is a successful operation for rejuvenation. Moreover, the ameba does not lose its individuality; the repeated surgery prevents division into new individuals. An ameba, then, with the help of man, is a potential Methu-

selah, and more, becomes deathless.

We must search farther, however, if we are to find the real Methuselah among animals—the creature which does not suffer a splitting of individuality and which has the longest *natural* life span.

Certain sea anemones are believed, upon excellent evidence, to live for more than 50 years; there is a record of one which lived more than 66 years. Some, displaying phenomena like that observed among the animalcules, can undergo a division of the individual, reproducing non-sexually in this way—indefinitely, agelessly; they also reproduce sexually.

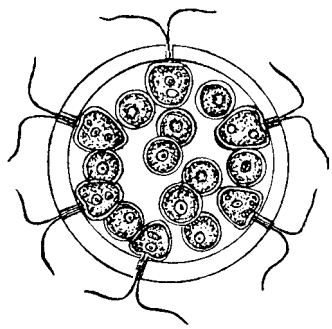
UP ANOTHER rung on the ladder of life, flatworms, with a life span of only a year or slightly more, have representatives which are likewise potentially immortal, and multiply by division, each organism becoming two youngsters. It is even possible to chop a lone flatworm into several pieces, each to become a new whole—just as with the starfish, which oystermen were wont to tear apart because starfish destroy oysters, though fragmenting one serves only to produce several healthy, actively growing young in place of the old one.

As we continue the consideration of cold-blooded, back-boneless animals, we note wide variations in the natural length of life. The earthworm may live ten years, and its cousin, the leech, three times as long. The widespread parasitic worm, trichina, all too frequently sneaking into man from pork not thoroughly cooked, is thought to have a life span as long as that of the leech. Three decades of life is also the maximum which nature has decreed for the crayfish and the lobster. Spiders may live half as long, and other spiders, with a life span of seven years, are only half as fortunate as that.

Especially annoying houseflies appear to live on deathlessly, but the authorities record only a 76-day span. The bumble bee ages to death in a year. As for honey bees, investigation has shown that drones have an existence of a few weeks, workers eight to ten months, and queens six, perhaps seven, years.

The soldiers and workers of the most familiar American termites succumb, presumably because of senescence, within a year or two, whereas worker and female ants are known to live five to as long as fifteen years.

Undoubtedly, the most precise information concerning any insect life span has been built up around fruit flies, which have been bred by the millions for research on the mysteries of heredity. It is frequently stated that a day in the life of the fruit fly corresponds to a year of human life—though this generalization has many exceptions. Further, as in man, in this



When Eudorina divides in two, each part lives on. Man also divides in two, but the larger part dies, only the smaller living on

insect there are short-lived and long-lived stocks, and intermediate spans of life emerge from cross-breeding. Such genetic researches have given rise to deep pessimism, at least in several scientific quarters, regarding the phenomena of aging in man. Length of life seems almost visibly to depend on a secret chemical factor inherited according to fixed laws. For example, there is a stock of fruit flies with small wings; the secret chemical combination producing small wings is handed down generation after generation. The small-wing stock has a short life span. The peculiarity, brief existence, is inherited with, and in the same way as, the other peculiarity, small wings. Similarly, in other stocks, different but equally striking body features are inherited with different durations of life—a specific duration with a specific body feature. These findings, then, are excellent evidence that longevity depends partly on what may be called "inherited constitution." So, at first glance, pessimism about the possibility of extending the natural span of human life would appear justified.

Nevertheless, behind the more or less mystical or ignorance-hiding term, "inherited constitution," lie the secret chemical combinations and reactions which make the body or constitution what it is. There are world-famous scientists who now hold unpublicized, informal meetings to discuss the latest advances toward the solution of the problem of the chemical causes behind aging. What one chemical reaction can do, another reaction may oppose or even undo.

The Methuselah of the insects, according to somewhat doubtful evidence, is to be found among the beetles. Many types of beetles die of so-called "natural" causes, or aging, within 7, 11, 15, or 30 years —depending upon the species. But instances are cited of larvae four decades old.

Snails can glide about for a score of years, while their distant relative, the giant clam, is thought to be of the stuff from which centenarians are made. To many freshwater clams Nature allows a mere ten years or slightly more, while to some species it may grant as many as 150 years.

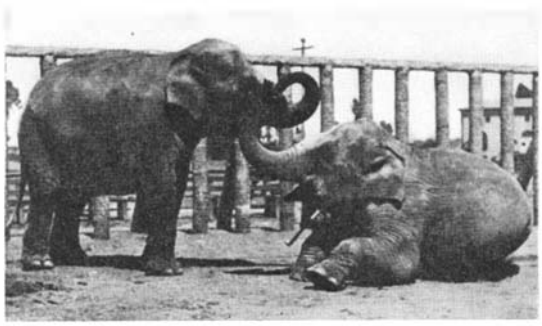
We have climbed to the top branches of the tree of life, whose highest forms are the backboned creatures, the vertebrates, both cold-blooded and warm-blooded. So far, all the forms encountered have been cold-blooded—and the span of life has been seen to vary from hours to more than a century. Cold blood, it follows, does not necessarily mean a long life.

SIZE is not a trustworthy indication of the extent of fated life. Of course, if an animal, such as many a fish, continues to grow throughout its existence, the greater the size, the older the animal is at death. But for a long time it was accepted that, as a general rule among backboned creatures, the bigger the species, the greater its potential longevity. Careful observations have disproved this belief. Potential longevity does not correspond with size. The goldfish may last 30 years, whereas the salmon usually passes on in less than half that period, and herrings within two years. In a year, Goby is no more.

The eel slips through half a century, ending in a dead heat with the carp. The catfish has been clocked at 80 years. Fabulous ages often assigned to the pike do not receive scientific confirmation. William Beebe's bathysphere, however, may someday discover a deep-sea dweller which swam miles beneath Columbus' ship. All discoveries have not yet been made. Conditions down there are nearly the utmost in calm and stability—two of the most publicized factors in realizing one's maximum potential longevity. Many fishes, like a few men, reproduce throughout life.

Amphibians, above the fish in terms of evolution, are below in terms of longevity. Common frogs in six years accumulate changes leading to senility; but it is said that you can come across bullfrogs a full decade older. A Methuselah among amphibians is the giant salamander, which may boast of being a semi-centenarian.

Obviously, reptiles are tough—physiologically so tough that they live a long time. This fact, of course, has given rise to the common belief that all cold-blooded creatures are long-lived. But all invertebrates, as well as fishes and amphibians, are cold-blooded—that is, they have body temperatures which vary with that of their surroundings, whereas birds and mammals maintain a remarkably constant, relatively warm, internal environment for their tissues. Also, many birds outlive many reptiles, and there is great diversity in potential longevity among the reptiles alone. Some lizards can survive only a decade or so, while others have life spans of three or four decades. Every now and then, snakes 30-odd years old are to be met with. Alligators are not as tough as their cousins, the crocodiles, among which semi-centenarians are not rare. Turtles or tortoises, though they do not achieve the years attributed to them by popular fancy, are veri-



On the basis of indisputable record, the elephant is Methuselah No. 1, though there is unproved suspicion that the whale wins

table Methuselahs. Science believes that they can paddle and waddle through seven score to possibly ten score years.

Our interest waxes as we come to the warm-blooded, the birds and the mammals; for now we are considering constitutions very like our own. Physiologically, the constant maintenance of a comparatively high body-temperature makes possible the existence of life in an entirely new guise. A warm, steady internal environment which does not shift with the winds, means increased freedom of activity, a steadier brain, a more agile brain cell, hence the development of powers of the highest order.

Because of the cramping effects of their peculiar anatomy, especially the lesser development of their nervous system, birds cannot realize the full potentialities of this constant warmth; but, as warm-blooded creatures of a type distinctly different from mammals, they do act as a source of important information about the general price to be paid, in terms of longevity, for the privilege of living in the top branches of life's tree. For example, the students of senescence often assert that a very active person, with a high rate of use of energy, will usually not endure as long as the quieter individual; calmness, they say, is the great aid to attaining maximum length of life. Birds are very active, and what creature is more excitable than a hen? Their body temperature may be ten degrees above that of man, and with small bodies having a more rapid loss of heat than the bulkier form, the rate of use of energy is remarkably high. Yet crows sometimes can outlive elephants and whales—and even many species of turtles. Vultures, too, are frequently stated to be centenarians. Records there are to show that geese as well as some parrots may aspire to three score and ten, and beyond. The ostrich, largest bird, is very lucky if it attains 50 years; per pound, its rate of use of energy is less than in its diminutive though longevous relatives. Hence, it has been suggested that that cloak of ignorance, the term "inherited constitution," obscures factors which by pure coincidence bring about the apparently frequent association of high excitability and low potential longevity.

Thus, a person who is overly excitable and overly active (from the popular viewpoint) may be so only because he has a peculiar combination of chemical factors adding up to a defect, and the same defect may, through an unlucky series of chemical events, bring about a rapid aging; in another man, the dice fall differently and the peculiar chemical combination may be the very means to longevity in this particular case, even with an

Dr. George C. Supplee, of the Borden Research Laboratories, recently discovered a longevity promoting vitamin. Such research is beginning to elucidate the influence of food on aging rate

accompanying over-excitability. Certainly, there are numerous cases on record of extremely longevous men who have made it a life-long habit to burn the candle at both ends. Nature works by devious systems, and the problem is not simple.

It is sometimes claimed that the mouse and the elephant must dwell in different worlds of time. The mouse in three years completes what the elephant does not for possibly 80 to 120—the life span. Because of its small size, the mouse loses heat more rapidly and must expend energy at a higher rate to keep a constant body temperature; per pound of bulk, the elephant has a lower energy turnover. Exhibiting this higher physiological activity, the heart of the mouse beats 20 to 30 times as fast as the elephant's. Many scientists have stopped here to speculate instead of going on to experiment and observe more. They tell us that the mouse in its lifetime has somewhat more than a billion heart beats; the elephant in its lifetime, somewhere near the same number. It is implied that our own life spans are dependent upon heart rate.

RECENTLY, Dr. Raymond Pearl, of Johns Hopkins University, a leading authority on aging and mortality statistics, reported that new records concerning more than 2000 dead men ran thus: The short-lived apparently differed from the long-lived in only one characteristic, the heart rate. The average pulse of the short-lived had been above the average man's 72 per minute; the average heart

rate of the long-lived had been below 72. Dr. Pearl and his associate, Dr. W. E. Moffett, tentatively conclude again that, in general, the duration of life depends on the rate of living. At best, this conclusion is merely tentative; so many factors are involved that we do not have any reliable conception of their relative significance.

The white rat, through the agency of Dr. Clive M. McCay and his collaborators in the Animal Nutrition Laboratory at Cornell University, has just increased the intricacy of our already vastly complex problem of senescence. Is the mammalian life span fixed? If not, how can we pick the Methuselah No. 1 among animals? May not some slight adjustment in the environmental conditions force us to give the championship of years to some dark horse? Ten years ago McCay set to work. His results are measureless in their implications. The life span of the white rat—chief source of modern knowledge of human nutrition—has been extended not merely a significant number of months but even so as to correspond to an extension of the human life span to 138 years.

The secret is a slow approach to maturity. Growth is slowed by holding down the number of daily calories; otherwise, the diet is complete. In 10 days, the white rat accomplishes what corresponds to a year in the life of man; in 700 days the creature lives the equivalent of 70 years in human existence. McCay's oldest, retarded rat lived almost 1400 days. The experimenters conclude: "Our data indicate that the retardation of growth affords a method of retarding senescence and extending the span of life far beyond the normal. The method provides an effective technique for attacking the problems of aging within the body of experimental animals. . . . Our philosophy need no longer anchor us to the concept of a fixed life span."

So it is now possible to claim that the belief in a fixed span is baseless and that the potential longevity of any animal is utterly unknown. There is no scientific reason to believe that this discovery could not have been made with the human being instead of the white rat.

An editorial in the *Journal of the American Medical Association* suggests that many so-called normal but pathological conditions almost characteristically found among senescent men and women, such as fragile bones, may really be abnormal, caused by deficiency of certain food factors, possibly including vitamin D. The time may come when all scientists, not just a few, will look upon aging as an unnecessary disease; or it may turn out that pessimism through the millenia has been justified and that the modern Ponce de Leons are in error, there being no fountain of youth nor any elixir of life. We need more facts, countless more, before we can judge.

But what of our search for the Methuselah among animals? On the basis of indisputable records, the elephant, just as is popularly believed, holds the title of Methuselah No. 1 among the mammals, but on the basis of unproved speculation, the largest animal—mammal or not—that ever lived, the whale, wins, with a longevity estimated by certain perhaps imaginative scientists at "several hundred."

Clams, turtles, elephants, whales, and men—these are our Methuselahs among animals. Will man upset all calculations and learn to live on and on, indefinitely? More and more our best scientists are coming to believe in this interesting possibility.

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TOO STRONG

Bones Can Be Broken

By One's Own Exertion

BROKEN bones due to violent muscular exertion are rare, but six such cases were reported by Dr. Frank P. Strickler, of Louisville, Ky., to the American College of Surgeons, according to *Science Service.*

In each of three of these cases, the muscular violence of pitching a ball broke the bone of the pitcher's arm. A young woman broke the bone in her left arm by forcibly throwing her arm out in an effort to catch herself while falling, although her arm did not hit anything.

A structural steel worker broke his knee cap by muscular violence when he was sitting with his back braced helping to push a steel beam into position with his left leg flexed at the knee.

A young farmer broke several vertebrae in the left side of his back when pushing a truck that had become stuck in a mud hole. He felt something give way in his back and had acute pain. At first he thought he had lumbago, but eventually an X-ray picture of his spine was taken and revealed the broken bones.

All the patients made good recoveries.

SCHIZOPHRENIA

New Operation Improves

Chronic Mental Patients

LONG-STANDING cases of schizophrenia, commonest form of insanity, have responded in encouraging manner to a new operation in which fibers of the frontal lobe of the brain are severed. This and other so-called "drastic therapies" were discussed by Dr. Edward A. Strecker, of the University of Pennsylvania School of Medicine, at a recent conference.

The surgical procedure mentioned by Dr. Strecker is known technically as pre-frontal leucotomy, referring to the cutting of white matter in the pre-frontal lobes of the brain. It was devised by Dr. Egas Moniz, of Spain, and was introduced into this country a few years ago by Dr. Walter Freeman and Dr. James W. Watts, of the George Washington University School of Medicine, who have modified the technique. A narrow spatula-shaped instrument is inserted through a hole drilled in the region of the temple and a fan-shaped cut is made in the brain tissue.

The results, he reported, were interesting and sometimes truly amazing. The patients' aggressiveness, in some instances homicidal in degree, disappeared; mental material which one would have believed irretrievably lost was apparently salvaged by the operation and was utilized by the patient in establishing realignments with life; panic reactions due to hallucinosis were terminated. The hallucinosis continued but a recall of the patient to reality in some of the cases was very easy, a few simple questions sufficing. Dr. Strecker said he believed the operation severed the vivid emotional setting of the hallucinations. While the operations did not effect complete cures, "life became bearable and pleasant for patients who before were living in veritable misery."

BROWSING with the Editor

THROUGH THE SCIENCE LITERATURE OF THE WORLD

DURABLE SWITCH—The world's first household mercury switch, which has been operated constantly by means of small electric motors turning the lamp on and off for a number of years, finally gave way recently after surviving 220,000,000 flips. This represents many centuries of ordinary household use.—Notes, General Electric Company.

MOVIE REALISM—Bleached cornflakes are gradually losing their job as movie snow, for some whole movie sets are now being refrigerated to insure greater realism. Also, recently one producer of a tropical picture kept the studio at 98 degrees in order to create an authentic heat frenzy among his actors.

REPULSIVE ODOR—The human nose registers rapidly and emphatically a concentration of butyric acid as small as six parts in 100 billion! This acid is a common constituent of "B. O."—*The Industrial Bulletin* of Arthur D. Little, Inc. No. 161.

BRITISH TOYS—Though Great Britain is not normally considered the home of the toy-making industry, the largest toy-making factory in the world is situated near London.—*Plastics,* (London), August, 1940.

LONG RUN—The longest regular run of a Pullman car is between San Francisco and New Orleans—a distance of 2492 miles.—Notes, Association of American Railroads.

A FORTRESS, A ROAD—Comparing the Maginot Line with the new Pennsylvania Turnpike: 15,000 men worked on each; the former involved 20,000,000 cubic yards of excavation, the latter 26,000,000; the former used 50,000 tons of steel, the latter 46,500; the former used 2,500,000 cubic yards of concrete, the latter 1,650,000. The Maginot Line took 10 years to build while the Turnpike was built in 20 months.—*Highway Research Abstracts,* November, 1940.

LLAMA FLEECE—All the members of the llama family—the domesticated llama; the wild guanaco; the vicuña, source of the rarest textile fabric; the suri, finest breed of alpaca; and the huarizo, born of llama father and alpaca mother—provide for the world's markets about 5,000,000 pounds of clean, usable fleece a year.—*Oil-Power,* November, 1940.

INSECT IMMIGRANTS—There are still at large in the world some 20,000 kinds or species of insect pests, which have not yet been found in the United States.—Notes, No. 1164, U. S. Department of Agriculture.

GASOLINE—American production of aviation gasoline of all grades has reached a record peak of about 45,000,000 gallons a month, or more than 1,500,000 gallons a day; and the supply has more than doubled in the past year.—Fred Van Covern, American Petroleum Institute.

OIL PRODUCTION—The United States produces two thirds of the world's petroleum, has two thirds of the world's refining capacity, and possesses the largest oil reserves in history.—Notes, The Texas Co.

WAR HORSEPOWER—During World War I it took about 4000 horsepower to run a division, but today it takes 187,000—for tanks, trucks, motorcycles, guns, and cannon.—Advertisement, Pacific Coast Petroleum Industry.

DEATH OF FALSE HOPES—Some years after the chestnut blight swept over the eastern part of the nation, killing all chestnuts, the regrowth of stump and root sprouts gave hope that these represented resistant future trees, but now, after 25 years of record keeping, not a single American chestnut tree has been found that can be regarded as truly immune.—Notes, Bureau of Plant Industry, U. S. Department of Agriculture.

PLUMBING, FIXTURES, ETC.—The total of all uses of steel in house construction and modernization in 1937—the last year for which comprehensive statistics are available—is estimated at 700,000 net tons.—*U. S. Steel News,* October, 1940.

FOOD—Approximately 1100 carloads of foodstuffs are delivered by the railroads in New York City and suburbs every 24 hours, on the average.

HOT AS THE HINGES—For the highest temperature ever recorded, consider Azizia, in Libya, with its one-day record of 136 degrees, Fahrenheit—in the shade! Death Valley, California, still holds the record for consistent, high average heat, which has been as high as 102 degrees for a whole month of July.—Dr. W. Gorczynski, Scripps Institution of Oceanography.

ROADS—There are an estimated 3,619,000 miles of highways in the 21 American Republics, of which over 3,000,000 are within the borders of the United States.—*Ethyl News,* October, 1940.

TURTLE EGGS—Loggerhead turtles deposit thousands of eggs in the warm sands along the Florida coast from May until August. Nests are made at night and the eggs are roughly spherical, the shells calcareous, but soft. It is thought that this species of turtle lays three times during each summer: approximately 150 eggs the first time, fewer the second time, and about 80 the third.—*Natural History,* September, 1940.

OIL VERSUS MUSCLE—It would take 8,000,000 galley slaves to propel the *Queen Mary.*—Arthur H. Compton in *The Rotarian,* October, 1940.

THE PEOPLE'S NATIONAL FORESTS—In 22 years, the number of visitors to the national forests has increased from 3,000,000 to 32,000,000; and this figure promises to double in the next decade.—*Forest Outings,* U. S. Department of Agriculture.

BRAIN DRAIN—Gerald Johnson, interpreting statistical tables compiled by Howard Odum of the University of North Carolina, estimates that the exodus of southerners to the north and west has exceeded 3,500,000; and that to rear, school, and then lose this many men and women to other parts of our country, has cost southerners at least $17,000,000,000.—*Forest Outings,* U. S. Department of Agriculture.

CROSS TIES—The number of cross ties in the average mile of railway track is 2994, with an average spacing of 21.2 inches, center to center.—Notes, Association of American Railroads.

Heroes In Glass Houses

High-Speed Planes and Modern Armament Provide Intricate Problems for Aerial Gunners

JAMES L. H. PECK

If the soothsayer who coined that phrase about stone-throwing had a soft spot in his heart, he might well appreciate the lot of the men who live and die in glass houses in the clouds. The stones they cast are of lead and steel; and in the throwing they trace smoking lines which literally write today's news against flaming skies. Among the bravest of air warriors are the men who ride the "rumble seats" of bombing planes—the aerial gunners.

Hectic 1940 will long be remembered for, among other things, the fiercest air war since the birth of the flying machine. This unpredictable year, 1941, may have also passed before the real air score becomes known; but whatever the tally, the flying gunners, of whom the communiqués seldom speak, have chalked up a goodly portion of the thousands of fallen Axis and Royal Air Force warplanes.

The long-range heavy bombers and medium bombers — smaller types carrying lighter loads of bombs and fuel over shorter distances—being employed for the daring and ruthless raids by belligerents are manned by combat crews consisting of two or more gunners in addition to the pilot, bombardier, navigator, et al. The machine gun or cannon armament with which they fend off enemy back-biters is disposed about the plane in such a manner as to provide defensive firepower against other planes from almost any direction. Certain angles forward, to the rear, and below—points from which assault is most probable—are covered by the fire of one gun and may be supported by the crossfire of one or more of the others. The bomber's mission, essentially, is not one of combat; it must penetrate enemy defense and then score. The gunner's job is to ward off tacklers—in the form of enemy interceptors—and an unglorified job it is.

He must sit cramped and alone in the narrow confines of his gadget-filled quarters for hours at a time. He is often cold, having only the shelter of thin plastic or glass walls to protect him from the frigid temperatures of high altitudes. His often-tense body becomes numb from the bomber's vibration; particularly so if his post is in a tail turret, but he must fight off torpidity as he would enemy planes. It is he whose responsibility it is to spot those hostile craft sneaking up from behind or diving down a blinding sun lane. Wherever the station—in nose turret, tail, or fuselage—he remains most exposed to gunfire.

GUNNER casualties run as much as three to one higher than those involving pilots. Because of the difficulty of entrance and exit, his chances of being able to escape from the turret of a disabled ship are small indeed: usually he remains a prisoner in his transparent cell until the crash. He is further bound by the most rigid discipline in the use of his guns. There are times when he must withhold fire until he can almost see the proverbial whites of their eyes; and, just so often, the enemy pursuit pilot who ventures that close can also register a vital burst. There are circumstances under which the gunner must sit idle while he is a target for the whole hostile force, staring death in the face literally and figuratively.

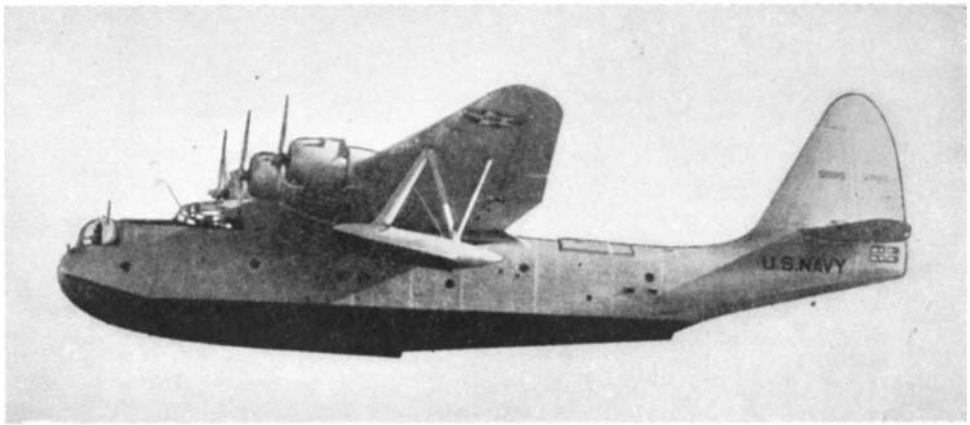
Such an unhappy situation might arise during long-distance operations over extensive enemy territory, such as the RAF forays against northern Italian objectives. Should the bomber be intercepted on the way over, the gunners would save ammunition while the pilot made a run for it. They would not commence firing until it became apparent that the ship and mission were gravely endangered. Such restraint, orders or no, is admirable in the face of imminent death. The reason for this is that ammunition must be conserved for the expected combat at or around the objective—once it is attained—and for the running fight on the homeward leg of the flight. When bombers are intercepted early on the outward leg, the crews may well expect a warm reception at their destination and a hot one on the way home.

Bombing-plane gunners use their armament, for the most part, for defensive purposes. This is also true in the cases of the boys who ride the rear seats of dive bombers,

Official photograph, U. S. Navy

Glass nose turrets and side "blisters" house aerial gunners who can defend these Boeing Flying Fortresses from planes attacking at any angle

torpedo planes, reconnaissance craft, and other multi-seaters. But the fellows who ride back there in the new two-place fighters are back-seat drivers, literally. Their ascendency to World War II authority—only in a tactical sense, as most gunners are low-ranking enlisted men—was a hard-won climb by trial and error.



Official photograph, U. S. Army Air Corps

A Vought-Sikorsky patrol bomber with rotable nose turret and gun emplacement at extreme end of tail. Here hold forth "heroes in glass houses" of this article

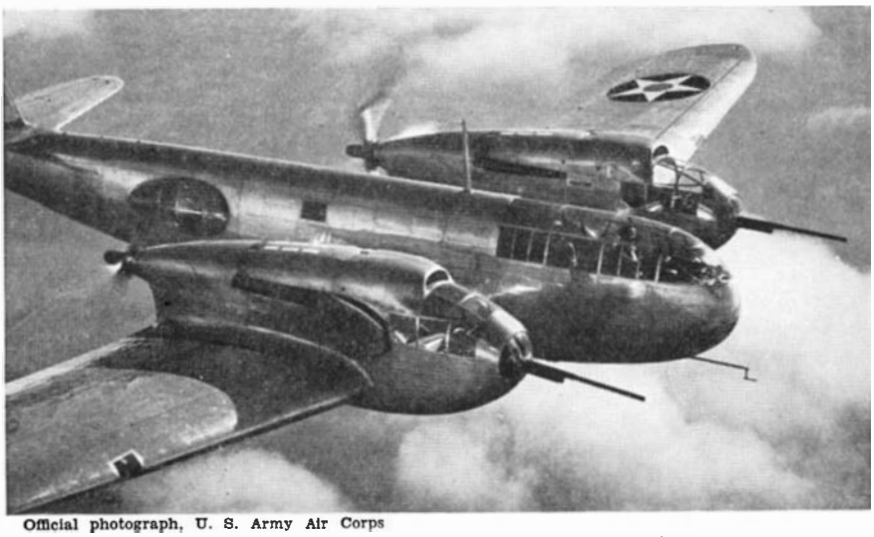
During the early days of World War I, enemy airmen waved greetings at one another as their ships passed in the air. Becoming more belligerent, they resorted to taking pot shots at each other. From this the military took its cue, and the pursuit or "chaser" plane came into being with the development of fixed machine guns that could be synchronized to shoot between the whirling propeller blades. In combat, the pilot aimed and flew his plane straight at the target—which is the current procedure for single-seater fighters—and the guns were actuated by a cable-control device with the triggers, or "trips," mounted handily on the ship's control stick. Then an additional gun was mounted flexibly on the top wing. When two-seater craft were used, this extra gun was installed on a universal-jointed Scarf ring atop the rear cockpit and a "full-time" gunner went along to keep the pilot company. Thus the combat team was born. The man in the front seat did practically all the fighting, and the rear gun barked only when the enemy happened to attack from within its sphere.

A few of the more enterprising combatants entered into the spirit of co-operation. In a sky scrap, after the pilot had done his best with the fixed, forward-firing guns, he maneuvered the plane to give the gunner a play. From then on, teamwork was the watchword. But the man behind that back-seat gun was even more exposed than today's gunners. It was a common occurrence for the pilot to land safely enough, only to turn and see his teammate slumped in a gory seat, draped grotesquely over the cockpit's side, or missing altogether. When the gunner remained unscathed, he was often slumped in his seat anyhow from the sheer fatigue of swinging the heavy armament against the terrific blast of the propeller slipstream. Today, the rotating, power-driven turret swings the guns and also protects the flying artilleryman from a slipstream which may amount to more than 400 miles per hour in combat planes.

Typical of World War II back-seat drivers are those aloft in Britain's two-place fighter, the Boulton-Paul *Defiant*. Here the gunner is ship's captain, and the pilot has only sufficient forward-firing armament to meet a head-on assault; he maneuvers the plane in accordance with the captain-gunner's instructions. Such orders are usually to swing alongside the enemy so that the gunner may deliver a shattering broadside with his multi-gun turret. Just as his tools have been improved through the years, the aerial gunner's trade has become a science; and the ever-increasing performance of fighters and bombers has introduced additional ballistic considerations which give the gunner headaches aplenty.

THE most painful of these have to do with "deflection," or off-aim. Hunters and skeet shooters "lead," or aim ahead of their targets, but their guns are fired from a stationary rest, comparatively speaking. Aerial huntsmen have to bag 400-mile-per-hour pursuits and 250- to 300-mile bombers from ships traveling at comparable speeds, hitting a moving target from a moving station. A gunner firing from a plane in a side-slip, for example, must allow for the fact that his weapons are traveling through *three directions* simultaneously; the slipping ship is moving forward, sidewise, and downward. Roughly speaking, if he were shooting at a plane just 100 yards away—providing that his plane and the enemy's were both flying at a constant speed of 240 miles per hour on 90-degree, perpendicular courses—the gunner would shoot 72 feet ahead of the crossing enemy plane. Speed in combat is rarely constant, however. To facilitate aim, reflector sights—which swing off center to compensate for the effect of the slipstream when the guns are fired at an angle to the planes' paths—are employed, but these only approximate the effect of windage and do not account for the enemy's speed. For head-on shooting with the fixed armament, the pilot is provided with a telescopic or ring sight with concentric circles to gage deflection.

There is another phenomenon called the "Magnus Effect" for which no sights will compensate. This is induced by the spin imparted the bullets as they leave the gun barrel: in most guns, the barrel rifling gives the bullets a clockwise spin. When the gunner swings his armament for a left broadside and fires, the spin causes the bullets to drop in their flight just as top-spin drops a tennis ball. Contrariwise, from a right broadside, the bullets would rise in flight like a golf ball given back-spin. The amount of this up or downward throw depends, of course, upon the ship's speed. When a bullet leaves the gun of a plane traveling at 400 miles per hour, it actually moves sidewise for an interval at this speed, which is two thirds of its muzzle velocity or forward speed. So that the gunner may follow the flight of his bullets, or their trajectories, throughout all this queer behavior, tracer bullets—to which are attached pieces of a phosphorus compound which is ignited by friction as it goes through the air—are employed. Every fifth car-



Official photograph, U. S. Army Air Corps

Gunners in multi-place fighters such as this Bell *Airacuda* must be quick on trigger; speeds of over 350 miles per hour make accuracy difficult

tridge in the belt is a tracer. In daylight, the tracer leaves behind a thin trail of grayish-white smoke; at night, streaks of blue and pink light, like fireworks. Aim is corrected by watching one's tracers.

IN FACT, the fire from the new multi-gun turrets is aimed wholly in this manner, the gunner literally spraying his firepower over the enemy water-hose fashion. The heavy-caliber aerial cannon shells are also tracer-aimed. Typical turrets are dome-shaped affairs having slits in which the guns are elevated or depressed, much after the manner in which observatory telescopes are raised and lowered. The guns are also "swung" with the turret, the whole unit revolving, like the observatory dome, on roller bearings. Hydraulic power, derived from pumps geared to the engine crankshafts, rotates the turret with remarkable speed and ease as the gunner works the two (left or right) foot pedals. Trips or buttons are built into the gun handles with which he elevates the weapons. Thus, he has only to raise or lower the guns, squeeze the trips, and press a pedal to go into action. The finest of World War II turrets are those manufactured by the Boulton-Paul concern of England. Into these squat cupolas are fitted four Browning .312 caliber machine guns, each of which shoots at the rate of 1200 rounds per minute. These turrets are installed in the American-built Lockheed *Hudson* bombers, the Blackburn *Skua* dive-bomber-fighter, and the Blackburn *Roc* dive-bomber-fighter as well as in Boulton-Paul's own *Defiant* fighter.

Strangely enough, the two-seater fighter was discontinued several years ago, both in this country and abroad, in the race for performance superiority. The two-seater is the only type of combat plane suitable for the highly touted, long-expected style of formation fighting under radio control. Furthermore, the extra armament is worth its weight in enemies —the B-P turret, four guns, hydraulic mechanism, ammunition boxes, and spare parts weigh close to 1200 pounds.

No warplane can carry too many guns. Today's fighting ships are built around their armament. This is referred to in terms of "firepower." The result of this firepower, in its application against enemy craft, is called "fire effect"; and this is influenced by the type of ammunition used, and several other factors. Greater fire effect is obtained when one's firepower is producing better results than that of the enemy. This is known as "fire superiority"—the object of any offensive action or combat: weapons are useful only to the extent to which they achieve this ultimate aim. Flashing speed and maneuverability are to no avail if one's firepower is too weak to gain a decision after overtaking an enemy ship. By the same token, the man behind the gun has much to do with the outcome of combat.

To be a gunner, this man must be short of stature and long on heart—guts, if you will. Small men are not at so great a disadvantage in the crowded turrets as bigger men would be; but today's gunners are big little fellows, literally. In addition to courage, they possess a keen eye, a clear conception of ballistics and mathematics; they are able to make quick decisions, yet they have certain qualities of coolness, restraint, or self-control under fire. The reincarnation of the multi-place combat plane and the tactical ascendency of the gunner have necessitated training of the type and amount comparable with that of the pilot. Notwithstanding this fact, the gunner remains just an enlisted man to the high command. With good fortune, and sufficient enemy planes to make him an ace—if he were in the front seat—he gets a corporal's stripes, or, at best, those of a sergeant.

Salute, Mister, when you meet a stocky, grinning chap wearing gunner's insignia and perhaps a stripe or two—he's earned them the hard way!

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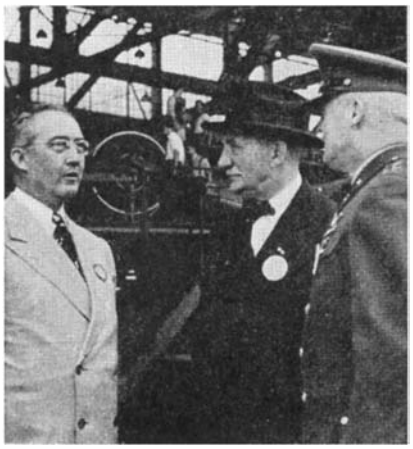
SPEED-UP

What It Means to Aircraft for Defense

CONGRESS votes billions; the President speaks blithely of 50,000 airplanes; William S. Knudsen goes to Detroit and the newspapers carry stories of miracles to be achieved by the automobile industry, with entire airplane fuselages to be stamped out in one operation like the roofs of motor cars. Certainly airplane production has already increased, and a good many airplanes are reaching Britain. But the double task of simultaneously supplying Britain and building up our air defenses is not an easy one. There should be removed the fundamental conflict between the Administration and American industry. Our leaders in the War and Navy Departments must make up their minds as to what they want and standardize on a relatively few basic types. Changes must be avoided once a type has been definitely settled. Army and Navy inspection must remain careful but not fussy and time wasting. Engine plants must be built and equipped with machine tools and filled with at least semi-skilled workers. These broad outlines of what is needed to speed airplane production are perfectly clear and the American people understand them perfectly. We are a production- and machine-minded country; only adequate direction is needed to give us and the British huge fleets of warplanes.



Glenn L. Martin, Mr. Knudsen, and Major-General H.H. Arnold, Chief of the Army Air Corps, on a visit to the Martin plant during a recent tour of inspection

When we get down to details, however, what do the airplane constructors themselves think of the problem? Paul G. Zimmerman, an oldtimer in aviation, recently read a most instructive paper on this topic at the Aircraft Production Meeting of the Society of Automotive Engineers; his views deserve careful study.

It is essential, Mr. Zimmerman thinks, to remember that even an order for 500 bombers, representing an outlay of, say, fifty million dollars, is still not mass production in the automobile sense, and that it is much more difficult to plan for 500 bombers than for 500,000 automobiles. Once the new car has been put into production there is no great urge to change. With the airplane service, however, information and news from the war front may make it irresistibly tempting for the engineering department or the Army or Navy air services to issue change orders. A few miles an hour more in the air, a little more gun power, somewhat better protection for the occupants, and air supremacy passes momentarily from one fighting nation to another. A change may appear more than justified, but a few such orders may alter the whole production plan of the airplane factory.

That is one difficulty. Another is in regard to materials. When starting an approved airplane, the first problem is to place an order for materials. Bills or lists are prepared, checked by engineers, shop, stock rooms, and so on. In Detroit, when building a car, so much experience is available that almost no mistakes are made in ordering material. The picture is different with the airplane. "I have found," says Mr. Zimmerman, "that it takes about 50 airplanes with the full co-operation of the shop and the engineering department to make the materials list accurate and reliable. There is no more important procedure to the speeding up of airplane production than to make certain of the completeness and accuracy of materials lists."

Once upon a time an airplane just grew in one spot with all operations going on in one big floor. Now, as Mr. Zimmerman continues, "The less work actually done on the airplane proper the more easily the line can be speeded up. This means that all possible work should be done by sub assemblies at a bench or a fixed location."

Other suggestions made by Mr. Zimmerman are good erection lists; bonuses for intelligent supervision; and so on. There are few experienced men in aircraft production, and all those engaged in this sphere of work or entering upon it would do well to digest his remarks.—*A. K.*

EXPANSION

Aircraft Plant to Provide For More Bombers

THERE are many valid reasons why it is easier to achieve mass production of the automobile than of the airplane. The automobile industry already has plants sufficient for its maximum capacity. The airplane people have to provide additional plant space for a production increase of at least 1000 percent in the short interval of a couple of years. Nothing illustrates what is happening better than the accompanying photograph of Boeing Plant No. 2 in Seattle, Washington, where the four-engined Flying Fortresses are being built. The original area of this building, four months ago, was 166,000 square feet and would have been ample for normal needs prior to Hitler's aggressions. The present floor area, just completed, is 832,000 square feet and would probably be sufficient were it not for the French collapse. The area now planned will give a total of 1,900,000 square feet. There should be plenty of room to give both our own Air Corps and the R.A.F. enough of these splendid bombers which are so vitally necessary to present plans.—*A. K.*

"BLACKOUT" FACTORY

No Lights Will Show in Aircraft Plant

WAR in Europe has determined the design of a new factory for the Grumman Aircraft Engineering Corporation on Long Island. This new plant, which will cost over $2,000,000, will be a "blackout" factory—meaning that it will be windowless and that work will be carried on under carefully controlled conditions. There have been other windowless factories built but the emphasis in their design has been on efficiency of production, while the emphasis here is on the possible need for continued operation with no lights showing during bombing raids.

It will employ approximately 4000 persons who will work in an air-conditioned atmosphere under fluorescent tube lights, except in the assembly aisles where high intensity Mazda lamps will be used.

What war orders have done to the Boeing airplane plant

The Inside Story of Rayon

When Wood Pulp Is Converted to Rayon, Just What Occurs and Why?

SIDNEY J. FRENCH
Assistant Professor of Chemistry,
Colgate University

THE greatest fear of the lumberman, as he drives his winter's cutting down the rapid, swollen spring stream, is a log jam. It may cost him most of his cutting in logs torn and wrenched into matchwood by the terrific pressure of the ever growing jam behind. To prevent just such a catastrophe, nimble lumberjacks ride the logs, endlessly poking stray logs back into the current, lining them up for the perilous journey through a swift bottleneck. Should one log cross the current and lodge in unseen rocks, the jam is on, logs piling and rising up like giant fingers on all sides in a great brush heap. Dynamite may be the only solution.

On a lesser scale, a pile of jackstraws is the log jam. Anyone who has played the game realizes the difficulty of removing one straw without disturbing the jumbled, interlocked heap.

Carry the scale down to the submicroscopic, substitute infinitely small crystal logs, and you have the essence of the job which concerns the makers of the man-made fiber, rayon. He must take a jumbled pile of these tiny "logs"—logs so small that the highest power of the microscope will not reveal their presence—line them up in orderly fashion, tie and glue them together into a lustrous fiber of rayon. All this he must do literally in the dark, with his chemical reagents and his scientific reasoning.

Like most valuable commercial processes, the making of rayon was a successful art some time before science was able to explain what happened in the conversion of coarse wood fibers into sheer rayon threads. Thanks, however, to powerful microscopes, the even more deeply penetrating X-ray, and keen scientific reasoning, science is now able to picture the vital steps in the seemingly magic translation of cheap wood pulp into valuable rayon. Once explained, the steps seem simple indeed. But more important is the fact that an understanding of the scientific process leads inevitably to continued improvement in the value of the product.

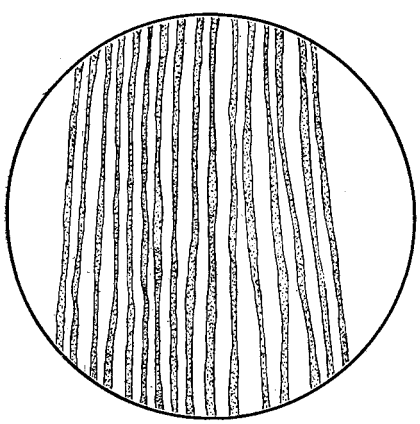


Figure 1: **Unravelled threads of rayon yarn, magnified 50 times**

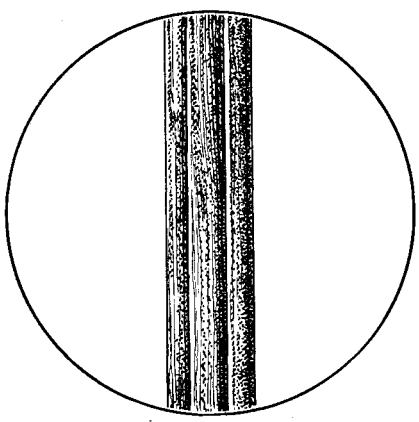


Figure 2: **A single thread of rayon, composed of fibers. X 500**

Like the Chinese, let us read this story backward, starting with a single strand of rayon yarn, examining it carefully, then probing even deeper into its structure and make-up by means of the microscope and the X-ray, carrying our investigation down even to the very atom, the fundamental building unit of all matter. This we may do by increasing magnifications till we have reached the limits of the microscope, and after that by picturing the probable structure as evidenced by X-ray analysis.

Figure 1 shows the unravelled threads which make up a single strand of rayon yarn, magnified 50 times. The threads are quite symmetrical and show little tendency to twist or curl. This is the important respect in which rayon differs from cotton. The twisted cotton threads reflect and scatter light irregularly, while the smooth rayon reflects it regularly to provide the well-known luster. In fact, manufacturers of rayon can, if desired, produce rayon with a sheen higher than that of silk; so high, in fact, that the lady objects and demands a softer luster. So the makers of rayon must leave some twist, some irregularities, in their threads.

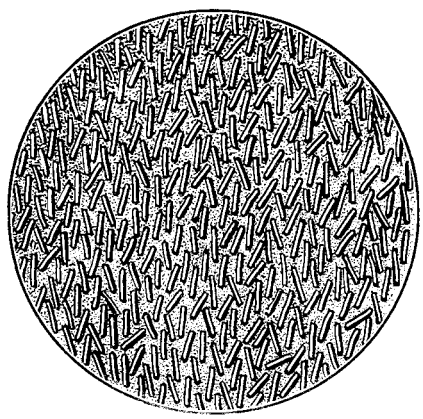


Figure 3: **Typical structure of rayon fiber, magnified X 5000**

Stepping up the magnification to 500 times, we next examine, in detail, a single one of the threads that make up the yarn (Figure 2). Instead of one solid thread, there are a number of fibers interspersed with apparently open spaces. Photomicrographs at this magnification are of considerable importance to the rayon technologist. They tell him whether the thread will take dye well, will have a soft or a high luster, will absorb moisture well or poorly, has objectionable impurities which must be removed in the manufacturing process.

Now we step up the magnification to 5000 times. We have reached the practical limits of the microscope (Figure 3). The single thread has been split apart and we are examining a single one of the fibers that make up the thread. Is this fiber a solid piece? No, it is actually a network having the appearance of matted felt. It is a jam of tiny crystal logs, but not

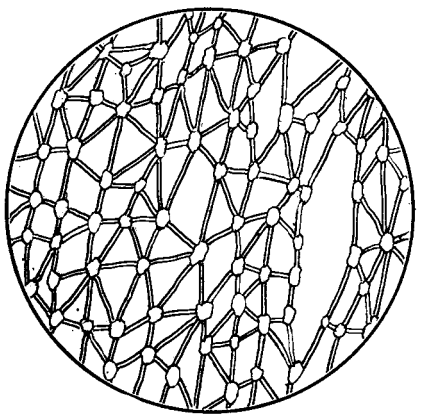


Figure 4: **The fish-net structure of rayon fibrillae, showing the crystal "logs," at an imaginary magnification of 50,000 times**

a bad jam, for the logs lie flat, none lies squarely across the current but all are pointed in the general direction of the fiber. These tiny crystal logs are known as fibrillae. Their lengths, their widths, their symmetry, and their directions are all important factors in determining the particular properties of the rayon thread—its softness, luster, elasticity, and resistance to folding or creasing. Still, we have discovered but little yet concerning the real causes of the nature of rayon.

WE MUST now pass from the realm of actual microscopic observation to that of indirect evidence based on the evidence of X-ray studies. We shall imagine a magnification of 50,000 times and examine, in detail, a few of the tiny crystal logs that make up the matted fibrillae (Figure 4). Here we have a true fishnet structure. The crystal logs are the strings of the net, knotted together with what the scientist, for lack of a better term, calls amorphous areas. The surprising thing is the apparent openness of the net, which at lower magnification appeared solid. It is this very openness, however, which gives to rayon many of its most important properties. A nice balance between open spaces and net is imperative in a good quality of rayon. Too tight a net means poor absorption of dye or moisture, little elasticity; too open a net reverses these factors. Uneven holes in the net mean weakness, unequal absorption of dye or moisture, irregular elasticity. Short logs and many knots cause the product to stretch too much; logs of irregular diameter reduce the sheen and cause irregularities in the thread. Again, the general direction in which the logs point is of great importance; they must all point downstream—along the fibrillae—but not in perfect alinement else the sheen is too high, the elasticity too low.

Are these tiny crystal logs actually single units, or are they in turn made up of still smaller units? Are the spaces between the logs actually empty or is there something there? To find the answer, we step up the imaginary

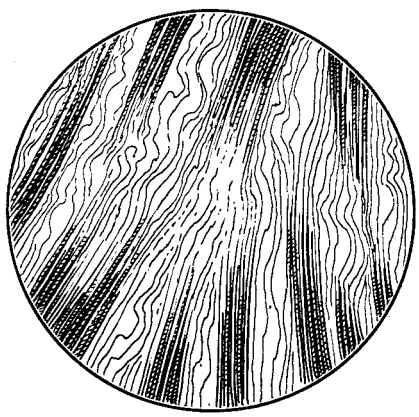


Figure 5: **Ends of crystal fibrillae, showing the loose strands which form the knots and glue. Imaginary magnification 500,000**

magnification to 500,000. Figure 5 shows in detail the ends of a few of these crystal logs knotted together. Each log of the previous magnification has become a close bundle of parallel strands; the chemist calls this a micellar structure, a unit bundle built up of many molecules. The spaces between the logs, which seemed empty before, are now seen to be filled with loose, wavy strands. It is these loose strands, filling the spaces between log ends and extending loosely from one log to the next, which form the amorphous knots of the fishnet. And it is to these wavy strands that we are indebted for many of the important properties of rayon. They bind logs firmly together, end to end, yet provide for elasticity. They tie logs together side by side with a flexible glue which provides a strong network to withstand tension. They are responsible for absorbing and holding dyes, for absorbing and releasing moisture. If the strands are too few, the knots lack strength and the fiber breaks easily; if the crystal logs are not firmly glued together side by side, the thread is loose and disintegrates easily. These loose strands are, indeed, the internal cement, the amorphous glue, so all-important in a fine product. What is it that makes these strands so all-important, that accounts for their glue-like nature?

Let us look at one of these strands at an imaginary magnification of 5,000,000 times. We have reached a magnification where we can see the very molecule itself. Figure 6 shows the hypothetical appearance of these long molecules, each dot representing an individual atom in the molecule. It is, indeed, a queer looking affair in which six atoms are tied together to form hexagonal structures, and hexagons are strung together in a zig-zag manner. The wavy nature of the strands now is readily accounted for, as is the elasticity of the fiber. When the fibrillae are pulled, the hexagons are stretched out into line. They spring back into zig-zag position again when the tension is released. But most important to the properties of rayon are the arms reaching out into space on each side of the

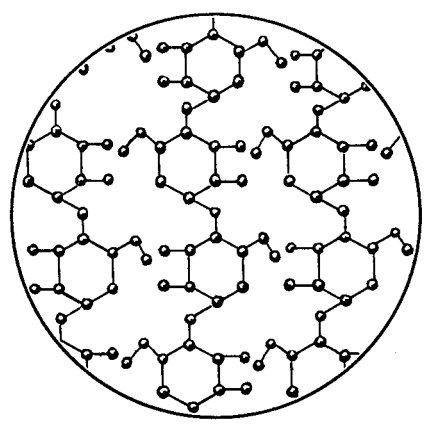


Figure 6: **Detailed appearance of single molecular strands, under an imaginary magnification of 5,000,000 times. Dots represent the atoms of the molecule**

hexagons. These are what the chemist likes to call active groups —groups that, like glue, are eager to grasp something: molecules of dye, water, or even, perhaps, oil or grease. If there are other chains of molecules in the near neighborhood, they will grasp the outstretched arms of these chains. It is this close grasping of chain to chain which accounts for the building up of the crystal logs, the micelles of the fibrillae; while the active arms of the loose strands lying between the logs provide the glue to tie log to log, to fill the interstices between strings of the net, to unite with dye molecules, water molecules, or other foreign matter. Without these active

fringes there would be no crystal logs, no network, no rayon.

As the final step of magnification, we observe what the chemist considers to be the fundamental chemical unit of rayon—under a magnification of 50,000,000 times. This unit, surprisingly enough, is *identical* with the fundamental unit of either wood or cotton cellulose, and bears a marked resemblance to a molecule of sugar. In fact, cellulose is easily converted into sugar by breaking the bonds holding hexagon to hexagon. Figure 7 shows the fundamental unit consisting of six carbon atoms, ten hydrogen atoms (which are omitted for the sake of clarity) and five oxygen atoms. These fundamental units unite to form the long strand molecules of Figure 6.

This, then, in brief, is the process of building up a single strand of rayon yarn. Fundamental molecular units unite to form long chains with active side-arms; these side-arms unite many chains into a compact bundle, a crystal log; loose strands form the knots and the glue holding the logs firmly together in a fishnet structure of fibrillae; these in turn are loosely held together by more strands to form the fiber; many fibers constitute a thread, and many twisted threads, a single strand of yarn.

THERE still remains one important question to answer. How is wood fiber converted into rayon fiber? Both have the same fundamental chemical units; both are structures of cellulose. But in wood fiber, unlike rayon, the crystal logs are in a log jam—interlocked, overlapped, and pointing in all possible directions. The first job of the maker of rayon is to break this log jam, dissolve the glue holding the logs at crazy angles. Then, he must straighten the logs out and send them on their way lined up to pass through the bottleneck side by side.

For the first step in the process, he uses chemicals — chemicals which tie themselves to the active side-arm fringes of the crystal logs—thus, in effect, dissolving and displacing the glue. In some cases he uses man-made glues to replace permanently that provided by nature. In others, he uses a temporary chemical which can be removed, once the logs are parted and re-alined. At this point, he has a viscous mass which is neither liquid nor solid, each log more or less freed from its near neighbors.

The next step is to line up these logs. This is accomplished by forcing the mass through funnels ending in tiny openings the size of a rayon thread. Each crystal log is swung and squeezed into line as it is forced through the ever narrowing opening.

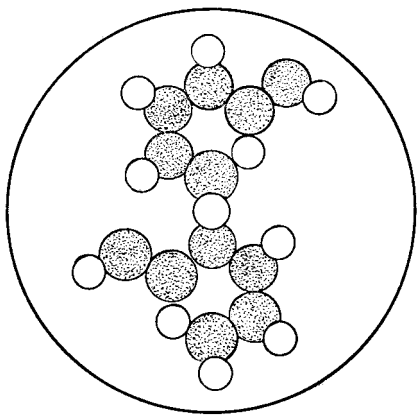


Figure 7: **The fundamental molecular unit of cellulose and rayon at an imaginary magnification of 50,000,000 times. Shaded circles represent carbon atoms, light circles oxygen atoms, hydrogen atoms omitted**

Were the product left in this state, however, it would be as weak as unhardened taffy—which, indeed, it resembles both in structure and chemical composition. The next step is to remove the chemical used to dissolve the glue and let nature's glue re-cement the logs in place—unless it is desired to retain a man-made glue. This is usually done by running the thread into an acid bath and allowing it to harden.

In the early stages of rayon manufacture, it was found that the threads disintegrated easily when washed. It was evident that the crystal logs had not been sufficiently lined up and glued together to resist the chemical effect of water. It was a simple matter to overcome this difficulty, once science had shown the reason for the weakness; the threads, before being allowed to harden, were stretched or placed under uniform tension. The result was to swing the logs more nearly into line, close up the open spaces in the net and give the glue a chance to act. However, care must be taken that the thread is not stretched too much—the logs pulled too closely together—else the thread loses much of its elasticity and tensile strength because the spaces between the strings of the net are squeezed out and there remains no place for either dye or moisture to take hold. Furthermore, if the logs are stretched too much, the resistance of the fabric to creasing is reduced, since this resistance depends both upon the overlapping of logs and upon a lack of uniformity in their directions.

Hence, the maker of rayon must strike a happy medium between stretching and relaxing; he must choose between strength and ability to absorb dye, brittleness, resistance to creasing, and many other factors. On the other hand, he can, merely by altering the tension, produce a variety of rayon yarns suited to a multitude of purposes. In learning to strengthen rayon, he has learned many other things about his product.

To make rayon, then, man has only to take the jumbled log jam of the crystals in wood fiber, unglue them, pull the tiny crystals apart, line them up, and re-glue them in place once more. But underlying the seemingly simple procedure, are many important principles which have taken science many arduous years to discover. The art of making rayon is rapidly becoming a science. It is still not an open book but many pages have been turned, many chapters read. In the remaining chapters, still to be read, lie, well hidden, additional principles which, added to those we already know, will make of rayon a fabric far superior to that we know today. No longer need the maker of rayon experiment in the dark to improve his textile. He knows what he must do, why he must do it, and with sufficient ingenuity he will find a way to do it.

• • •

BETTER GLASS

Makes Stronger, Smaller Bottles

A NEW technique in glass making, called Duraglas, resulting in a stronger and more durable container than was heretofore possible to produce, was announced recently by William E. Levis, president of the Owens-Illinois Glass Company. Duraglas has been placed in production at several of the glass plants under the company's operation, and will be available in quantities for the beer and beverage market immediately.

New architecture of the glass container likewise will contribute

both to its durability and its serviceability.

The new technique includes:

An exact determination of the fluidity of molten glass of various batch mixtures with resulting improvement in fabrication; improvements in batch mixing and automatic weighing, assuring absolute uniformity; better laboratory controls, governing raw material quality; simplification of glass furnaces and automatic feeding; modernized heat-recording instruments, assuring accurate furnace control; and further developments of the Owens automatic vacuum bottle-making machine, including synchronization of the melting pot to the machine.

FREQUENCY METER

To Study Vibratory Cycles

A NEW vibration frequency meter, weighing only eight ounces, and designed to aid the engineer in ferreting out the causes and cures of troublesome machine vibrations, is announced by the Westinghouse Electric and Manufacturing Company. The new instrument is no larger than an engineer's slide rule, but it can indicate what frequencies between 500 and 20,000 cycles per minute are present in a vibrating body.

This compact device is built around the principle of the vibrating-reed and consists of a thin spring steel vibrator clamped at one end between a set of steel rollers. A knurled knob connected to the rollers permits their rotation, and moves the steel reed in or out, changing its frequency of vibration. A sliding pointer on the back end of the steel reed indicates the vibrating frequency, which is read off the calibrated scale on the frame of the instrument.

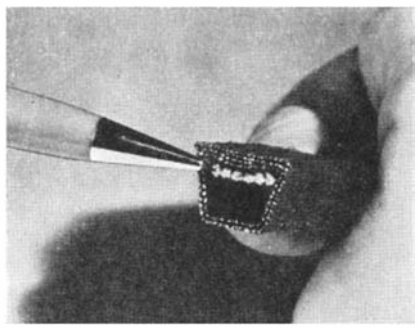
To use the meter, its head is held against the vibrating body and the adjusting knob rotated until the vibrator reed moves to and fro at maximum amplitude. If more than one vibrating frequency exists, there will be a point of maximum amplitude for each, and vibrations in differing planes may be detected by changing the axis of the meter. The meter is very sensitive; it will indicate a vibration whose double amplitude is one ten-thousandth of an inch or greater. It can measure harmonics of basic vibration frequencies. Although not designed to measure the amount of vibration, it may be used as a rough indicator of its magnitude.

Checking vibration frequency

STATICLESS BELT

Prevents Accumulation of Static Charges

WHAT is believed to be the first V-belt ever manufactured which prevents accumulation of static and retains its static-discharging qualities during its entire service life, is announced by The B. F. Goodrich Company. The belt will be sold, for the present, only to machine or equipment makers.



Wires dissipate belt static

This development in V-belt construction is of interest and importance to manufacturers and users of washing machines and other machinery where static discharges might create a fire hazard. These include gasoline pumps, other service station equipment, and machines in chemical, explosive, and milling plants.

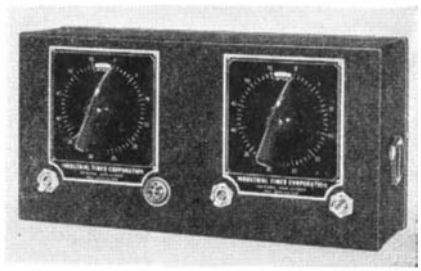
One of the important features of the new V-belt is the absence of any danger of the belt acting as a "short" between the motor and its operator. The resistance built into the belt is just enough so that the belt itself cannot act as a direct passage for current.

TIMER

Accurate for Industrial Operations

ANNOUNCEMENT of a tandem timer by the Industrial Timer Corporation brings public interest to the whole electrical timing field, a growing "infant industry." Until recently, it was impossible for industrial firms to control timed operations accurately by electrical means. Mechanical timers were subject to difficulties of adjustment and mechanical breakdown.

The new tandem is the first timer which can time-control both "on" electrical circuits and "off" periods. One example of its use offers potentialities never before realized in precise time: "Gaged-up" tandems—whole series of them—can be used to control mass production lines from start to finish.



Tandem timer for industrial use

Construction of the tandem is not made public at this time. Tandem timers, by Industrial, are the first and are believed to be the only timers in which precise selection of *both* "on" and "off" periods can be achieved, and single or continuous operation be effected.

WOOD BENDING

Chemicals Make Possible Permanent Bends

IT IS now possible to bend or twist wood into various permanent shapes, Dr. Elwin E. Harris of the Forest Products Laboratory, Madison, Wisconsin, said recently in an address on "Lignin and Lignin Plastics" before the Rochester Section of the American Chemical Society.

"Chemists can add a plasticizer to wood that will so soften the lig-

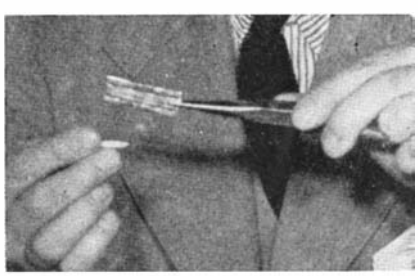
nin, which with cellulose constitutes the essential part of woody tissue, that when it is hot the wood may be bent or twisted into various shapes," Dr. Harris explained. "If it is then held in shape until it is cooled, it will retain the bent shape. The plasticizer has the disadvantage, however, that moisture causes the wood to revert to its original shape.

"Phenol and formaldehyde both react with lignin, causing it to soften. If wood is treated with such a mixture in a water solution, these chemicals enter completely into the structure of the wood, and if heated and pressed, a new wood composite is obtained in which a lignin-phenol-formaldehyde plastic holds the cellulosic fibers more tightly together than in the original wood. This new wood has much greater water resistance than the original wood."

MIDGET GIANT

Tiny Thermostat Strip Delivers Five-Pound Blow

A FEATHERWEIGHT strip of metal, its tenth-of-an-ounce frame bent and crimped like a hair-pin, snapped into action recently for the



A match starts the blow

first time in public—showing how it controls electric power by tossing off five-pound blows faster than you can blink your eye. The heat from a match flame furnished the driving power.

Research engineers of the Westinghouse Electric & Manufacturing Company who developed the metal strip for regulating temperature in electric machines, have calculated that a replica of it, weighing as much as Joe Louis, could strike blows with a force of 160,000 pounds.

Development of the new control was announced by William J. Russell and Paul R. Lee. Its thin, slotted strip of metal, Mr. Russell asserted, can be made to work contacts to interrupt as much as 10,000 watts of electric power and maintain temperatures up to 1200 degrees, Fahrenheit, with as little as two degrees' variation.

This means that industry now has a thermostatic regulator some 10 times more sensitive than any inherently snap-action bimetallic thermostat previously used.

The scientific principle used to make the new thermostat open and close electric contacts has been known for centuries, but for 10 years the investigators have been seeking ways to control the amount and direction of metals' expansion and contraction. The final design is a bimetallic strip, slotted twice to distribute the stresses. Then the two outside strips, or "legs," are crimped to reduce their length. "This improves the snap action," Mr. Russell points out, "and also gives the piece stability and makes sure that it always acts the same way under similar temperature conditions."

CONTROL GAGE

Watches Width of Moving Steel Strip

A NEW photo-electric gage which gives a continuous and accurate indication of variations in the width of moving steel strip without making contact with the metal has been announced by General Electric. With the new device, the width of the strip can be measured "on the fly" at any point or points in the mill and variations from the required width can be accurately transmitted to any number of desired stations such as the control pulpit. Thus, while the strip is moving through the mill, adjustments to the edging rolls can be readily made by the operator to correct deviations from normal width.

This continuous method of measurement is in sharp contrast to present practice where the width is checked after the strip is delivered in coils from the coilers. By the time this manual checking is accomplished, several other slabs are in process of being rolled and on these no correction for width can be made. Obviously, undergage material means possible rejection while strip excessively wide might have to be side-trimmed. Thus the continuous indication offered by the new photo-electric gage should make possible substantial savings in time and material.

Although the gage was developed primarily for use on hot-strip mills, it can be readily applied to many other industrial jobs involving width control of moving strips of material.

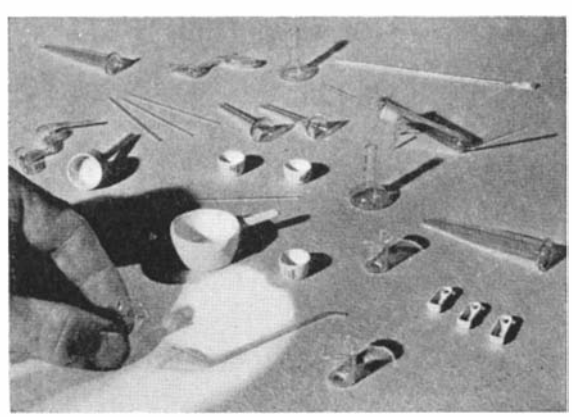
In operation, both edges of the strip are followed simultaneously by narrow light beams and true indication of its width is given regardless of any sidewise movement of the strip. The movements of the light beams are photo-electrically transmitted to indicating dials.

MICROCHEMICAL

Doll-Size Tools For Infinitesimal Quantities

FOR some time now, modern chemists have been improving their technique in the analysis of quantities of material as tiny as one millionth of a gram. Such quantities — about one ten-thousandth the weight of an ordinary pin — are handled with extraordinary efficiency in the Westinghouse microchemical laboratory, as one example.

While we have discussed this amazing procedure before, we have never previously been fortunate enough to obtain so striking an illustration of the equipment used as the photograph on this page.



All the tiny test tubes, crucibles, beakers, and glass tubes shown in picture at right—enough for a wide range of experiments in microchemistry — would easily fit in the palm of one hand. Microchemical analysis is finding increasing use in many industries

INDUSTRIAL TRENDS

COLUMBIUM

If the already highly efficient steam turbine is to attain even greater efficiencies as a producer of mass power it will be necessary to operate it at higher temperatures. This raises a number of technical problems. One of these is to get a metal that will not creep unduly. Hitherto, special steels alloyed with such metals as molybdenum, tungsten, and vanadium have solved the problem, and it was thought that adding more of these metals would permit raising temperatures from 1000 to 1100 degrees, Fahrenheit. This is not the case.

According to a recent report, columbium dispersed in iron produces an alloy having greater strength at 1100 degrees than the carbide steels. At the General Electric laboratories this columbium-iron alloy—it isn't a steel—has been made by sintering powders of the metals and by casting, and the resultant product is the best yet at all specified temperatures, when due consideration is given to cost, ease of production, and machineability.

Columbium is a little-known, rarely used metal, discovered 140 years ago on this continent. It is the sister metal of tantalum and always found with it in minerals. When tantalum predominates, the ore is called tantalite, but it is columbite when there is more columbium. Columbium is inert to most acids and even surpasses tantalum in the property of absorbing and retaining gases at high temperatures.

FIXATION OF FRACTURES

While columbium has won new favor, its sister tantalum has been gaining laurels. Preliminary reports indicate that tantalum can be used to great advantage for surgical purposes because of its great resistance to corrosion. Over the past century the medical profession has tried out about every known metal with unsatisfactory and often sad results. Corrosion can cause necrosis of the tissue by liberating toxic metallic ions and by building up local deviations from the normal hydrogen-ion concentration.

Until now, an alloy of chromium, cobalt, and nickel, known as vitallium, has been most satisfactory in surgery. But this alloy risks the introduction of highly soluble and toxic chromium salts into the tissue. Furthermore, it cannot be machined and must be cast or ground. Tantalum, on the other hand, has shown no toxic effect whatever in experimentation, probably because the formation of a strong oxide film makes corrosion negligible. It is very strong and easily handled, which favors it for further trial.

OLIVES, CORN, AND CHEESE

Trade disturbance in the wake of war can be turned to advantage by the alert. Consider for the moment what is to be done to relieve the scarcity of olive oil.

An olive-infused corn oil has just been placed on the market which utilizes a process new to the food industry. It has been discovered that if ripe olives are salted, dehydrated, and macerated to form a paste, and this paste is infused in corn oil, a quite satisfactory substitute for olive oil is produced. The flavor and aroma characteristic of olive oil is present even when the product comprises 90 percent refined corn oil.

It would seem simpler to mix olive oil with corn oil, but even if the olive-oil content runs as high as 35 percent, it is less satisfactory than the product made with a 10 percent infusion of the paste, because the flavor and aroma of the olive is lodged in the meat. Heat employed during the infusion process has been found to retard the development of rancidity in glyceride oils.

The infusion process can be applied to most of the refined oils which are edible but unpalatable, such as those obtained from cottonseed, soya bean, sesame, peanuts, cocoanuts, palms, linseed, and sunflower seed.

Foreign cheeses are being supplanted by domestic products with a great deal of success and so the war boosts another industry.

PRODUCTION FOR WAR

Spurred on by the demand for speed and more speed, many new production processes and much revamping of the old come from the vast defense program. While strictly for the making of war materials, there will be commercial application after the war which will have profound influence on our conceptions of production. Here's one example:

There is a large machine now about to pass final tests which if successful will produce 3.325-inch shells at the rate of 480 an hour or something over 11,000 in a 24-hour day. It will take a slug of steel and, through forging and extruding operations, operated automatically, will form a shell needing only to be loaded and supplied with a nose. So skilful will be the work that no machining will be required.

Success of this new venture hinges on the ability of metals to stand the punishment of high heat applied continuously during the forming operations. If they can take it, shell manufacture will be speeded up more than 10 times.

ADD ANOTHER PLASTIC

Manufacturers now have a tough problem in selecting a plastic from the many on the market. Each plastic boasts its own peculiar combination of qualities and properties, and there is practically no limit to the combinations available.

Vinylidene chloride is one of the newest to make a bow. It has great tensile strength, toughness, resistance to fatigue and abrasion, resistance to water and chemicals, is non-flammable, has high dielectric strength, and machines and colors easily. It has been put into immediate use for leaders, trolling lines, and snells for fishermen. It appears as a bonding agent in new grinding wheels, and in the form of strong, flexible, rattan-like strands it has been woven to make seat coverings for use in public service vehicles where wear is severe.

CONFIDENTIALLY

A radical change in the ignition system of automobiles is being given serious consideration. If experiments prove successful, manufacturers may introduce it to the public on 1942 model cars.

— *Philip H. Smith*

The Brightest Known Star

Recent Search Reveals a Star Shining at Least 45,000 Times Brighter than Our Sun

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

TO FIND the star which looks brightest in the sky is no trouble, for Sirius happens to send us twice as much light as any other. But to pick out among thousands of stars those that are *really* brightest is another sort of problem. It would be fairly easy if we could measure the distances of the stars with precision; but the direct method, by measurement of parallax, has the disadvantage common to all range-finders. The greater the distance, the smaller is the angle upon which its determination depends and, for the remoter stars, even among those visible without a telescope, this angle is less than the inevitable errors of even the most careful observations. We have more accurate ways of finding the average parallax—and hence a kind of average distance—of groups of stars, but, in the absence of specific reason, we cannot be sure that a particular star in our group resembles the average.

Our best chance, then, is to pick out stars which have distinctive properties of one sort or another, get the average distances of groups so selected, by various statistical methods, and so find out by experience what characteristics are associated with high luminosity.

It is evidently useful to pick our stars by some property which is not affected by the distance of the star. The color of its light, for example, would be a pretty good choice; indeed, if we were to select stars of strongly bluish-white color, we would find them far brighter than the average. A more precise way of doing much the same thing is to select stars by the characteristics of their spectra.

Forty years and more ago, thousands of stellar spectra had been photographed and classified at Harvard. Miss Maury, while examining them, noticed that, now and then, one came upon a spectrum in which the lines were unusually strong and sharply defined (with the low dispersion employed). This peculiarity appeared in spectra of many different types, according to the ordinary classification. In the catalogue of spectra, it was denoted by the letter c—now used as a prefix to the symbol representing the ordinary spectral type —thus the spectrum of Rigel is cB8, and of Alpha Cygni cA2.

These spectra were picked out without any thought—indeed, at that date, without any knowledge—of the real brightness of the stars. Thirty-five years ago Hertzsprung —then a young man—pointed out that these "c-stars" had without exception very small apparent proper motions. Did this mean that their real motions in space were slow, or that they only seemed so because of great distance? Hertzsprung's discussion showed that the latter was the case. The c-stars were three or four times more distant than others of the same brightness and spectral type, and must be correspondingly brighter.

THIS was the first evidence that it is possible to get information about the real brightness of a star by looking at its spectrum, and led to the spectroscopic method of estimating absolute brightness and distance, which has already been used to find the parallaxes of more than 5000 stars. The later work has shown that the "c-characteristics" are the best method we have of picking out stars of very high luminosity—especially in the "early" types B and A. Enough stars of spectra cB and cA are known to permit a fairly good determination of their absolute magnitude, which comes out from -5 to -5.5, corresponding to a real brightness from 8000 to 12,000 times that of the Sun.

It was not till many years later that the reason was understood why unusually strong lines in the spectrum should be such good indicators of exceptional brightness. The spectral lines are produced, as everyone knows, by absorption (more accurately by scattering) of light in the atmosphere of a star. Hence strong lines must mean extensive atmospheres—if we signify by this, not depth in miles, but quantity of active material in the absorbing layer, in tons per square mile.

But the stars are not hot solid bodies, with overlying atmospheres; they are gaseous throughout. The only thing which keeps the light from reaching us directly from their intensely hot depths is that the stellar gases are hazy—they scatter light just as haze does on earth, so that a direct beam, like that of a searchlight, is soon depleted. The "depth of atmosphere" on a star is therefore a sort of shorthand expression for a depth such that the haziness prevents most of the light from the deeper layers from getting out. Other things—such as the temperature—being equal, anything which makes the gas less hazy will permit light to reach us from deeper down. It will find more of the absorbing substances in its way, and so the spectral lines will be stronger.

Compare, for example, the spectrum of Sirius with that of the Sun. Sirius is hotter, roughly 10,000° against the Sun's 6000°. This higher temperature should knock more electrons off the atoms, diminishing the number of neutral atoms but increasing that of those which have been ionized. We might therefore expect that the lines of neutral atoms (for example, of iron) should be weaker in Sirius than in the Sun, and those of ionized atoms stronger; but both alike are weakened, though the neutral atoms suffer most. It was once supposed that this happened because the temperature of Sirius was high enough to knock a second electron off most of the metallic atoms. But it is now certain that this is not true. The metallic atoms are in a rather better position to absorb many of their lines in Sirius than they are in the Sun.

The only reasonable solution is to assume that the atmosphere of Sirius is much more hazy, so that the actual quantity of material per square mile, above the depth to which we can "see," is much less. But why should the hotter atmosphere be more opaque? This we can answer. The haziness arises al-

most entirely from the presence in the atmosphere of electrons and of the charged atoms from which they have been ejected. At a temperature of 6000° most of the metallic atoms have lost an electron apiece, but very few hydrogen atoms, since it is much harder to ionize. Only the metals contribute to the haze—the hydrogen is clear. But, at 10,000°, a large part of the hydrogen is ionized, and there are many more haze-producing particles. The more hydrogen there is in proportion to the metals, the more conspicuous will be the change. From its actual amount, it can be calculated that, in the atmosphere of an average star like Sirius, there must be at least 100, and probably 1000, times as many atoms of hydrogen as of all the metals together. There must, indeed, be fewer atoms of hydrogen per square mile, above the depth to which we can see, in Sirius than in the Sun. The hydrogen lines are much stronger in Sirius; but this is a secondary effect. The visible lines are absorbed only by atoms in a highly excited state which are present in extremely small proportions at 6000°, but form a much greater fraction of the whole at 10,000°.

SUPPOSE now that there were some stars which contained a considerably smaller proportion of hydrogen than the general run. What would they be like? For comparison, we may reasonably pick stars from both sets with the same surface temperature, say 10,000°. At this temperature the atmosphere haze in ordinary stars comes mainly from the hydrogen. With less hydrogen the atmosphere will be deeper, but the amount of hydrogen above the depth at which there is a given amount of haze will be much the same. We should therefore expect the hydrogen lines to be not much changed, but the metallic lines to be greatly strengthened. In a fully developed case, we might find a spectrum very much like that of Alpha Cygni—a typical c-star.

If, at the same time, there was less hydrogen in the deep interior of the star it would be hotter inside, more heat would escape to the surface, and it would be much brighter in proportion to its mass. We know very little directly about the masses of the c-stars, but here is at least a partial explanation of their great luminosity.

Consider now an extreme case, of a star of fixed temperature, in which the hydrogen was reduced till it became less abundant than the metals and finally vanished. As this process continued, the atmospheric opacity due to the metals would remain, so that the "depth" of the atmosphere would not increase indefinitely, but reach a limit. The metallic lines would then be very strong while those of hydrogen would weaken, and ultimately disappear. We should expect such a star to be even brighter than Alpha Cygni.

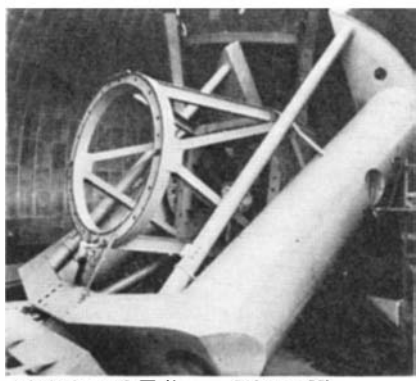


Photo by Ted Watterson, Palomar Mt.

Scale of the 200-inch telescope is shown by the man in the picture. You had to hunt? Is the man a dwarf? He has normal stature. The telescope would stump a Jimmy Durante, for his "Colossal!" would tell merely the true fact, fail to exaggerate

One good example of this is known—Upsilon Sagittarii, a star of the fourth magnitude. Its spectrum is packed with very strong lines of metals—mostly ionized, but some neutral—has weak hydrogen lines and rather strong lines of helium. This combination is almost without precedent, and suggested that this star was double—the metallic lines coming from a cooler component, and the helium lines from a hotter one. But—by one of the fortunate circumstances which sometimes help astronomers—the star is a spectroscopic binary, and shows large shifts of its lines due to orbital motion. These shifts affect the lines of the metals, of hydrogen, and of helium, in exactly the same way, both as regards amount and time. No more conclusive proof could be desired that the whole spectrum is produced by a single star.

It is only very recently that the solution of the puzzle has been provided, in the manner just sketched.

A thorough study of this very interesting system has recently been published by Dr. Greenstein of the Yerkes Observatory. The hydrogen lines, especially in the ultra-violet, are extraordinarily weak. Beyond the end of the hydrogen series there is a wide region of the spectrum in which hydrogen atoms exercise a continuous absorption. This, added to the opacity due to other causes, makes the "depth" of the atmosphere so small that the metallic lines, which are numerous in this region, are weakened almost to disappearance. Even in Alpha Cygni this effect is very conspicuous; but in Upsilon Sagittarii it is hardly perceptible. Greenstein's calculations show that hydrogen may nevertheless be more abundant than the metals, when atoms are counted; but, by weight, the latter predominate.

THE helium lines are so strong (despite the fact that they are absorbed only by very highly excited atoms) that helium must be very abundant, possibly 100 times more so than hydrogen. Greenstein, after a masterly discussion of a great mass of data, too technical to report in detail, concludes that this may be accounted for if the star has about 70 times the Sun's diameter, its surface temperature near 10,500°, and gravity at its surface about 1/200 that at the Sun's.

Not much is known about the star's real brightness. McLaughlin has estimated it from the intensity of the interstellar lines and finds an absolute magnitude of −7. Greenstein, from galactic rotation, gets −7.5. These correspond to 45,000 and 70,000 times the Sun's light. The estimated distance is 9000 light-years.

It is probable that this remarkable object is one of the most luminous in the galactic system. At least, it will be hard to find any brighter star. It might be picked out by its spectrum—provided that this could be observed with powerful enough instruments; but to determine its distance and real brightness would be very difficult.

A search in remote star-clouds and clusters is more promising. There is nothing in the globular clusters as bright as this, nor in the spiral nebulae — excepting, of course, the tremendous and evanescent supernovae. One star in the Small Magellanic Cloud is even brighter—the variable S Doradus, which has an absolute magnitude of −8.9, six times brighter than Upsilon Sagittarii. Among the stars visible to the unaided eye, however, the latter may well claim the title of the brightest.—*Princeton, November 1, 1940.*

Water For Our Greatest City

Longest Large Tunnel in World Is Deep Aqueduct to Bring More Water to City of New York

R. G. SKERRETT

THE City of New York, for the fourth time in the course of a century, is going far afield in quest of more water for her continually increasing population. Again, she will tap resources in the Catskill Mountains, west of the Hudson River, and make use of watersheds that do not contribute to the Catskill Aqueduct which has been serving all five boroughs of the metropolis since early in 1917.

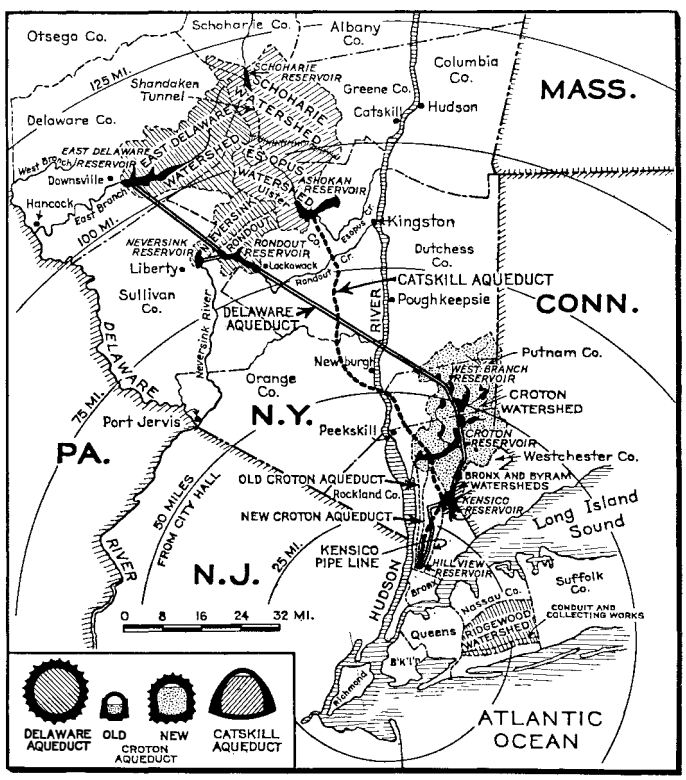
During the past hundred years, the population of the City of New York has grown from 312,000 people to approximately 7,500,000, while the daily water consumption per capita has mounted from about 35 gallons to a figure of 131 gallons. Even more to the point, the rate of daily consumption is now millions of gallons in excess of the estimated *dependable* sources of supply. For this reason, the Board of Water Supply has specified that each section of the Delaware Aqueduct — the great project now in hand— shall be built in the shortest time consistent with good construction.

The work underway is the first stage of the Delaware Project, so called because it includes the impounding and use of flood waters of several streams originating in New York State on the southern slopes of the Catskill Mountains, that actually are tributaries, with one exception, of the Delaware River. That exception is Rondout Creek, which flows into the Hudson River; and on Rondout Creek will be created, by the Merriman Dam, the major reservoir of the Delaware Aqueduct system. Water from the Rondout Reservoir will reach the City of New York by the longest and greatest series of interconnected pressure tunnels so far essayed. This three-unit conduit is now being driven deep in bedrock where, in case of war, it will be secure from gunfire, aerial bombs, and sabotage.

From its intake portal at the Rondout Reservoir to the Hill View Reservoir, where the mountain water will be finally discharged, the aqueduct will have a total length of 85 miles. That immense rock-enveloped and heavily concrete-lined artery will have an internal diameter ranging from 13.5 feet throughout its first and longest section to a maximum of 19.5 feet throughout its last and shortest section. The conduit so proportioned will be capable of transmitting to the Hill View Reservoir— which is just outside the northern boundary of the metropolis and serves as the regulating and distributing basin for the city's water-supply system—as much as a billion gallons every 24 hours to meet an emergency. At present, the City of New York is drawing close to a billion gallons daily from its three aqueducts now in service and many municipal and private deep wells in Long Island. However, a considerable percentage of those wells are approaching exhaustion.

The Delaware Project will be brought to completion in three stages. The first stage, being pushed at this time, will include a dam on the Neversink River and a tunnel about six miles long that will carry water to a point where it can flow by gravity a short distance to reach the Rondout Reservoir. The Neversink River and Rondout Creek, together, are counted upon to provide a daily supply of 170,000,000 gallons for transmission through the long aqueduct tunnel. The second stage, which will be started before the present work is finished, calls for a dam on the East Branch of the Delaware River, to form a reservoir fed by a watershed having an expanse of 370 square miles. From that East Branch reservoir, 370,000,000 gallons of water daily will be carried to the Rondout Reservoir through a rock-driven grade tunnel 26.5 miles in length. The completion of the two stages will assure a total of 540,000,000 gallons daily of "new and additional" water to the City of New York and to a few lesser communities located along the line of the aqueduct and outside the metropolis. The combined cost of the first and second stages of the Delaware Project will be about $273,000,000.

The third stage of the development, for which preliminary plans have been made, will include the damming of three other tributaries of the Delaware River—all originating in New York State—and construction of tunnels that will take the captured flood waters to the Rondout Reservoir. This third stage will contribute an additional



Route of old aqueducts and the new Delaware Aqueduct. Inset shows comparative sections of several

160,000,000 gallons daily and thus raise the total to be carried from the Catskill Mountains by the Delaware Aqueduct to 700,000,000 gallons.

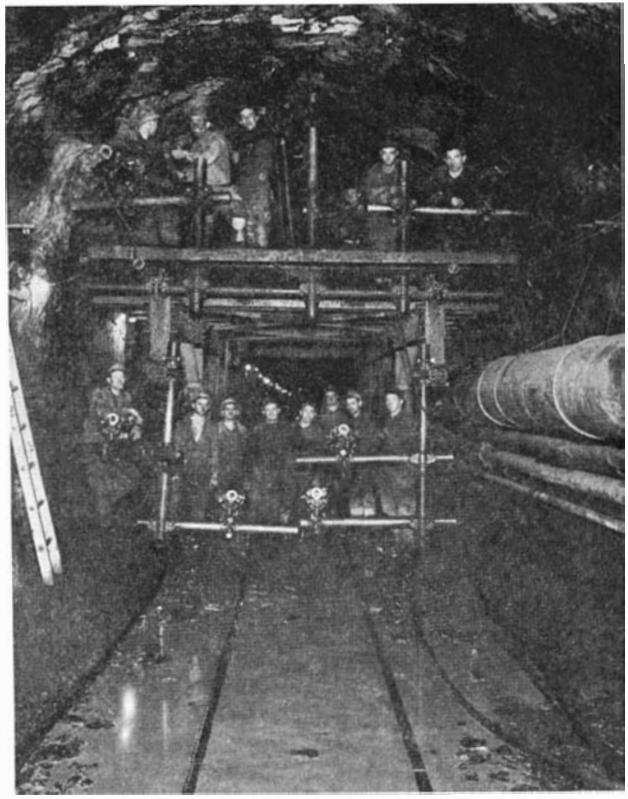
Although the primary purpose of the 85-mile aqueduct tunnel is to link the Rondout Reservoir to the Hill View Reservoir, engineers did not plan its course by the shortest, most direct line. Instead, the tunnel for its first section, with an internal diameter of 13.5 feet and a length of 44.6 miles, goes straight southeast from the Rondout Reservoir, passes under the Hudson River above Newburgh, and continues eastward and inland to discharge through an uptake shaft into the West Branch Reservoir, high in the hills of Putnam County. Through a downtake shaft there, the aqueduct will carry on southward—through a tunnel section 15 feet in diameter and 22.3 miles long—Catskill water plus 100,000,000 gallons from the Croton watershed. This admixture may be discharged into the Kensico Reservoir, at the southern end of this tunnel section, to mix with water coming through the older Catskill Aqueduct.

From Kensico Reservoir, the Delaware Aqueduct will take its flow through the final tunnel section, 13.6 miles long and 19.5 feet in diameter, to Hill View Reservoir, whence 100,000,000 gallons daily will be distributed by gravity.

THE detour traced by the Delaware Aqueduct will render practicable the interconnection of all four of the aqueducts—something not now feasible; it will permit the unwatering of certain long and continuously used tunnel sections for inspection and repair; and, finally, the arrangement will compensate for deficient rainfall in any given watershed by drawing upon the probable abundance of the other watersheds.

The detour through West Branch and Kensico Reservoirs will also expose aqueduct water to the sweep of winds and to sunlight, so that objectionable micro-organisms may be destroyed. Furthermore, movement through the reservoirs will promote sedimentation of any solid matter suspended in the water. At the West Branch Reservoir provision will be made for chlorinating the water, if deemed desirable, before it enters the downtake shaft. Again, at Kensico Reservoir, the water arriving by the uptake shaft will, when required, be treated with a mixture of lime and alum to coagulate any suspended solid matter.

When the Board of Water Supply may not wish to deliver water from the Delaware Aqueduct to the West Branch Reservoir or the Kensico Reservoir, the flow in the main tunnel will be allowed to continue without interruption. Under West Branch Reservoir, a 15-foot by-pass tunnel 2.4 miles long is now being driven for that purpose; and a by-pass tunnel 2.3 miles long, and also 15 feet in diameter, has already been driven beneath Kensico Reservoir at a depth of more than 1000 feet. Gate chambers at both ends of these reservoirs will control the movement of water between the aqueduct and the reservoirs.



Drill carriage with seven pneumatic drills in a tunnel to be concrete-lined to a 13.5-foot diameter

The Delaware Aqueduct Tunnel will be a full-pressure tunnel throughout its length of 85 miles, will be completely filled with water from end to end. In this respect it differs from the older Catskill Aqueduct which, throughout its length of 92 miles, has but five sections of pressure tunnels that total but 17 miles. The remainder of that system is made up of various types of partly filled grade tunnels and steel-pipe siphons.

To drive or excavate the 85 miles of tunnel for the Delaware Aqueduct, the work was started by first sinking 30 shafts located at intervals of from 2.1 miles to 5.2 miles. The deepest of these shafts, sunk in a mountain valley, has a depth of nearly 1551 feet. The 29 other shafts have depths varying from slightly more than 300 feet to a maximum of 1024 feet. Some of them were sunk only to offer more points from which to drive sections of tunnel, but others will later serve as aids in operating the aqueduct; as means by which tunnel sections may be drained for cleaning and repair; and also to provide connections with the aqueduct for supplying water to communities outside the metropolis.

From the bottoms of the shafts, all of which were sunk to the projected tunnel line, tunnel-drivers began their operations. In some cases, they advanced only a single heading from a shaft bottom, while in other cases, two headings moving away from the shaft in opposite directions were driven. The rock penetrated has ranged from soft to hard formations that have presented difficulties to the drillers. While most of the rock has been sound, in some places the rock has been fissured and carried large quantities of water. In one stretch of tunnel the rock has been rotten and filled with water, entailing a long and hard battle in safely advancing the excavation—requiring six months to go 152 feet.

IN NEARLY all of the present tunnel-driving, each contractor has drilled and blasted the entire face of a heading at every succeeding step of advance, even in the largest of the tunnel sections. Tunnel-driving was started early in 1938, and since that time about 85 percent of the excavating has been finished, and the concrete lining has been placed in approximately 10 percent of the 85 miles of the tunnel. This remarkable progress has resulted from the intensive application of the most improved mechanical aids and by carrying on the work, night and day, in three shifts. In one section of tunnel that has an internal diameter of 13.5 feet, when lined—17 feet in the rough—an advance of 1863 feet was made in 31 consecutive working days. In that part which underruns the Hudson River at a depth of 600 feet, the contractor drove stretches at the rate of 40 feet a day. In driving sections of 19.5-foot diameter, excavated to diameters of from 23.6 to 25 feet, the advance was as much as 236 feet in a single week!

The foregoing records were made by mounting on a mobile drill car-

riage, at its forward end, from six to nine powerful pneumatic rock drills of wet types which minimize dust. These drills can bore from 42 to 90 holes at one setting. Depending upon the nature of the rock and the number of holes required in a face, the drilling time has been from one hour in favorable rock to six hours in hard granitic formations. After drilling, the carriage is shoved back from the heading 100 or more feet, and all the holes are then loaded with dynamite. The cartridges are so wired that a few holes in the center of the face are shot first to form a cavity. The outlying holes are then shot successively to move the blasted rock inward toward the center. Immediately after firing, the noxious gases are withdrawn through a large vent pipe leading surfaceward to powerful blowers. Then the course of the air is reversed, and about 12,000 cubic feet of air per minute is blown toward the working face to freshen the atmosphere so that work can be resumed within 30 minutes.

After a blast, the tunnel drivers remove the shattered rock or muck from the floor of the tunnel at the face and dispatch it backward to the bottom of the service shaft. There the material is loaded into one or more capacious skips or buckets and hoisted to the ground surface for transfer by large motor trucks to a spoil bank—usually nearby. The mucking is now done by a rugged electrically-driven machine that scoops up the broken rock and throws it backward on to a conveyor that drops the muck into a side-dump car shoved up close for that purpose. A muck train is made up commonly of six or seven side-dump cars, each capable of holding from five to six cubic yards of broken rock, and each train is pulled by a storage-battery locomotive. To shift each loaded car and to place an empty car at the end near the mucking machine, the contractors make use of different forms of "cherry pickers"—steel frameworks equipped with electric hoists that can pick up and lower an empty muck car. This apparatus obviates the use of switches. A muck car can be loaded in from one half to two minutes; and the mucking at a heading takes from 1½ hours to four hours.

At the surface, compressor plants of large capacity provide operating air for many purposes, while big blowers continually force fresh air down into the workings. Sanitary precautions, both underground and at the surface, keep the men in excellent health and working condition. Most of the workmen live away from their work, commute by motor cars and buses. Contractors' camps are a rarity on this great undertaking.

Probably the first section of the aqueduct that will be placed in service will be the 13.6-mile tunnel now building between Kensico and Hill View Reservoirs. It will be ready for use during 1942, and will permit the Catskill Aqueduct, between those two basins, to be unwatered and inspected after 23 years of uninterrupted service.

In the lining of the tunnel sections, we have today further proof of what can be done with the aid of mechanical facilities. For example, at this writing a 19.5-foot section of tunnel is being poured at an average daily rate of more than 2000 cubic yards! All these things are being done so that the unheeding citizens of the metropolis can have all the water they may expect whenever they turn their faucets.

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"PANCAKE" LOCOMOTIVE

Flat Design For Coal Mines

With an overall height of only 26 inches, a new electric mine locomotive made by General Electric for the Jewell Ridge Coal Corporation's mines in Virginia is several inches lower than previous locomotives of same weight and power.

The locomotive weighs 15 tons and is powered by two 90-horsepower motors. Equipment includes a 10-step controller, reverser, handbrake wheel, air-raised trolley, airbrake, air-sander, and whistle valve. Air reservoirs are contained in the two all-welded bumpers.

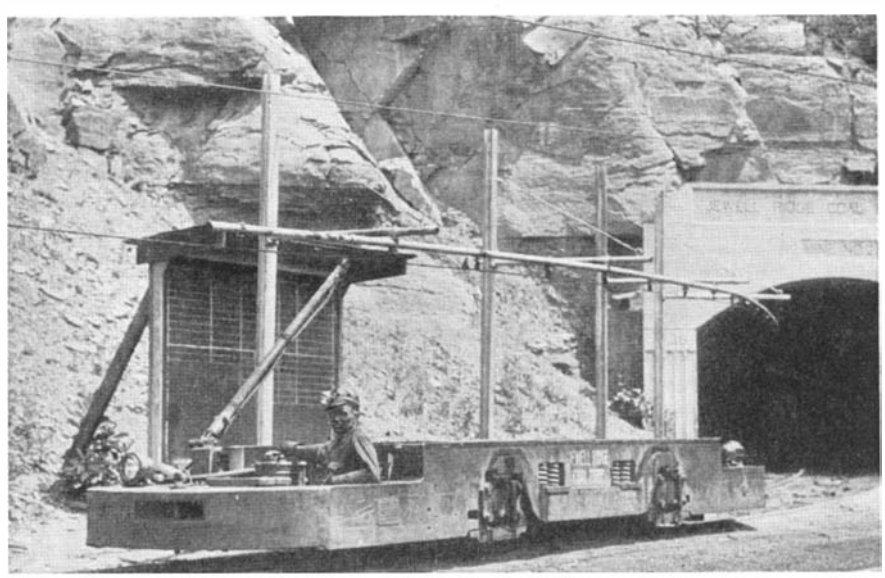
Savings are effected in costs by reducing the amount of top and bottom material requiring removal along main haulageways. The unit is able to operate in a 40-inch vein without brushing top or taking up bottom.

GROUND WIRES

Eight Miles of Them Plowed Under in Two Days

Ingenious constructors of the radio tower KFAR, near Fairbanks, Alaska, buried more than eight miles of heavy copper ground wires without first digging trenches. They plowed these cables 18 inches underground, radiating from the tower base every three degrees and extending to a distance of 500 feet in all directions. Hand methods of installing this amount of ground wire would have been both difficult and costly. A 25-horsepower Caterpillar Diesel tractor did the work in two days.

The plow rig behind the tractor resembles a modern farm rooter, with two high wheels and a knife-type blade between them. Fastened close behind the blade is a pipe, extending from the lower cutting edge to a point two feet above the ground. The wire was threaded through this pipe and fed into it as the tractor pulled the plow and packed the earth at the same time.



Mine locomotive with an overall height of only 26 inches

Psusennes' Tomb

Not Even the War Sufficed to Prevent the Archeologists from Excavating in Egypt

ALBERT G. INGALLS

WHEN wars hamper their digging, as World War II has been doing rather seriously, most archeologists simply shrug their shoulders and come home from the field. Some, however, find it practicable to remain in the warring country and go ahead with their excavating, so long as the battles do not touch the actual spot where they dig. Few wars touch all of a country all of the time. Moreover, the archeologist's attitude regarding wars differs somewhat from that of the rest of us. We live mainly in the present, its daily events tending to fill our horizon. The archeologist, dealing with the past as his vocation, is a dweller in all the centuries. He knows that men always have warred, yet that life always has kept on rolling along, so why should he become too excited about the squabbles going on in the period in which he happens to live? Hence he digs on, if he can.

Professor Pierre Montet is a Frenchman from Strasbourg University who, despite the current combat, has been excavating a magnificent tomb of the ancient pharaoh, or king, Psusennes, in Egypt. He discovered this burial at the site of the ancient city of Tanis, the Zoan of the Bible and the Sân of today, in the lower, northern, or delta part of Egypt where war knocks loudly as this is written in November.

Psusennes the First, second King in the mysterious, little-known 21st Dynasty of Lower Egypt, lived from about 1054 to 1009 B.C., or approximately three centuries later than Tutenkhamon. He was the father-in-law of King Solomon.

THE exposed site, or top, of Psusennes' tomb is a flat square of massive stone masonry about 75 feet in each dimension. This square is the deck of a deeper stone structure down through which shafts lead to the burial chamber in the rock far below. In this chamber, about five feet in height, Professor Montet found a huge, rectangular stone box, the first sarcophagus of what was hoped would be a resplendent royal mummy. Such outer sarcophagi are hewn from a solid block of stone, with walls about five inches thick, and are provided with one-piece, hewn stone covers of considerable weight.

When this cover was removed the French archeologist found an inner or second sarcophagus of black granite, having the general shape of a human being but much larger — the object shown at the left in the photograph.

Nested within this enlarged human form in stone was the smaller sarcophagus at the right in the same photograph, yet this one was fully seven feet long. It was made of solid silver, decorated in colors—"the most beautiful object discovered in recent years." In the hands of this silver image, which is also shown on page 6, were the crook and flail, ancient Egyptian symbols of suzerainty, and on the head was the cobra, royal insignia, made of solid gold.

Next within was a six-foot silver and gold body covering which may be seen at the rear of the silver sarcophagus in the photograph. It has a solid gold mask.

The mummy itself was reached last, in the course of removal of one outer covering after another, but was found to consist of only a few bones. The tomb had not been robbed, but dampness had almost wholly disintegrated the body, not all of Egypt being dry and dusty.

Professor Pierre Montet bending over the heavy, solid silver sarcophagus of one of Egypt's kings. The same sarcophagus is shown on page 6. In the lower left-hand corner is the larger, hollowed granite sarcophagus in which the other one lay, neatly nested

What Makes 'Fantasia' Click

Multiple Sound Tracks and Loud-Speakers Give Auditory Perspective to Sound Movie Screen

A. P. PECK

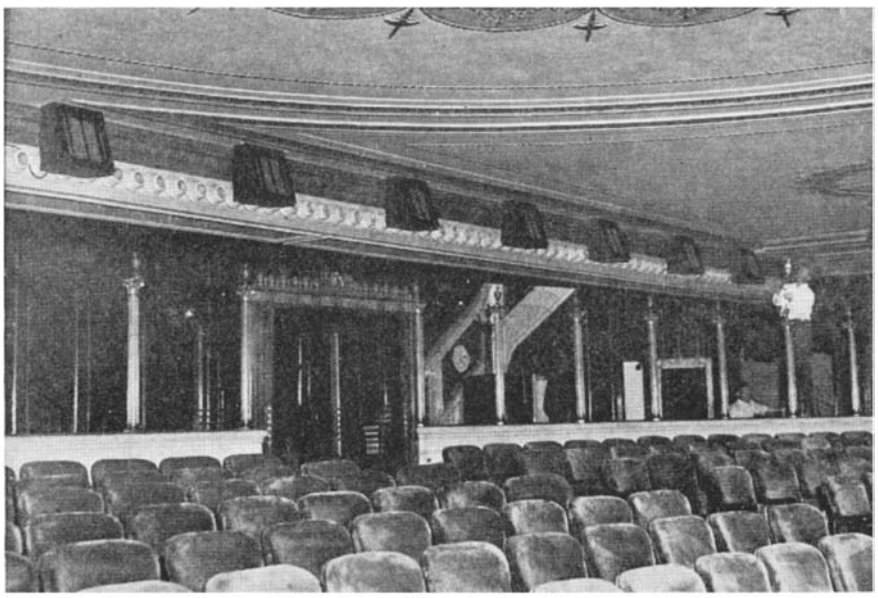
WHEN Walt Disney planned the motion picture "Fantasia," he was working toward a two-fold change in the entertainment world. First, as the daily press has already well told, he was correlating classical music with pictorial and visual pattern interpretation. He was anticipating the introduction, in sugar-coated form, of great music to the masses. Secondly, and perhaps of more genuine significance, he was working with a sound reproduction system for movies which would bring to motion-picture audiences this great music in all its glory, in a form closely approximating that enjoyed by the privileged few who attend symphony concerts.

In co-operation with engineers of R. C. A., and with the aid of Leopold Stokowski and the Philadelphia Orchestra, the Disney studios turned out a masterpiece of the sound screen. The effects achieved — Mickey Mouse as the Sorcerer's Apprentice; ostriches, hippopotami, elephants, and alligators as ballet dancers in the Dance of the Hours; spouting volcanoes, dinosaurs, and pterodactyls in The Rite of Spring; and so on— have been so widely discussed as to need no further encomiums or criticisms here. The "how" of the sound system is something else, however, and, in this writer's opinion, constitutes the most interesting phase of the production. The implications of the new system are such as to hold great promise for the future of the sound screen.

FROM the outset it must be understood that this sound system cannot be used with the regular movie-theater equipment of today. Also, production costs are high, and, at the time of writing, there is only one theater (the Broadway, in New York City) where "Fantasia" can be properly shown. The reasons why will be readily grasped from the description of the equipment. Disney's plans, however, call for a minimum of 12 projection units, spotted throughout the country, where equipment will be installed that can present this film, and other films to come, in their proper sound setting. How many more than 12 will follow rests with public demand.

Some appreciation of the results obtained in "Fantasia," and of the technical problems involved, can be gleaned from these figures: The range in decibels (sound volume units) of the best conventional sound-on-film production is about 35 db. The range of a symphony orchestra is about 70 decibels. In "Fantasound," as the new system is known, the range is about 75 decibels. Hand in hand with this greatly increased volume range goes a correspondingly increased range of tonal frequencies and hence quality of reproduction. With "Fantasound" it thus becomes possible to approximate closely the symphonic effects heretofore so definitely lacking in sound movies.

One of the large speaker units located in the theater balcony



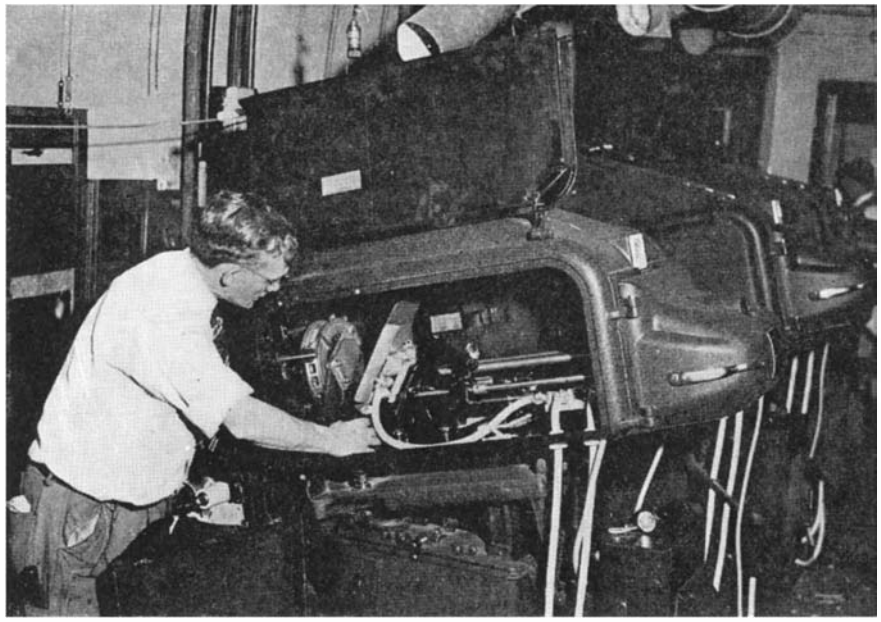
Only a small part of the loud-speakers used in reproducing the sound of "Fantasia" are shown in this view of rear of the Broadway Theater

Basically, the principles of present-day sound movies do not differ materially from those described by the writer some 13 years ago in these pages. There are still the microphone that translates sound waves into electrical impulses, the sound-modulated light that creates the sound track on the film, the photo-electric cell that re-converts the sound track to electrical impulses, and the loud-speaker that re-creates the original sound from these impulses. During the intervening years, of course, there have been refinements and developments that have improved quality, broadened the originally restricted frequency range, and so on.

In the conventional sound film, a narrow longitudinal strip—between the edge of the picture and the film perforations—carries the sound record. This track is present on the "Fantasia" film also, but only for emergency use. If the high-quality sound system should fail, for any reason, this track will permit the show to go on, but it will function only in the conventional manner and with none of the exquisite quality of "Fantasound." This quality depends on a second strip of standard movie film that runs in a specially designed sound reproducing unit. It operates simultaneously with the picture film and in precise synchronism with it. On the second or sound-only film are *four* individual sound tracks. In this multiplicity of sound tracks, and how they are made, lie the secrets of increased quality, volume range, and auditory perspective effect of the new system.

Chief Engineer W. E. Garity, of Disney studios, checking circuits on one of the amplifiers

The first step in the production of "Fantasia" was to record a variety of selections played by the Philadelphia Orchestra. This was done by installing, on the stage, nine groups of microphones, each of which was connected through the usual amplifying equipment to individual sound-on-film recorders. Each of these recorders took care of a specific part of the orchestra—wood winds, strings, percussion, and so on. Thus it was possible to record the exact tonal quality emanating from each section, instead of forcing one sound track to record the over-all effect of a full orchestra, with the consequence of drowning out certain delicate passages or over-emphasizing others.



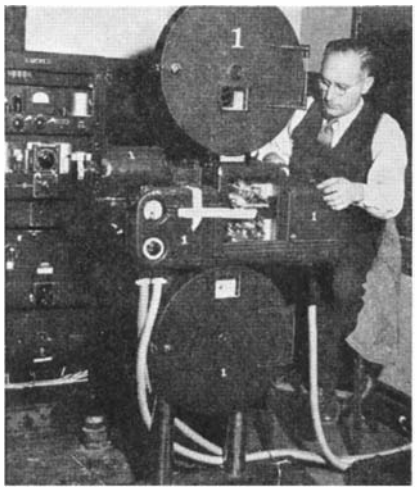
An operator inspects one of the picture projection arcs. As in most theater installations, the projection machines are installed in multiple units

Now the nine sound tracks were shipped back to Hollywood where the real work started. Each of the tracks was placed in a play-back unit connected through three variable controls to amplifiers and to other recorders where new sound tracks were made from the electrical impulses. By means of the variable controls the operators could vary the volume of sound from any particular section of the orchestra, and, at the same time, the position from which the sound will be projected in the final production. (This "position" question will clear up presently.) By this process the nine sound tracks were melted down into three tracks that retained all the quality of the original music. These three tracks were again played back through variable controls and amplifiers to establish a frequency control track. Thus were obtained the four tracks that are used in the final film.

IN the conventional sound movie, all of the reproduced sound comes from one or two speakers located directly behind the movie screen. The source of the sound is permanently fixed and, no matter where the characters on the screen may move, the sound always comes from the same position. With "Fantasound," however, there are a large number of loud-speakers located in various parts of the theater. In the initial Broadway Theater installation there are a total of 90 speakers, 36 of them being located back-stage and the remainder distributed throughout orchestra and balcony of theater.

By means of this varied grouping of loud-speakers, and the four tracks on the sound film, it is possible to vary the projection position of the sound for special effects. By proper control of the recording equipment the sound can be made to follow the characters on the screen with uncanny fidelity or even to "creep down the aisle" of the theater, if such a procedure should be desired. The sound tracks on the film do all the work. Three of them produce the program material; the fourth controls the position and volume of the sound as determined in the recording studio. It thus becomes possible to obtain a virtual auditory perspective effect. Suppose, for example, that the sound of a violin is to accompany the flight of a shooting star across the screen. The record of the violin sound will then start, say, on the sound track that feeds the right-hand speaker on the stage, will pass to the track for the center speaker, and end on the track for the left speaker, or possibly for speakers located on the left-hand side of the theater itself.

When the projectionist prepares for a program of "Fantasound," he, of course, adjusts his equipment to compensate for the sound absorption of a full house, a partially filled house, and so on. Otherwise, the film takes care of itself. The picture film is threaded in the projection machine. The special sound film is threaded in the sound machine, synchronism is checked, and everything is ready for the show.

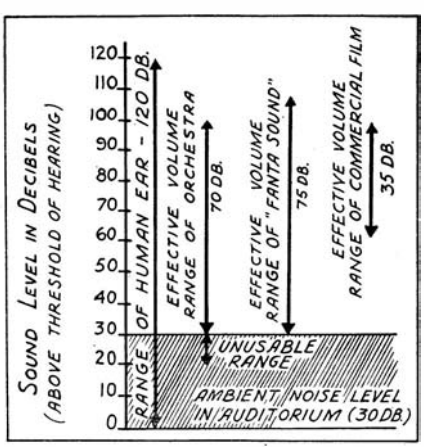


The projectionist inspects one of the special sound units in which is run the "Fantasia" film with its three sound tracks and the single control track

Perfect synchronism between picture and film is maintained through electrical interlock; it is impossible for the two films to run other than at the exact speeds desired and in precise unison. In the special sound machine a single light source illuminates the four sound tracks and is focused through a lens system on four photo-electric cells. Three of these cells, in turn, feed amplifiers and loud-speakers; the fourth, operated by the control track, produces the auditory perspective and extreme volume range effects.

Production and exhibition costs for this new sound system are naturally high. The complex recording process demands multiple units in every step. Many more thousands of feet of film must be used in production than would be required for a conventional movie of similar length. Projection of the film in the theater calls for special equipment; in the one theater initially equipped for "Fantasound" the cost approximated $85,000 for picture projectors, sound reproducing machines, and multiple loud-speakers, although "mass production" will reduce this about one half.

When sound movies first loomed on the horizon, as possible competitors with the old silents, there were those who said that they were a flash in the pan, that they would never come into wide use. And almost overnight the whole motion picture industry turned to sound. But it was sound coming only from one direction. Will the new "Fantasound" system cause a similar revolution in the entertainment industry? If first reactions can be depended upon, "Fantasound" indicates a trend.



Sound range in decibels of "Fantasound" compared with that of conventional sound film and of a symphony orchestra. Note that effective ranges of orchestra and of "Fantasound" extend downward to the noise level commonly present in auditoriums, and below which any sound would not be effective

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Fireless Steam Locomotives

The Successful Revival of an Idea That Was Considered a Failure Forty Years Ago

COMMANDER W. MACK ANGAS (CEC), U. S. N.

UPON first seeing a fireless steam locomotive at work as a switching and yard engine in an industrial plant, and upon hearing of the capability, efficiency, and economy of the machine, businessmen, and for that matter many engineers, frequently ask if such engines are not a recent development in mechanical engineering. Actually the fireless locomotive is by no means new, the successful fireless switching engine of today having been produced by a revival of interest in an idea tried 68 years ago and believed at the turn of the century to be a demonstrated failure.

The idea of running a locomotive on steam drawn from an insulated pressure tank, charged at intervals by stationary boilers, dates back at least to 1864, when Mr. Zerah Colburn pointed out the possibility of using such locomotives in the underground railways then coming into use in London. No practical application of the idea was made, however, until 1872 when Dr. Lamm had one or more experimental fireless locomotives built for trial on the street railways of New Orleans. The engines gave such promise that, in 1875, eight engines were ordered from Theodore Scheffler of Paterson, New Jersey, for the Crescent City Railroad Company.

The Scheffler engines, which were described and illustrated in the October 20, 1877, Scientific American, were strikingly similar to modern fireless locomotives except for their diminutive size, which was due to the fact that they were called upon to pull only light street cars, and to the method of charging. Each engine had a cylindrical, insulated, pressure tank holding about 300 gallons of water which was charged into it at a pressure of 220 pounds per square inch and a temperature of about 390 degrees, Fahrenheit, from stationary water-tube boilers. Considerable difficulty was experienced in charging the engines with hot water, so experiments were made with a method of charging which introduced steam at 220 pounds pressure into the tanks through perforated pipes at the bottom. The steam condensed and heated the water until the temperature and pressure in the tank were substantially the same as that in the boiler supplying the steam.

This method of charging fireless locomotives, the one in use today, was thoroughly developed and successfully used by M. Leon Francq, of Paris, who designed fireless locomotives which, in 1876, were put into use on a tramway in the

The opinions expressed in this article are those of the author, and should not be interpreted as those of the Navy Department, any of its bureaus, or the Naval Service at large.

vicinity of Paris, and others which went into service in 1878 on a line between Rueil and Marly-le-Roi. Articles written by M. Francq for technical journals of the late seventies show that he thoroughly understood the thermodynamic principles of the engines he designed. In these articles he explained that the locomotive was in reality a heat-storage rather than a steam-storage engine, the energy available in the steam in the top of the tank being trifling when compared to the energy stored in the hot water. As the engine ran and the pressure in the tank fell, this energy stored in the water became available, causing the water to boil and furnish steam until the pressure was gradually reduced to the minimum which would satisfactorily run the engine.

Other municipalities, among them Vienna, experimented with fireless locomotives on street railways and tramways but the development of practical electric traction systems in the eighties gave street railways a far more satisfactory motive power which was almost universally adopted. Except for an abortive attempt between 1898 and 1901 to revive a variant of the steam-storage engine under the name of the "Kinetic Motor" for suburban service on railways of Long Island and around New York City, and its adoption by the street railways of Batavia, Netherlands East Indies, where it is still in use, the fireless locomotive seems to have disappeared almost completely by 1905.

The revival of the fireless locomotive as a switching engine appears to have started in Germany. In 1913, Mr. Grant B. Shipley, of Pittsburgh, was shown a fireless yard locomotive at work in the plant of a Berlin locomotive builder and was so impressed that he purchased a similar machine for the Reed City plant of the Michigan

Official photograph, U. S. Navy

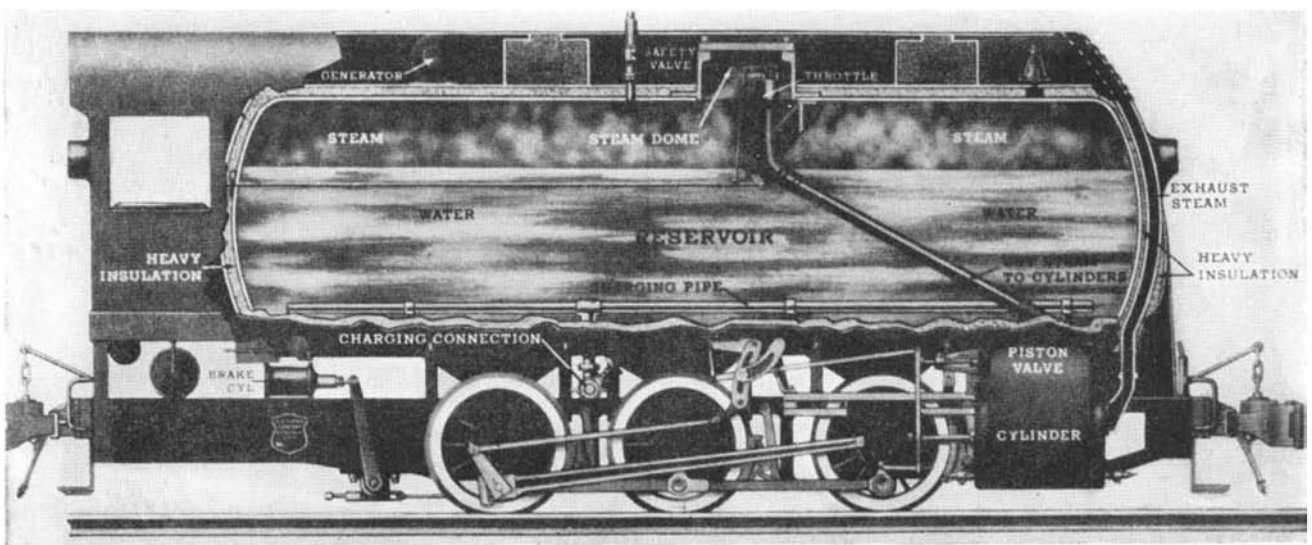
Fifty-ton fireless steam locomotive designed for 400-pound steam but now running at 160

Wood Preserving Company. The engine proved so satisfactory that within a few months a second one was ordered for the Ohio Wood Preserving Company's plant at Orrville, but the commencement of the first World War prevented delivery. Arrangements were accordingly made for the construction of a 22-ton fireless locomotive in this country. These two machines were followed by others.

By their surprising capability and economy, these engines attracted the attention of other users of switching engines. And the fireless yard locomotive appeared as a competitor of fuel-burning yard engines in plants where machines of the latter type could not be operated without risk. This development was fostered by the relatively high boiler pressures of modern power plants operated for general power purposes but available for charging the engines. Almost all such plants are now capable of furnishing steam at pressures in excess of the 125-pound minimum necessary, and many have 400- or 450-pound steam available for charging.

The first geared fireless locomotive, a 50-ton machine built for a maximum charging pressure of 200 pounds, was put into service at the New York Navy Yard in 1934. The two-cylinder engine of this locomotive runs at about four times the speed of the driving wheels, to which it is connected by reduction gearing, a jack shaft, and side rods. The thermal efficiency of the relatively small, high-speed engine of this locomotive is somewhat higher than that of the larger slow-speed engine which would be required for a direct-connected locomotive of equivalent power. Against this advantage, however, must be offset the disadvantage that the locomotive is slower, particularly when running light.

The Navy's second fireless locomotive is a direct-connected 50-ton machine recently put into service at the Charleston yard. Built for a charging pressure of 400 pounds in anticipation of the possible future installation of boilers working at this pressure in the yard power plant, it is now being charged with steam at 160 pounds and does eight hours work a day on two full charges and two partial charges, the full charges being obtained before the beginning of the working day and during the noon hour, and the partial charges in the latter part of the morning and afternoon when the engine happens to be near the



Diagrammatic cross-section of a modern fireless steam locomotive. Steam from a stationary boiler plant is introduced through charging pipe at bottom. Heat energy is absorbed by the water, which later turns to steam

power plant. These partial charges are taken in about 15 minutes each. With 400-pound steam from a test boiler, the locomotive has demonstrated that when fully charged to this pressure it will do heavy switching work for over four hours.

The Navy's two fireless locomotives are by no means unique as to size or charging pressure. Both engines are exceeded in size by many engines, the rather high designed charging pressure of the Charleston engine being exceeded by a 73-ton engine which takes steam at 450 pounds. The largest fireless locomotive built to date is a 95-ton, direct-connected machine taking steam at 350 pounds pressure.

The growing popularity of the fireless switching locomotive is due to its economy, safety, and convenience. The fireless locomotive is economical because its first cost is low, because the steam it uses is generated in the efficient boilers of a central power plant at a low fuel cost, and because it eliminates the boiler which is the most troublesome and expensive part of a fuel-burning locomotive to maintain. The safety of the machine is due to the complete absence of fire and explosion hazards. Its convenience is due to its constant readiness for intermittent work, and its cleanliness which enables it to enter buildings and shops without scattering ashes and blowing smoke and cinders about. Furthermore, its silence is a minor blessing to the office force if there are important tracks near the administration building.

From the above enumeration of its good points, it should not be concluded that the fireless locomotive is a universal panacea for all switching engine troubles. In many plants the mileage of track to be served, the absence of a boiler plant for charging, or other considerations may make other forms of yard locomotive preferable to the fireless, but nevertheless the fireless locomotive is an auxiliary tool the value of which industry is beginning to realize.

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Photo-Finishes

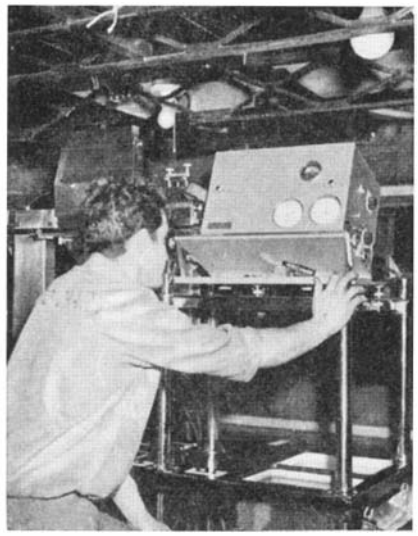
New Lighting Equipment Takes Last Element Of Chance from Horse Racing—Except the Horse

FRANCIS M. FALGE

JUDGING a horse race is no simple feat, and there can be no compromise for the fan who has put his two dollars on the nose of Ecstasy only to see Nerts' nose given first choice. Small wonder, therefore, that no expense has been spared to develop photographic methods of registering the finishes of horse races, now familiarly known as "photo-finishes," to take the guess work out of race judging.

Many racetracks, including Hollywood Park in Los Angeles, use the Photo-Chart Camera equipment invented and developed by Lorenzo Del Riccio, well-known in motion picture circles for his work with sound and color at Paramount Studios.

The principle of the Photo-Chart Camera, developed several years ago, is briefly this: Located at the top of the stands is the photo-finish camera as well as a complete darkroom for ultra-speed photofinishing. The camera is accurately aligned so that its narrow slit, 0.008 of an inch wide, is focused on the finish line. A telephoto lens of 5½-inch focal length and *f*/2 aperture images the full width of the track on the film which moves behind the slit opening at the same relative speed as the horses. The film speed averages an inch and a quarter per second, which gives each section of film approximately 1/35 of a second exposure. Because the film and horses are moving at approximately the same relative speeds, a short and undisturbed exposure of each horse is recorded, though, of course the background is completely blurred.

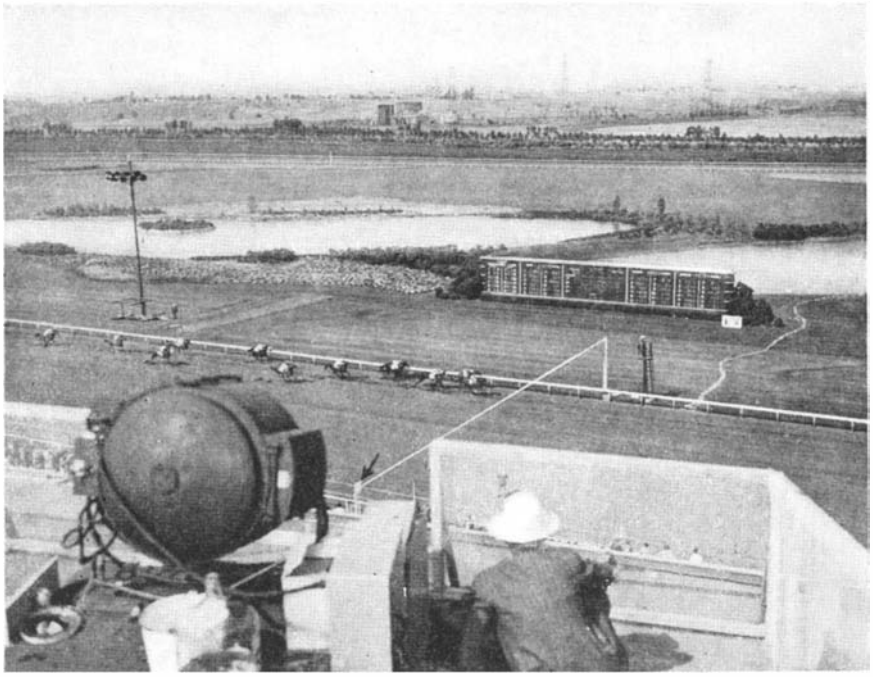


Interior of camera house showing the Photo-Chart equipment

Water-cooled 24-inch "sunspot" lamp used to illuminate finish line for photo finishes

In an average time of 48 seconds, an enlargement of the photo-finish negative is produced and delivered to the judges. With this equipment, dead heats, which have averaged 2 percent of all races, have been reduced to 0.5 percent with no dissension from fans, owners, or newspaper columnists.

The Photo-Chart equipment has provided accurate judging for all except the later afternoon races when the light is low in both level and direction and comes from behind the horses. Disturbing shadows result, which make judging even with a photograph difficult. To overcome this obstacle, Hollywood Park has installed the first 1000-watt, water-cooled mercury lamps for this purpose, engineered by Del Riccio and installed



A view from the spotlight equipment atop the grandstand, showing its location relative to finish line. Arrow indicates double lamp near ground

by the Keese Engineering Company of Hollywood. The mercury lamps were selected because of their high actinic value and small source, making control a simple matter.

Two lamps are installed in inconspicuous housings near the finish line. These illuminate the tape. Ballast transformers and water control equipment are all located in the same house. Atop the grandstand, at an angle of about 20 degrees to the tape from the Photo Chart house, is a 24-inch Mole-Richardson "sunspot" with a triple mercury lamp, with water-jacket equipment. The light from these lamps is directed in a narrow beam to the finish line, from the forward side of the horses.

With this extra lighting equipment turned on from the Photo-Chart house as the horses are in the stretch, adequate light is projected to the horses' heads to provide for late races and to erase shadows to permit accurate judging, thus removing this last bone of contention from horse racing. This now leaves but one variable, the selection of the horse itself!

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HUMIDIFIERS

Chemical Assists Home Humidification

SIMPLE open pan evaporators on radiators, designed for humidifying the home in winter, are cheap, but of little value because of the small amounts of water which can be evaporated from the exposed surface of the water. New devices called wick evaporators are more desirable because they expose a larger surface of water to evaporation. These evaporators are for sale in many hardware and house-furnishing stores, and from mail order houses. They are inexpensive and new wicks cost about 25 cents each.

In a wick evaporator, the capillary pores in the cotton fibers of the wick draw up water from the reservoir on top of the radiator and the water is then evaporated by the rising heat. The amount of evaporation, therefore, depends on the rate at which the water is drawn through the wick by capillary action. Carbonate salts in the water eventually plug up these capillary pores as the water is evaporated and, when one observes this salt deposit, the wicks should be cleaned by soaking in a dilute solution of muriatic acid, using a glass or pottery container. If the wick of the evaporator dries up, the capillary pores fill with air and the wick needs to be squeezed under water to release this air.

Recently, the chemist has contributed to the market a product which will greatly increase the efficiency of a wick evaporator. The chemical, one of the "wetting agents," is of a type that has been widely used in industries to make water "wetter."

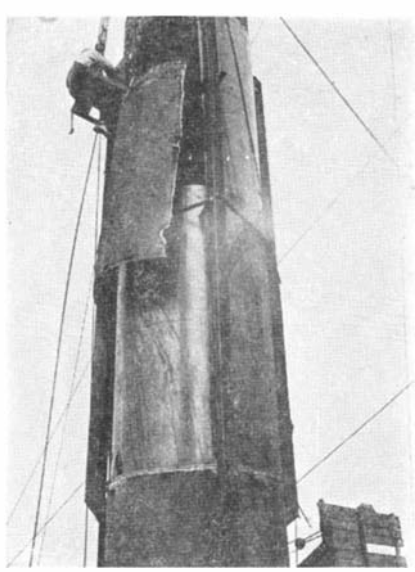
A small amount of a wetting agent, when added to the water in a wick evaporator, will keep the wick wetter and, because of the heat of the radiator, will have a marked effect on the amount of water evaporated and the relative humidity of the home. Also, if the evaporator should go dry and one must add water, the wick will immediately become wet and one can observe the air bubbles being released from the capillary pores of the fibers of the wick. Thus the necessity of squeezing the wick under water is obviated. Because these wetting agents are non-volatile, a few treatments a year in each wick evaporator is all that is necessary.

STACK "SURGERY"

Costly Plant Shutdown Eliminated by Electric Welding

BELIEVED to be the first of its kind ever attempted, an ingenious electric welding job has saved a large public utility company from a possible plant shutdown, with its accompanying financial loss, plus the additional cost of entirely new boiler stacks.

Upon inspecting two of the company's three 20-year old steel stacks, engineers found that the ⅜-inch steel center plates had been corroded down to as little as 1/64 of an inch; in some places they



"Operating" on a steel stack

found a full ¼ of an inch of rust. Cause was the corrosive action of combustion products from the forced draft coal fired boilers. In an effort to forestall a possible shutdown, the company called in the Weldrite Corporation, asked them to repair the stacks, if possible.

To solve the problem of supporting the top half of the stack so that the corroded plates could be removed, offset steel angles were welded across the faulty section. The old plates were cut out, leaving the stack's upper portion supported only by the angles. The prepared new plates were then inserted and welded in place.

Cost of repairing the two steel stacks with a Westinghouse Flex-Arc welder was less than one fifth the estimated cost of a new brick structure, taking no account of the expense of the shutdown which would have been necessary.

COLD-TINNING

New Process Has Wide Application

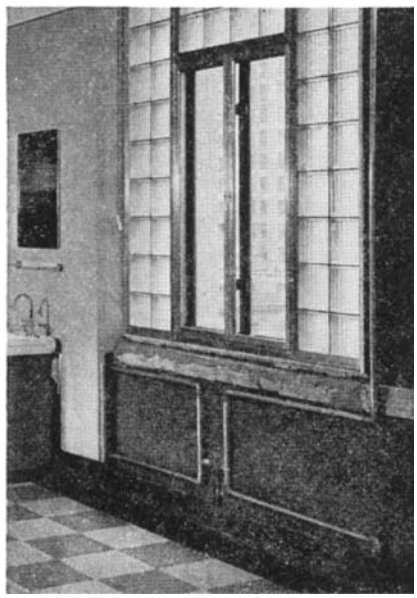
A NEW process of tin-plating copper and its alloys by cold dipping overcomes many of the difficulties encountered in the hot-tinning method, it is reported in *The Frontier*.

According to a manufacturer who is now using the process to tin copper and copper alloy tubing, it is possible to obtain an adequate coating on both interior and exterior surfaces of the tubing. The process, it is also claimed, is equally adaptable to straight lengths of tubing or to coils.

It is expected that the process will offer a satisfactory way to overcome the condition known as "green water." When copper and copper-alloy water lines are used, chemicals present in the water frequently react with the copper to form metallic salts. This condition is especially common when the water is drawn from surface wells, and may color the water perceptibly when flow is intermittent. While tinning the interior surface of the pipe by earlier methods gave reasonable satisfaction in preventing "green water," the process was limited to relatively short, straight lengths, was complicated, costly.

The cold process, in addition to offering a new weapon against "green water," is expected to find other applications in such fields as beer dispensing equipment and air conditioning.

The method employs a solution prepared by the reaction of stannous chloride and sodium hydroxide to form sodium stannite, after which sodium cyanide is added. The internal surface of a tube can be coated merely by pumping the solution through the tube, it is claimed.



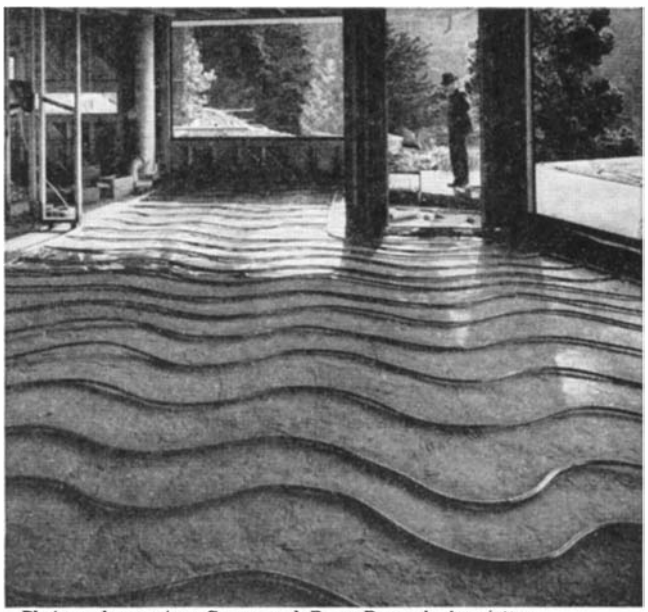
One-inch copper tubing in a wall-warming heating system

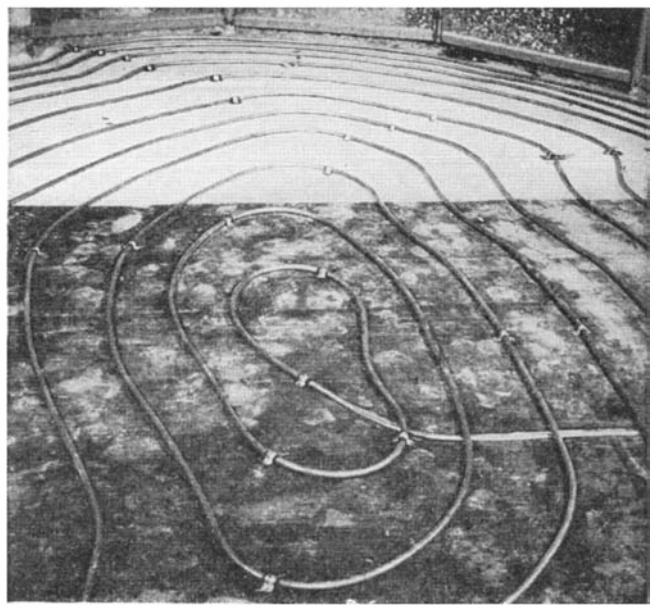
PANEL HEATING

Methods of Installing Pipes

MORE and more buildings and residences are being equipped for panel heating, the system which consists of the insertion of heating pipes within the floors or walls. In many respects this is far superior to the use of exposed radiators, primarily because, as research has shown, occupants of a relatively cool room will be more comfortable if the walls are warm; body heat radiates more readily and rapidly toward cold walls.

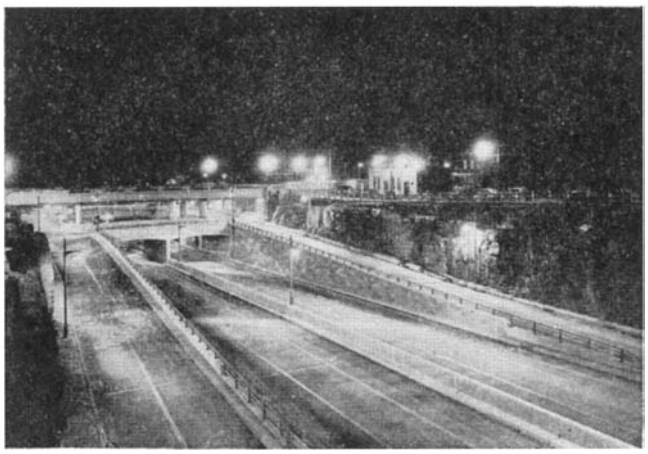
Panel heating is not new but, like many similar developments, its growth has been slow but steady. On the other hand, some of the methods of installing the pipes and the form these pipes should take are new. The accompanying photographs show methods of installing soft and standard copper tubes in





Photographs courtesy Copper and Brass Research Association

Two types of floor-warming pipe installations, before laying floor



Safety lighting. *Left:* **Three-level traffic intersection in New Jersey.** *Right:* **Lake Washington floating bridge**

floors and walls. Usually, in floor installations, a bed of gravel or other insulating material is laid under the pipes; in exterior walls cork insulation is mounted between the exterior wall itself and the piping system.

FRONTS

For Shirts — Like, but Unlike, Celluloid Collars

GONE — thank Heaven — are the days of the celluloid collar. Whatever else might be said of them, their flammability gave some of their wearers very serious burns when they caught fire.

Many advantages are seen, however, for waiters' and bellboys' uniform shirt fronts made of "Vinylite" plastic sheets. They are, of course, non-flammable, but they are also readily cleaned with a damp cloth, are completely resistant to spilled foods and liquids, and are permanent in shape and size.

HIGHWAY LIGHTING

Modern Systems Are Engineering Achievement

MODERN engineering achievements are shown off to their best advantage at night because of great improvements in outdoor lighting systems. More important, however, is the fact that these lighting systems provide illumination which is essentially glareless. So much research has gone into the development of such lighting systems that the result constitutes an engineering feat of no mean order.

Two outstanding examples are illustrated on this page. One shows the night illumination of the world's longest floating bridge, the Lake Washington Bridge, at Seattle, which consists primarily of 25 enormous concrete pontoons, as described some months ago in Scientific American. The lighting units used are sodium lamps developed by General Electric engineers. The other photograph shows the near-daylight illumination of the three-level traffic intersection on the New Jersey approach to the Lincoln Tunnel. The special system of illumination here was designed by General Electric engineers also. Reflectors direct light to the pavement surface, while little is lost upward.

FOR REFRIGERATORS

Deodorant Brick Renewed By Boiling Water

A MARKED advance in activated charcoal deodorants for refrigerators and iceboxes is presented in Syn-Char, a deodorant brick manufactured by R. MacKellar's Sons Company.

Instead of the usual granulated charcoal used for this purpose, Syn-Char is a highly compressed small brick, free from powdering and the resultant black dust and soot heretofore experienced with refrigerator deodorants. Also, Syn-Char lasts indefinitely, since it can be restored to its initial odor-absorbing state merely by placing in boiling water, followed by drying slowly in the sun, over a very low gas flame, or in a heated oven. This deodorant is of adequate capacity to keep the largest household refrigerator or icebox free of disagreeable odors, and also prevent the contamination of butter and other susceptible foodstuffs. Syn-Char is available for any "box" as an inexpensive accessory.

PETROLEUM FERTILIZER

Gaseous Ammonia Steps-Up Crop Production

IN THE West where crops are crops, they've been growing even bigger and better lately with gaseous ammonia blown into irrigation water. An acre of ground fertilized with 400 pounds of ammonia produces 736 crates of celery as against 565 crates from an acre dressed with a ton of mixed fertilizer.

Gaseous ammonia in its raw state is a petroleum gas, a mixture of methane, ethane, nitrogen, oxygen, and several other things. Intricate processing is required to make it suitable for agricultural use.

The gas is cracked and unwanted substances are removed. Cracking produces carbon, which is washed out with water and removed by electrical precipitation. This leaves a gas composed of hydrogen and small amounts of other unwanted substances.

This is only the beginning. Before ammonia is obtained, the hydrogen must be purified. This is done by putting it through iron

oxide boxes, an oil scrubber, a water scrubber, and two caustic soda scrubbers. Then it is ready for the final process of purification. This involves cooling the gas to 380 degrees below zero, after which the gas is washed through liquid nitrogen obtained from the air. The scene then changes to the synthesis plant where the gas loses the last of its oxygen and carbon monoxide and is synthesized into ammonia which emerges as a gas, ready for liquefaction or crystallization.

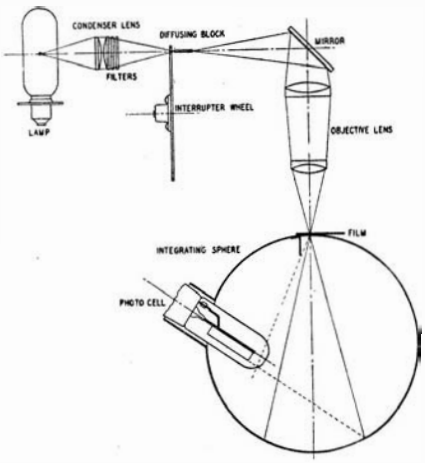
DENSITOMETER

Determines Density of Motion Picture Film

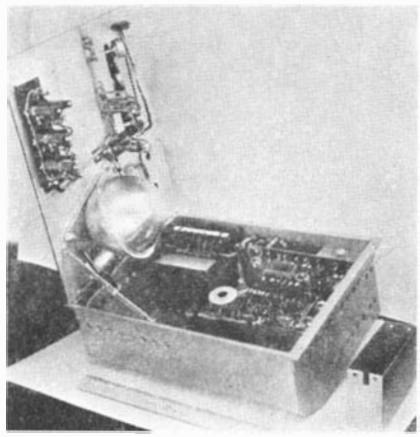
"LET one lightning-bug in a swarm of 500 stage a blackout and the Integrating-Sphere Densitometer can spot him!" That's how Dr. W. J. Albersheim, mathematical physicist of Electrical Research Products, Inc., described the precision of the latest optical instrument of show business. Not only does the new device boast a sensitivity five times keener than the human eye but, unlike the eye, it can tolerate the blinding glare of Hollywood's most powerful sun-arc without impairing its delicate perception in the slightest.

But the engineers who developed the new instrument were not concerned with lightning-bugs nor sun-arcs. They sought a scientific method of measuring the "density" or pattern of light and shade which comprises the image on a motion picture film.

To make such measurements, the Integrating-Sphere Densitometer traps that portion of a beam of light which succeeds in penetrating a test sample of motion picture film. The trap consists of a hollow ball or sphere, the inner surface of which is finished in white, and fitted with a photo-electric cell or "electric eye." Light entering the globular chamber is reflected many times and finally falls on the photo-electric cell as a thoroughly mixed or "integrated" product. Its value or brightness is then translated into electrical current and registers, in terms of density, on a meter. This information enables technicians to regulate with extreme accuracy the processing of movie film. Dr. Albersheim says the device will speed up the finishing operation and materially increase the uniformity of the final product.



Predicting behavior of movie film with the new densitometer



Above: **Interior of densitometer, showing metal sphere.** ***Left:*** **Diagram of the optical scheme**

FOR BLACKOUTS

Sodium Lights and Blue Glass Windows

YOU won't have to pull down the shades or turn out the lights if the blackout of war ever comes to America. General Electric scientists, concentrating on United States defense problems, are working on a combination of light and glass which will allow daylight in through your windows during the day but keep light from shining out at night.

By pitting one color against another, the lighting experts are working on the problem confronted by war-torn Europe: the danger of lighted windows guiding enemy planes.

H. A. Breeding, physicist at the Schenectady lighting laboratory, disclosed recently that a combination of blue-painted windows and sodium lighting in homes and factories is one answer to this particular defense problem.

The paint to be used, Breeding said, is ordinary paint treated with a special blue dye, experiments on which are still proceeding. Windows treated with this special blue paint will admit daylight. But, more important in war time, homes and factories can be lighted inside with sodium lights, not one ray of which will escape through the blue windows.

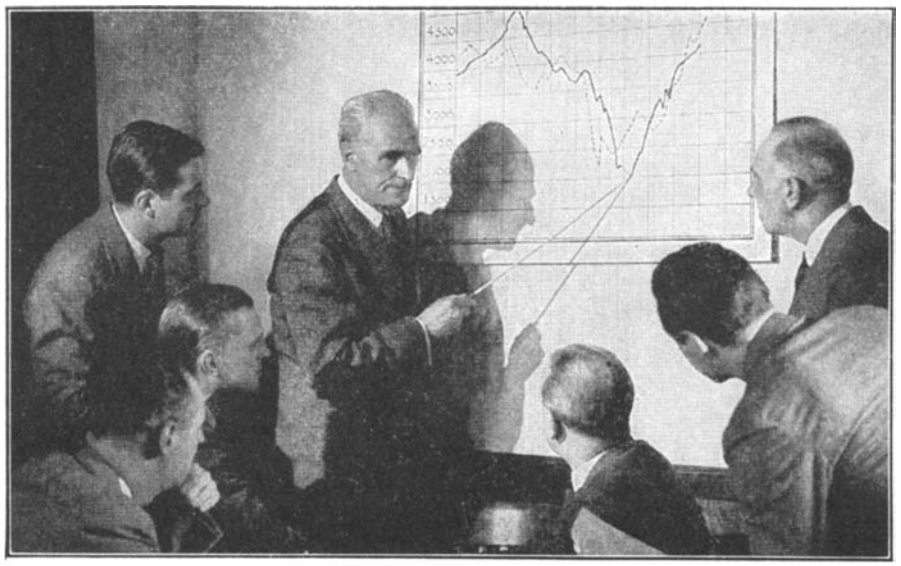
Of course, people might not like the yellow of sodium lights in their homes and factories as well as incandescent or fluorescent lighting; but, Breeding points out, this would be a minor inconvenience in war time.

PORCELAIN

New Frits Fire at Lower Temperature

THE daily bath is taken by Americans simply as a matter of course without much thought as to the background of research that has made it possible. Nevertheless, plebeian though the bathtub is, an enormous amount of research has gone into the development of new and better porcelains, improved methods of casting the iron base, and so on.

The seemingly unimportant reduction of the temperature of porcelain firing by just 200 degrees takes on great significance. The Porcelain Enamel and Manufacturing Company introduced, way back in 1911, new porcelain enamel frits which fired at 1600 degrees, which was just 200 degrees lower than those generally used then in the industry. The company has now developed another enamel frit, Pyroflex, which fires at only 1400 degrees. The first reduction was recognized as one of the biggest forward steps the industry has known, and is generally accepted as having been instrumental in



Study Your Leaders —Know What They Know!

IF you merely admire and envy the executive ability of leaders in business, finance, and industry, you will never be endowed with their capacity, or be able to duplicate their success.

To succeed on your own account, you must gain what they have and you lack: *an understanding of the entire field of business.*

A leader in business has a thorough grasp of the principles which underlie all successful businesses. If you could sit unseen, at his conference table, during the planning of an advertising campaign, you would see that he is guided by a broad understanding of the laws of distribution, supply and demand, the psychology of selling. Advertising to him is not a daring gamble—it is a powerful, measurable force.

And if you could observe his daily conduct of financial operations, you would see his decisions based on an understanding of the principles of banking, finance, investment. His entire management is guided by a thorough knowledge of organization, costs and credit. His policies are constructed with clear understanding of commercial law. He knows business as a whole.

This knowledge has been collected, classified and presented for your use in the Modern Business Course and Service of the Alexander Hamilton Institute.

Big men founded the Institute and big business leaders are contributing to the course. Among the contributors are such executives as Alfred P. Sloan, Jr., *Chairman of the Board*, General Motors Corporation; Colby M. Chester, Jr., *Chairman of the Board*, General Foods Corporation; Thomas J. Watson, *President*, International Business Machines Corporation; Edward R. Stettinius, Jr., *Chairman of the Board*, United States Steel Corporation; Major B. Foster, *Chairman*, Department of Banking and Finance, New York University, and many others.

What is the verdict of business men as to the value of the Institute?

Chief Engineer of a Public Utility:

"The Course has brought me, not only concrete practical ideas that were directly applicable to my own work, but has given me a much wider knowledge of business in general than I could otherwise have secured. No man today has time or money enough to spend in learning basic principles *by experience.*"

Vice-President of a National Bank:

"There is no doubt that, after having conscientiously followed the Course from beginning to end, one would be thoroughly acquainted with most of the problems that are to be met in the ordinary course of business. I am glad to recommend the Alexander Hamilton Institute Course to anyone who is interested in equipping himself with that business information which will enable him to improve his position."

We could quote hundreds more. These men are leaders. They have not only taken the Course themselves, but have watched its influence on younger men. Their judgment of the Course *must* be right.

Send for "Forging Ahead in Business"

The coupon will bring you a copy of this famous book which has helped so many other men to shorten their route to success. If you are one of the few who are asking, "What am I going to be earning five years from now?" you will send for "Forging Ahead in Business."

To the
ALEXANDER HAMILTON INSTITUTE, Inc.
213 Astor Place, New York, N. Y.

Please mail me, free, a copy of "Forging Ahead in Business."

Modern Business

Name.....

Business Address.....

Position.....

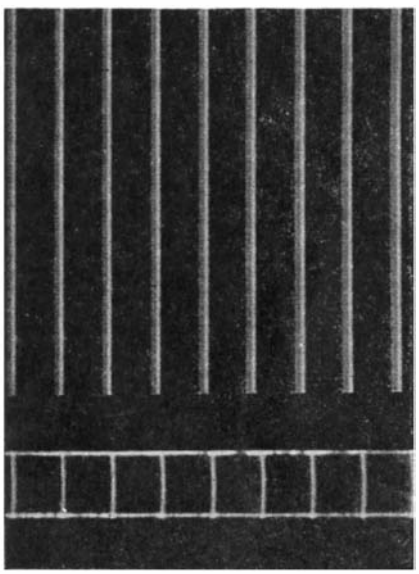
popularizing the wider use of porcelain enamel. This second reduction of 200 degrees permits the use of lighter gage enameling stock or black iron, thus greatly reducing manufacturing costs.

Pyroflex, as the name indicates, will withstand heat and will not flake off when bent or flexed. It may be applied in a wide range of colors, effects, and graining finishes, and requires only half the firing time of baked enamels.

PLASTIC WITH "SLATS"

Plastic Sheeting With Louvers For Lighting Fixtures

A NEW type sheeting has been developed in Plastacele, cellulose acetate plastic, with which it is possible for the first time, it is said,



Magnified views of "Louverglas," edgewise at bottom, flat at top, showing translucent "slats"

to combine the efficiency of direct lighting with the comfort of indirect lighting.

Very thin, parallel, translucent louvers, or "slats," either white or colored, running through the depth of a clear transparent sheet at right angles to the surface, make possible this new eye comfort and bring other previously unattainable qualities to the lighting fixture field. The material also opens new possibilities in vision control.

This sheeting, called Louverglas, was conceived by L. C. Doane, President of the Doane Products Corporation, and developed in collaboration with the research staff of the Plastics Department of E. I. du Pont de Nemours and Company. It is the first material to combine in large measure the diffusion obtainable with an opal material with the directional efficiency obtainable with a clear material.

Louverglas is said to be the best material found to date for direct lighting fixtures for the new fluorescent lamp for which it is primarily intended.

According to the angle from which smooth-surfaced Louverglas is viewed, it appears as a transparent sheet with fine, parallel, translucent hair lines, which are the louvers, running through it; or as a completely translucent surface due to the louvers overlapping one another like the slats of a picket fence; or in various proportions of translucency and transparency.

For purposes where it is desired to cut off glare from all directions to the normal field of vision, one sheet of smooth-surfaced Louverglas may be used on top of another, with the louvers forming an egg-crate pattern.

Another innovation is Louverglas combining clear transparent plastic with colored louvers. There is no appreciable loss of lighting efficiency, as all but a negligible fraction of the light transmitted is through the clear transparent sections. Sheeting with black louvers, with which only direct light transmission is retained, will also have specialized use.

STRIP SEALING

Metal Foil Strip Covers Seams, Irregularities

FROM England comes news of rather wide use of a strip sealing process which employs aluminum foil to cover such surface irregularities as those along the rivet line of an airplane. Other places in which this strip sealing may be used is along the overlapping joints of any metal or wood construction.

To reduce friction or protect against corrosion under extreme conditions, the metallic foil, usually of aluminum, is coated on one side with a thermo-plastic adhesive. Before it is applied, the point to be covered is cleaned of any grease or dirt and given a light coating of a similar adhesive by brush or spray. The foil is then placed in position and low heat and light pressure are applied by means, preferably, of a special thermostatically controlled iron. When the joint cools, the metallic foil is securely fastened but retains its flexibility indefinitely. The covered surface may then be lacquered and finished in the usual manner by a spray or brush.

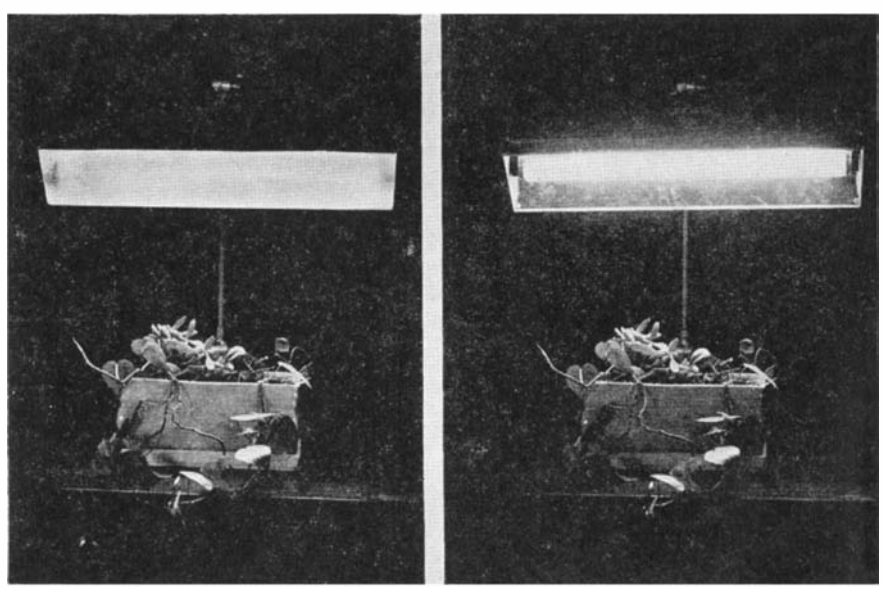
This process is a product of Cellon Limited, Kingston-upon-Thames, England.

WHIPPOOR-WILL

The Famous Bird, Often Heard, is Almost Never Seen

PROBABLY not one person in a hundred ever has seen a whippoor-will. Its melancholy song is one of the most familiar notes in the symphony of the summer evening but to the majority of listeners it is only a disembodied voice in the dark, for the singer has come about as near to achieving invisibility as any living creature, says Dr. Winsor M. Tyler in a bulletin issued by the Smithsonian Institution.

The whippoor-will is a migrant,



Fluorescent lighting without and with "Louverglas"; note glare reduction

spending its winters in Florida and its summers from March to September in the north. It travels entirely at night, sometimes in large flocks. It builds no nest but lays its flecked eggs on the ground, depending on the flickering shadows of the woodland over the dried leaves to conceal them.

The bird is masterfully camouflaged and usually selects a spot for its eggs where the woodland floor is free of underbrush and the trees are spaced far enough apart to cast an uneven shade. The newly hatched chick, almost exactly the color of the dead leaves among which it lies, remains essentially invisible. Nests are found almost exclusively by accident.

Dr. Tyler tells how one may catch a glimpse of a whippoor-will: "In order to study the whippoor-will at short range it is well to visit its haunts for a few evenings and learn how the bird behaves when it wakes from its day's sleep. Whippoor-wills move about over a considerable territory when they come into the open for their daily session of singing and feeding. They follow a route, evening after evening, that varies little, and on the circuit there are stations—a stone wall, a low branch, or a certain spot on the ground—where they are almost sure to stop and sing for a while.

"If we seat ourselves near one of these stations where the light, which will be almost gone when the bird arrives, will favor our view, and where a dark background will obscure us from the bird, we shall be able to see the whippoor-will at short range, for if we sit motionless the bird will pay little attention to us. We must sit quietly and wait, following the song as it swings around the circuit, and we must watch the spot where the bird is about to alight, for, although in flight it looms big even in the dusk, when it comes to rest, with a flick of its wings it becomes a bit of dead wood, a clod of earth, or vanishes altogether."

PHENOTHIAZINE

Almost Universal Remedy For Wormy Animals

IN THE old days when animals such as sheep and cattle became infested with nodular and common stomach worms, the farmer or rancher could do nothing but guess at the kind of parasite and prescribe some anthelmintic which he hoped might work. If his guess were correct, the

organism would be eliminated by this worm expeller; otherwise his animals died. Yet, all the while there was in existence, says *The DuPont Magazine,* a synthetic product, phenothiazine, which is an effective treatment against most internal animal parasites.

It was not until recently that the anthelmintic characteristics of the pale, greenish-yellow powder, which is tasteless and insoluble in water and relatively non-toxic to animals, was found. First, investigators of the United States Bureau of Entomology and of the Du Pont Company began experimenting with it as a plant insecticide. Later came the discovery that, while deadly to certain insects, phenothiazine was relatively non-toxic to animals. This was the incentive for further experiments in the Zoological Division, Bureau of Animal Industry, leading to the development of the drug as an anthelmintic to remove several species of gastro-intestinal worms. Early findings proved it to be successful in removing common and lesser stomach worms, bankrupt worms, hookworms, large-mouthed bowel and nodular worms from sheep, as well as ascarids and nodular worms from swine, at least to the degree that they were not harmful to the animal's health. Later developments indicated its value for treating strongyles in horses, nodular worms and stomach worms in cattle, and for removing cecal worms from poultry.

Courtesy Jensen-Salsbery Laboratory
Veterinary administration of an aqueous suspension of phenothiazine to a variety of farm livestock

Phenothiazine is the only known anthelmintic that has proved effective for the elimination of various species of gastro-intestinal parasites, including those most commonly injurious to cattle, horses, and sheep. It is the only medicament that will remove nodular worms from swine and is an entirely satisfactory treatment for cecal worms in poultry. It will, in fact, remove more different kinds of worms successfully than any other chemical now known.

RECORDING PAPER

For Recording Instruments: Affected Only by Electricity

ONCE a closely-guarded secret, Teledeltos, the dry, electro-sensitive, recording paper which makes practicable facsimile telegraphy, long the dream of telegraph men, is now available for public use, the Western Union Telegraph Company has announced.

Numerous inquiries from manufacturers of recording instruments and from laboratories, colleges, and scientists who use automatic recording devices indicate a growing interest in this new recording paper.

Methods now in common use employ a recording pen moving across a paper chart, a point vibrating against a carbon paper record, a discoloration of paper by chemical methods, a marking by electrical discharges, and even photographic records made by moving points of light. These records show a wide variety of things, such as a time record of traffic, production performance of machines, water or electricity consumption, fluctuations of power and temperature, and so on.

Teledeltos paper has definite advantages for many purposes because it requires no developing, processing, or fixing, and records made upon it are instantly available. It is an electrically conducting sheet of paper coated with material which shows permanent changes of color at any point where an electric current passes through the sheet. The current is applied to the coated side of the paper through a metal stylus and the circuit is completed to a metal cylinder back of the paper. Neither the coating of the paper nor the record is affected by light or atmospheric conditions.

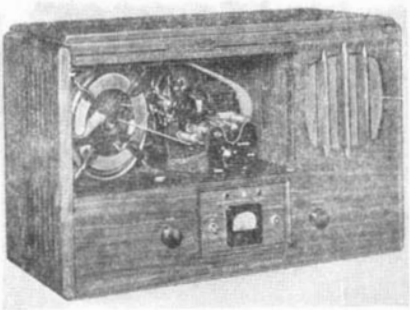
SOUND RECORDER

Records on Film— Speeches, Dictation, Conferences

A NEW instrument in the sound recording and reproduction field, making commercially feasible the non-photographic recording of sound on film and foreshadowing

a new era in the recording industry, has been perfected and is now ready for marketing and introduction to the public. The recording machine, to be known as the Recordgraph, was developed by William L. Woolf of New York and his associates, all radio engineering experts.

Mr. Woolf described his device as economically adaptable to business, social, and home markets. He explained that it can be used in amateur recording, for business dictation, and for recording conferences and meetings.



Panel of Recordgraph is lifted to show the interior mechanism

So precise is the recording operation that 96 sound tracks may be recorded on the conventional 35mm film stock. By the new process, 25 feet of film will support an hour's recording of speech or music of excellent quality, while as little as 6¼ feet will support an hour's recording of intelligible speech, at which rate the standard 1000-foot reel of film commonly used in the movies to supply about 10 minutes of entertainment, is sufficient to support 160 hours of continuous recording by Recordgraph. In the reproduction of recorded sound, the new machine may be instantly set at any one of the 96 sound tracks, making possible the reproduction of specific excerpts from any film record.

DIVING SUIT

Successfully Heated, Uses Glass Insulation

THE use of helium-oxygen diving gas has made possible deeper and more effective deep-sea diving. With this mixture, the diver is less subject to the bends, but he suffers much more from the cold than he does when he breathes ordinary air. It has, therefore, been necessary to supply artificial heat within the diver's suit by means of electric heating elements. With these there has always been the danger of short-circuits which could easily prove fatal because of the diver's contact with salt water.

New insulation made entirely of Fiberglas eliminates all chance for short-circuit, for this material is 100 percent glass and will not burn. This new heat-insulated diving suit, which marks an important chapter in the United States Navy's long record of pioneering development of modern submarine and diving safety devices, was announced recently at a demonstration by the Navy's Experimental Diving Unit in the Washington Navy Yard. It is being manufactured by the Colvinex Corporation.

MORE SELF-SUFFICIENT

Home Source of Previously Imported Insect Poison Discovered

PROGRESS in making America self-sufficient in her present war against injurious insects has been reported to the American Chemical Society by Drs. L. D. Goodhue and H. J. L. Haller of the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture.

Rotenone, a poison which is highly toxic to insects but entirely harmless when eaten by birds or mammals, has been found in one American weed known as "the devil's shoestring." During 1940 the United States imported about 7,000,000 pounds of root of the derris and lonchocarpus plants, which contain rotenone, in its fight against pests. Discovery of rotenone in Tephrosia Virginiana, the scientific name of "devil's shoestring," may lead to making this country independent of others for its supply of this material.

COVER SLIPS

War Shortage of German Glass Overcome By Americans

AMERICAN chemists and glass makers have overcome the threatened war shortage of an important German-made medical glass by learning how to make this rare glass here.

In reporting this fact, *Science Service* explains that the particular glass in question is the very thin and clear glass used as cover slips. Like the cloth slip covers used by careful housewives to protect furniture, these glass cover slips

are used to protect blood or other material being examined under a microscope.

Medical examinations of the men drafted for Army training will increase the need for this glass more than 33 percent, it is stated. During the World War, medical scientists were hampered in some of their work because this type of glass could be made only in Germany.

The glass, to be known commercially as Lustra Cover Glass, is extremely thin and practically colorless. Its thickness varies from 0.005 of an inch to 0.010 of an inch as compared with the normal home window glass that is 0.091 of an inch in thickness.

It would take a total of 36,000 separate ¾-inch-square cover slips to equal the amount of glass in a glass block 12 inches long by 12 inches wide by 1 inch thick.

CALLING ALL WORKERS!

To Build Iron Lung In Emergency

IN AN emergency, American workers always seem equal to special urgent tasks within their range of abilities. This is exemplified by the successful construction of an emergency mechanical respirator by 30 metal shop workers to save the life of a co-worker's 10-year old son, stricken with infantile paralysis in Grand Rapids, Michigan.

The youth, Cabell Pratt, son of Percy P. Pratt, western division engineer of Post Products Company, sheet metal fabricators, was stricken on a Sunday. Following a frantic but fruitless state-wide search for a respirator, the father reported his dilemma to the chief engineer and, at 9:30 Tuesday morning, the actual job of constructing the "lung" began. The 30 workmen toiled continuously for 28 hours, working all night Tuesday. Structural details were taken from one of two standard Drinker-Collings iron lungs in use at a local hospital, and an engineer produced the plans for the emergency unit.

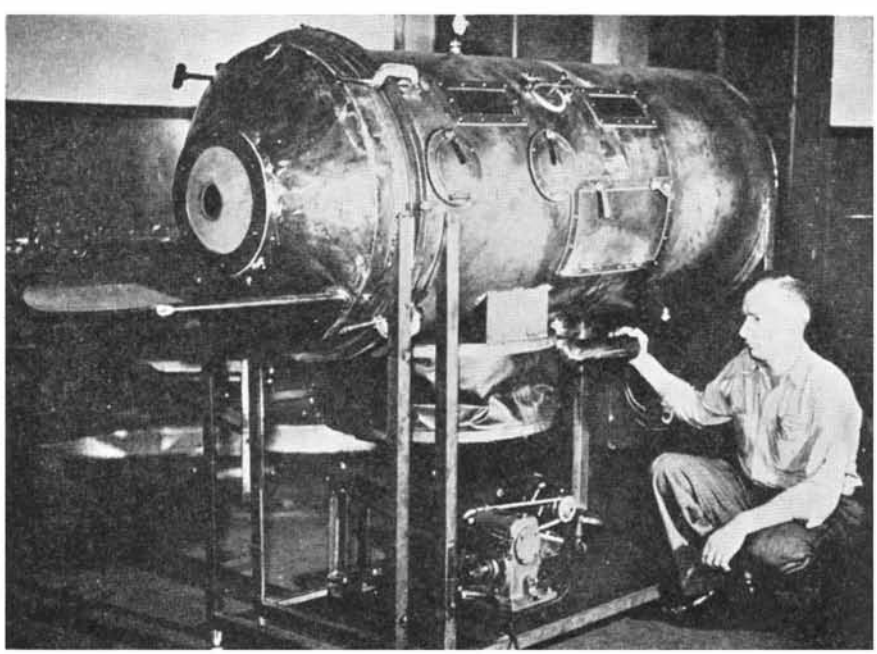
Setting to work, the men cut the parts of the breathing machine from 14-gage sheet metal and arc welded the pieces together by the modern shielded arc process of The Lincoln Electric Company. Then they installed wires, valves, gages, and electric motors. The framework is of angle iron, arc welded. Portability is provided by six casters on which the unit is mounted.

The "tailor-made" breathing machine, completed at 1:30 P. M. Wednesday, three full days before the disease reached its crucial stage, was accurate to the last detail.

SKUA

British Plane Could Be Its Namesake

IT HAS been said that the British fighting plane, the Skua, is named for a European species of sea-gull. There is another skua, living in the Antarctic, of which the British fighting plane might be more appropriately the namesake. For, according to a recent note from the



The iron lung that was built in 28 hours

Smithsonian Institution, this southernmost bird on earth is a fierce killer. Incidentally, it is the only higher animal except man and his dogs that goes close to the South Pole.

To carry out the analogy between the bird and the plane, this particular skua is a creature of relatively enormous strength, flying long distances while carrying chunks of meat bigger than itself. Furthermore, it is an extremely noisy, quarrelsome creature, but here the analogy ceases—if we are to be perfectly honest; it is utterly devoid of parental affection. The parents hardly bother to feed them, but the little skuas (like those British planes?) come out of the eggs fighting.

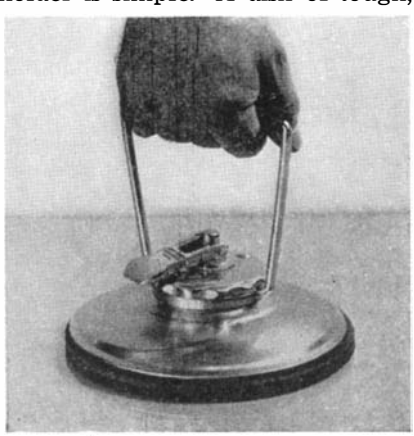
VACUUM HOLDER

Lifts Glass, other Smooth-Surfaced Materials

THE new style vacuum cup holder, or lifter, shown in our illustration, is a safe, sturdy, lifting device capable of holding as much weight as a strong man can lift, and its uses are practically unlimited.

The device, called the "Red Devil" vacuum cup, literally puts a handle on all kinds of glass as well as marble, granite, and various smooth-surfaced articles whose weight normally makes lifting, pushing, raising, lowering, or carrying awkward and difficult. It is being used in many refrigerator and range showrooms, and some automobile companies are known to be using the larger models for lifting solid steel tops onto the bodies. These holders are also highly effective in handling wallboard and numerous other materials on which the strong vacuum cup can get a grip.

Construction of the vacuum cup holder is simple. A disk of tough, durable rubber mounted on the bottom is connected through a central post to a hand-operated lever. When the device is placed on a smooth surface, this lever is thrown all the way over, as shown in the illustration, so that it lifts the center post, thereby lifting the center of the disk beneath, so that a strong "vacuum pull" is exerted.

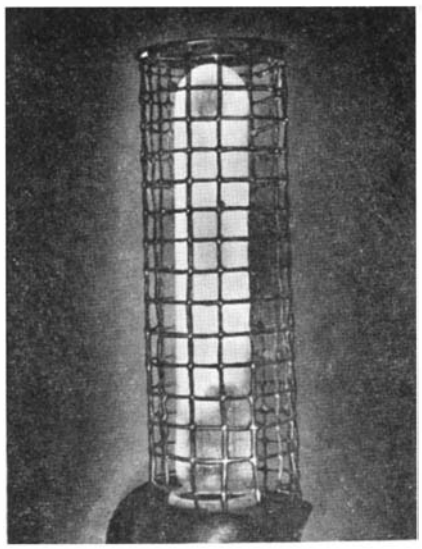


Versatile vacuum lifter

GERM-KILLER

Ultra-Violet Now Works in the Laundry

ULTRA-VIOLET rays have been used for several years to kill germs, fungous growths, and the like, in food packing and meat storage plants; recently a special ultra-violet ray lamp was developed for use in the home refrigerator. Now, for the first time, a special lamp has been developed "to bring sunshine into the laundry." An accompanying illustration shows this new lamp which has been designed for use in washing machines.



Sterilizing lamp for launderies

This washing machine germ-killer produces a high percentage of the ultra-violet rays that are the most powerful for the purpose—those of approximately 3000 Angstrom units.

BESSEMER BLOW

End-Point Now Determined Automatically

PATENTS were recently granted to Jones & Laughlin Steel Corporation on a new method for controlling the Bessemer blow. In this method, an arrangement of photo-electric cells and other instruments eliminate

the human element in determining the all important end-point of the blow. Several major steel producers are expected to use the new method.

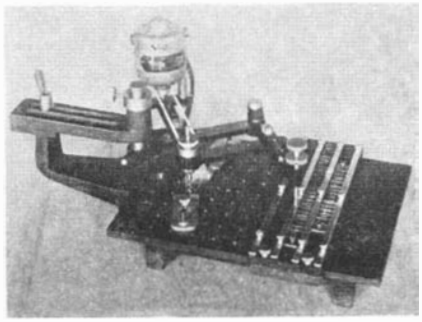
The determination of the finishing time of the blow of the Bessemer converter is important because, although the Bessemer process is essentially automatic in character and will proceed satisfactorily, the end-point is not automatic. Mr. H. W. Graham, under whose direction this development was made, says: "In fact, at a given moment the charge begins to 'commit suicide,' so to speak, by burning itself back into iron oxide." This change takes place with great rapidity; hence, precise control of the end-point by the ubiquitous photo-electric cell becomes a matter of greatest importance.

ENGRAVER

Pantograph Set-Up

Uses High-Speed Tool

MANUFACTURING plants, experimental laboratories, and home workshops will find use for a small motorized engraver operating on the pantograph system. Called the Mico Engraver, this instrument will



Many industrial and home workshop uses will be found for this small engraving unit powered by a vertical motor. It will work a variety of materials

do engraving and light routing in steel, brass, sheet plastics, and similar materials.

The cutting tool is carried in a ball-bearing spindle that revolves at 10,000 revolutions per minute, the power being supplied by a small vertical motor mounted directly on one pantograph arm.

The pantograph set-up used has the advantage of having the master copy and the finished work directly before the operator, and, as the pantograph is three-dimensional and the type grooves are very deep, no damage results if the tracing stylus slips out of the letter groove. The three-dimensional feature also allows engraving on curved objects with simple attachments to gage the depth of cut.

The operator has the choice of four finished letter sizes from one set of master type.

X-RAY ANALYSIS

New Technique

For Industry

A NEW technique for X-ray analysis of metals, alloys, welds, or small metal parts, which may be of great value to the armament industry as well as for peace-time work, was discussed recently at a convention of the American Society of Metals, by G. L. Clark, University of Illinois chemistry professor, and Dr. W. M. Shafer, Iowa State Teachers College chemistry professor.

It involves X-raying a thin specimen of the metal on plates having special, extremely fine - grain photographic emulsions, and then enlarging this negative 100 to 200 times. The original photograph is about the size of the end of a lead pencil.

The enlargement shows elements in the metal, whether they are spread evenly or bunched, as well as flaws or cracks. These flaws may be originally present or result from working the metal. Flaws in welds are instantly noticeable. Entire small metal parts may be X-rayed.

MITER KIT

A SMALL, well-designed miter cutter, complete with saw and selling at a modest price, is now being offered to professional and home craftsmen. Metal parts are cadmium plated; wood parts are of kiln-dried hardwood. Maximum depth of cut is two inches and the angle of cut can be adjusted through a wide range and locked firmly by a simple locking handle.

ELASTIC PAINT

For Coating Metals to Inhibit Rust

IF STEEL is kept absolutely dry—and that means that even the surrounding atmosphere must be dry—it will not rust. Yet even the best paints will let some moisture through. Therefore, a coating is needed that will exclude moisture and at the same time inhibit the

electrolysis which occurs where moisture does seep in.

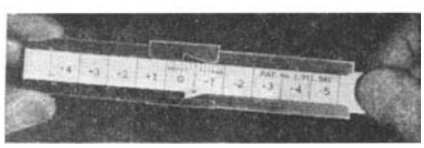
A new product called Elastic Primer does both of these things. As a coating on iron or steel, it keeps out moisture because it forms a highly impermeable, rubber-like coating that expands and contracts with the metal under varying temperatures. Because of the nature of the pigment used, it inhibits the electro-chemical action that results in rust. The manufacturers claim that it never dries out hard and brittle but remains elastic so that it is useful for such things as ship bottoms, sky-scraper roofs, bridges, railroad cars, and the like.

DECIMALIZER

Finds Decimal Point

In Slide Rule Answer

WHEN a slide rule is used to multiply and divide a string of figures, it is extremely difficult for the user to determine the location of the decimal point in the final result. This is not news to an engineer,



but the development of the "Decimalizer" *will* be news. The inventor of this simple sliding device explains that with proper manipulation it is possible to determine easily just where the decimal belongs in the product or quotient of a complicated bit of slide-rule mathematics. As shown in our illustration, the Decimalizer is similar in construction and operation to the slide rule which it assists.

ALUMINUM SOLDER

Fluxless, Easily

Applied

THERE has always been much difficulty in joining or soldering aluminum and its alloys. Soldering the metal is an exceptionally difficult problem, and many soldering fluxes to remove the stubborn aluminum oxides have been attempted but with little success. The common practice of roughening the metal surfaces and brushing-in hot solder is admittedly not dependable.

No flux is needed, however, with the new Colaweld "T" Rod, the application of which is much like soldering. With it the surfaces of aluminum and its alloys need no roughening, and the absence of flux removes the danger of toxicity and burns to the worker, as well as corrosion of the metal. On most types of joints the rod is simply rubbed over the heated metal until the rod melts, or it may be applied with a hot iron moved back and forth over the metal to spread the molten rod until it "takes."

COMET

Will Be Conspicuous Around

New Year's Day

CONCLUSIVE evidence that the new comet discovered recently by Leland S. Cunningham, of the Harvard College Observatory, will be the most conspicuous since 1910 is contained in his latest calculations of its path. These have been made public by Dr. Harlow Shapley, director of the Harvard Observatory.

They show that, in early January, the comet will be easily visible in the western sky for an hour or two after sunset, as it passes south of the bright star Altair in the constellation of Aquila, the eagle. At that time, it will be about as bright as Altair, and possibly even more brilliant, though it is somewhat uncertain just what brilliance it may attain.

Its distance from the earth, at the beginning of 1941, will be about 60,000,000 miles, and from the Sun about 50,000,000 miles. It will be closest to the earth about January 10, when some 54,000,000 miles away, and to the Sun, with 33,000,000 miles, on January 16. Between these dates it will be most brilliant. However, it will then be so close to the Sun as to be seen, if at all, only in the evening twilight. Consequently, it will not be as conspicuous as earlier, when it has a dark background. In the closing days of December, the moon, in a crescent phase, will pass to the left of the comet.

Though several comets in recent years were just barely visible when one knew where to look, this will be the first conspicuous naked eye comet since 1910. In that year there were two: Halley's, making one of its 75-year visits, and another which appeared earlier in the year, and was so bright that it was discovered independently in the southern hemisphere by a number of persons. Later it was visible in North America.—*Science Service.*

CAMERA ANGLES

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

Multiple Flash

INSTEAD of using one flash in one reflector, we use two or more in two or more reflectors, shooting all simultaneously with the operation of the shutter—that is the principal difference between straight or conventional flash photography and multiple flash work. Mechanically, this work requires a convenient means of hooking up so that the auxiliary flashes will operate synchronously with the main flash when the cable release actuates the synchronizing unit.

Until recently, multiple flash has been used chiefly by commercial and news photographers in photographing large groups or large areas. With the introduction of equipment designed to simplify multiple flashing, the use of this method has been extended to the ranks of the amateur and is being used extensively in carefully planned portraiture by outstanding photographers. In color work, too, its advantages have been great. Because of the small stops necessary to obtain the deep field required in color photography, and the slowing down of exposures due to the relatively low speeds of color materials, flashbulbs, duplicating the technique of regular lighting units, are practically a *must* wherever live models are being photographed. The use of multiple flash actually amounts to a speeding up of ordinary lighting units by supplying a great volume of light in an instant, although within the lighting scheme of regular flood-lighting equipment. The advantage lies in the fact that the latter might call for a longer exposure than is practical if subject movement is to be avoided and natural results achieved.

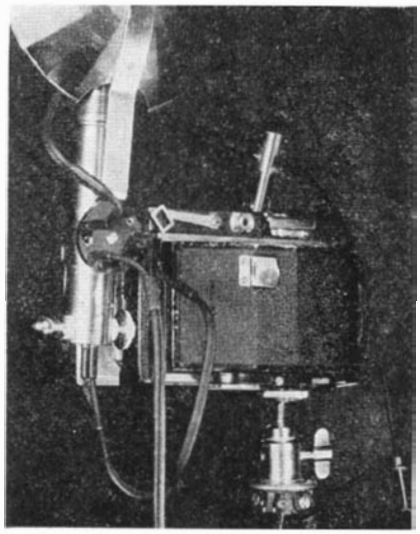


Figure 1

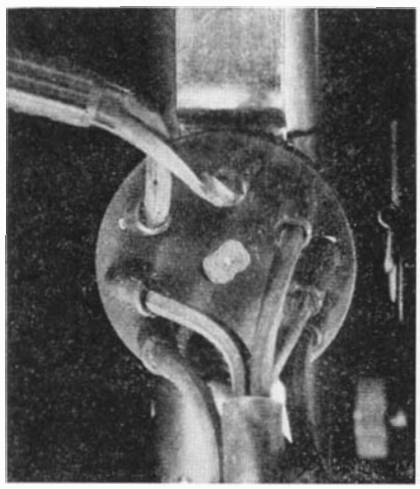


Figure 2

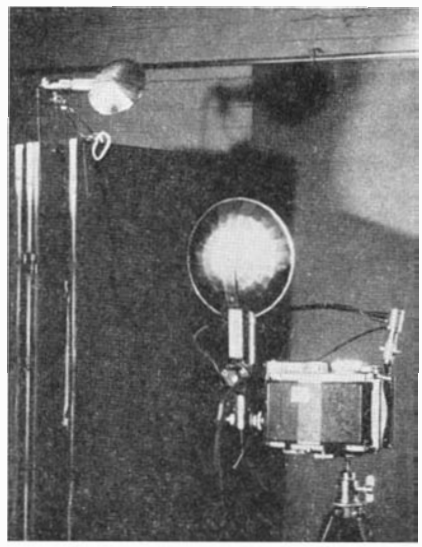


Figure 3

A number of the leading synchronizers on the market have provision for multiple flashing through extra sockets on the synchronizer battery case to take extra wires leading to auxiliary units placed at any required distance from the camera. The latest to appear, designed particularly for multiple flashwork, is the Chardelle Meteor kit illustrated in the accompanying pictures. With this outfit, the hookup is accomplished by means of a connector block screwed to the main unit and connecting the main unit with other units at a distance from the camera, all to be shot in synchronization with the shutter.

Figure 1 shows the set-up used on a Plaubel Makina camera. In this instance, only one auxiliary flash unit is being used. Wires lead to the connector block from the base of the battery case, from the base of the auxiliary battery case, and from the synchronizer unit screwed into the cable release socket on the camera. A cable release attached to the syn-

Figure 4

chronizer unit is plunged to set off the flashes and actuate the shutter.

A close-up of the connector block is shown in Figure 2, where it can be seen how the pairs of positive-negative contacts are arranged. Where it is found necessary to use more than the maximum of three flashing units provided by the connector block, additional blocks may be used on the auxiliary battery cases, each supplied with its own complement of cells, to augment the number of units and to distribute the lighting over a larger area.

Figure 3 illustrates a typical multiple flashing set-up, with the auxiliary light supported by a clamping bracket supplied with a swiveling head that screws into the battery case and permits direction of the extra unit at any desired angle. The unit may be clamped to any convenient support, such as a piece of furniture, a screen, and so on, or it can be screwed into a tripod supplied with a tilting head.

The average worker will probably find that two units will be all he needs, unless he wants to illuminate the background, which can be done with a third unit. In making the first few trials with multiple flash work, it is advisable to make the set-up with regular flood lights in order to study what the effect will be when the flashes go off. The two, or three, flash reflectors, are then placed in exactly the same positions previously occupied by the flood lights. After a little experience, you will be able to judge where the flash reflectors should be placed in order to achieve desired results.

Even spotlighted effects can be obtained with multiple flash lighting by having one lamp at or near the camera and the other near the subject, but above and to one side. Since the closer light is to predominate in order to provide the modeling light, as in the case of ordinary lighting, the unit at or near the camera should be far enough away, or its volume controlled by a diffusing screen. The reason for this, of course, is to weaken the latter in relation to the closer light. An example of the result of this technique is shown in Figure 4.

Diffusion Kink

FOR simple diffusion in enlarging, where only a slight softening is wanted, experienced workers recommend the use of a sheet of plain glass. The glass is held in front of the lens at a slight angle and is kept moving during the exposure.

Amateur Movie Makers

ONE of ten similar groups throughout the country, Continental Motion Pictures, of Kearny, New Jersey, is composed entirely of juveniles interested in movies. With Continental, these groups have formed the first nation-wide chain of amateur movie makers, made up of juveniles, and known as the "Amateur Movie Producers of America."

The Kearny group, writes Robert E. Johnson, in charge of productions, was organized in May, 1936, since which time they have produced about 15 photoplays and travelogues, the most successful of which has been "Hansel and Gretel." When this was shown in the schools of Kearny it met with instant acclaim—"so much so," writes Mr. Johnson, "that we have a standing offer to come back with all of our new films." One travelogue which required some time was "Newark Airport" and an important newsreel was "The Visit of the King and Queen of England at the New York World's Fair." The most recent films are "Sadie and Mabel Out Camping." "Sadie and Mabel are our great comedy team," Mr. Johnson explains. "They are newspaper people who for four films have been going out on scoops and having lots of adventures." "The Taggs" appear in a

Mr. Johnson directs

Sadie and Mable

family series similar to the Jones or Hardys of Hollywood, their latest film being "Aunt Cora's Visit."

Money received from shows given by the group is put back into the business. Continental is run by a Board of Directors. To assist the Board there is one technical adviser, the only adult, who is technical director and make-up director.

Other member groups of the Amateur Movie Producers of America include: Century Films, Santa Ana, California; Empire Pictures, Chester, Pennsylvania; Modern Films, Stillwater, Oklahoma; Pixilated Pictures, San Antonio, Texas; Skyline Productions, Kansas City, Missouri; United Pictures, Buffalo, New York. The national group's aim is "to further interest in amateur movie producing, to distribute the AMPA-member films and to swap story ideas and films." The group publishes bulletins of information for the member groups as well as a trade paper called "The Floodlight."

American Honors Awards Inaugurated

AWARDING of honors for outstanding American photographers similar to those conferred by the Royal Photographic Society of Great Britain, has been inaugurated by the Photographic Society of America. The awards are made to members of the Society on the basis of distinctive achievement in the various phases of photography. Members do not apply for honors consideration and are not required to submit examples of their work. Furthermore, members may be elected to Fellowships without first having been awarded Associateships.

The first group of recipients of the four classifications of honors, including Honorary Fellow, Honorary Member, Fellow, and Associate, was announced at the October Sixth Annual Convention of the Society in Cleveland. The result of two years of investigation, the Society's first awards included three Honorary Fellowships, conferred upon William H. Jackson, New York City; Dr. C. E. K. Mees, Rochester, N. Y.; and Alfred Stieglitz, New York City; two Honorary Memberships, conferred upon William A. Alcock, Brooklyn, N. Y.; and Louis Fleckenstein, of Long Beach, Calif.; 10 Fellowships and 22 Associateships.

Photo Coloring Contest

PHOTOGRAPHIC contests usually rule out pictures that have been hand colored, so that the latest Raygram contest, just announced, is probably the first of its kind because it specifies that *only* hand colored prints are eligible! The only requirement in the contest, which is unusually broad in scope, is that the print be colored with the Raygram Photo Colors, a new coloring medium recently introduced. It is in the form of processed cotton and is used by twisting it around the end of a stick, moistening in water, and applying to either glossy or matte prints. Entry blanks must accompany prints submitted. If your dealer cannot supply you, write to Contest Editor, Raygram Corporation, 425 Fourth Avenue, New York, New York.

Books on Color

THE recent upsurge of interest in color photography has had its effect on the publication of books on the subject, according to Sydney J. Croan, who is in charge of the book department at Willoughby's in New York City. Mr. Croan knows whereof he speaks because he not only sells books but is an accomplished amateur photographic worker on his own account and is therefore in a position to evaluate the worth of the books he sells.

We asked Mr. Croan to list the color books which, in his opinion, and without reference to sales volume, have the greatest lasting worth. He obliged with the following list, in the order of their importance:

"Color Photography in Practice," by D. A. Spencer.

"Color in Theory & Practice," Vol. I, by Murray and Spencer.

"Color Photography for the Amateur," by Henney and Dudley.

"Natural Color Processes," by Carleton Dunn.

"Photography in Color," by Paul Outerbridge.

"Kodachrome and How to Use It," by Ivan Dmitri.

"Miracle"

THE walls of a particular house were calcimined just before the house was closed for an indefinite period. When the house was reopened, after some lapse of time, it was found that one of the walls had a picture of an outdoor scene upon

it. Investigation revealed that opposite the wall was an old window shade with a very small hole in it, which acted as a pin-hole "camera" to imprint a picture of the outside scene upon the wall. The explanation seemed to be that calcimine becomes darkened when exposed to light. The many times the sun lighted up the outside scene, coupled with the smallness of the pin-hole, evidently was adequate for making the image.

An Atmospheric Bed

WE ARE so accustomed to observing clouds as floating tufts of "cotton" in the sky that it becomes a complete new experience to observe them at a very high altitude. The result is something like that shown in the illustration, by Mrs. Flora K. Howes of the London Terrace Camera Club (New York City). The cloud banks appear literally to be resting on a "bed" of atmosphere. Mrs. Howes reports that this picture was made looking north from Pike's Peak at an altitude of 14,700 feet. It was shot at 11 o'clock one August morning on Eastman Infra-Red film. With a 6x light red filter, the exposure was *f*/8 at 1/50.

By infra-red

Color Prints

CHAMPIONING the making of color prints by the man-in-the-street photographer as a practicality of today rather than a possibility of the future, Jack Hevesh, of Fotoshop, Inc., writes us that "any competent amateur photographer, capable of making a good black and white print, can make a good color print" from Kodachrome transparencies.

"One process, for example," he continues, "makes use of the familiar Velour Black emulsion. This process, Defender Chromatone, uses a system of toners identical in manipulation to the sepia, the difference being that instead of sepia, yellow, cyan, and magenta toners are employed. A full natural color print may be made by this process in less than an hour.

"The Curtis Orthtone Process is one in which duplicate prints may be made at will, to the number of 100 or more, from a set of matrices. The matrix making is correlated to the appearance of three black and white Kodabrom prints, made from separation negatives.

"The Carbro process, long considered 'tops' for color rendering, is now available in a Nation Photocolor Kit which includes even a set of bromide prints from which the user can make his first carbro. A Carbro Kit from another manufacturer, Devin McGraw, features manipulation in any darkroom, almost independent of the temperature factor, which for many years made carbro difficult to work."

Even separation negatives from your favorite Kodachromes are available ready-made. Fotoshop, Mr. Hevesh reports, does the job at nominal cost.

"Latensification"

A NEW term for the photographic lexicon, "latensification" was recently introduced by R. A. Cabeen, on behalf of the Du Pont Manufacturing Co., as the latest kink in hypersensitization of film. By the method described, the latent image on the film is intensified after exposure and before development. After the film has been exposed in the camera, the film is removed in the dark and exposed to a safelight for 25 to 40 minutes at a distance of 5 to 10 feet. Mr. Cabeen said that high-speed film can be intensified in this way so that only one half to one fourth normal exposure is required. The treatment may be applied, he said, to all kinds of films, plates, and papers.

Up-Side-Down Pictures

A FAVORITE portrait method with the glamor boys is to shoot the model up-side-down, with the forehead towards the camera and the chin where the forehead normally is, in relation to the camera. This is done by having

Up-side-down

the subject lie down. A spotlight is usually employed for the dramatic effect, although flood lighting may also be used. The result is rather surprising and frequently very flattering to the subject.

Fluorescent Light Ratings

THE use of fluorescent daylight-type light calls for a change in the speed rating of Kodachrome, although no change is required when using regular black and white films. According to information issued by the Weston Electrical Instrument Corporation, the Kodachrome ratings when using the Weston Master meters are as follows:

Kodachrome	*Type*	*Rating*
35mm	Regular	Weston 6
35mm	Type A	10
16mm	Reg.	5
16mm	Type A	8
Cut film	Professional Daylight	4

For other than the Master models of the Weston meter, the ratings are, in the order of the above listing, Weston 8, 12, 6, 10 and 5.

• • •

THE ROUND TABLE

Questions Answered for the Amateur Photographer

Q. Will you suggest a method for adding luster to the surface of a matte or semi-matte print?—A. H. W.

A. Commercial waxing solutions are available for this purpose, or you can use a mixture in equal parts of olive oil and turpentine. This is applied evenly over the surface with cotton, after which the print is polished with a soft cloth. Another formula is:

Benzol	8 ozs.
Beeswax	1 oz.
Rosin	¼ oz.
Turpentine	2 ozs.

Pour a little of this solution on the print and then rub it in with cotton. After this treatment, polish it dry with soft cloth or fresh cotton.

Q. What is a good way to clean old prints?—D. M.

A. One method that has been successfully used is to apply a thin paste of common starch to the face of the print and, after allowing it to dry for ten minutes, removing the application with running water.

Q. I have been advised that black spots may be removed from prints simply by scraping them off with the edge of a sharp etching knife. This seems rather difficult. Is there some chemical method?—E. B. L.

A. With practice, you will not find it difficult to use the etching knife in removing black spots; if too much is cut away, leaving a white spot, this is easily spotted out with a pencil or spotting color at the tip end of an almost dry spotting brush. Chemically, black spots may be reduced by using ink eradicator at the end of a toothpick and touching the spot lightly, removing a little at a time, or with Farmer's Reducer used at half strength. After the application, wash the print thoroughly.

Q. How can I steady the tripod on a windy day?—J. K. L.

A. A most effective method is to tie a string around some weight, such as a rock, a log of wood, or anything handy, and the loose end of the string to the tripod screw. This permits the weight to hang between the tripod legs; it will thus reduce vibration of the camera.

Q. What can be done to "revive" old and stale bromide paper that gives "foggy" results?—N. L. G.

A. The following method can be used, but the worker is warned that it cuts the speed of the paper by at least 50 percent. Soak the paper for one minute in

Potassium permanganate	5 grains
Sulfuric acid	30 minims
Water to make	50 ounces

Then transfer for a one-minute immersion to

Sodium sulfite	400 grains
Water to make	20 ounces

Rinse the paper and either use it while it is still wet or dry it in the dark.

Q. How can I remove developer stain caused by using old developer? —J. L. L.

A. After fixing, wash thoroughly as usual, and immerse in the following solution:

Ferrous sulfate	3 ozs.
Sulfuric acid	1 oz.
Powdered alum	1 oz.
Water to make	20 ozs.

After the stain disappears remove the negative from the solution and wash well.

• • •

WHAT'S NEW

In Photographic Equipment

KODAFLECTOR SENIOR ($12): Lighting unit for amateur still and movie work. Features reversible reflectors, of sheet aluminum, conical in shape when in use, "unbuttoned" for storing flat, one side bright and polished for narrow beam for use with home-movie camera lenses, other side sand-blasted matte center providing wider beam of less intense but more uniform light. Adapters for both No. 1 and No. 2 Photoflood lamps. Stand consists of two 30-inch telescoping nickel-plated tubes, clamping at various height settings by thumb screw. Outer tube seated in small black lacquered iron casting with sockets for

four 11-inch removable steel rods which form base of unit. Two lamp sockets mounted on L-shaped extension rods at top of Kodaflector Senior stand, adjustable for angle. Available accessory Extra Assembly ($3.75) adding third light to basic two. Kodaflector Senior supplied in suit-case type box of corrugated cardboard, with extra space for lamps, and so on.

INGENTO FILMPACK ADAPTERS ($3 to $3.50): Available in sizes 2¼ by 3¼, 3¼ by 4¼, and 4 by 5 inches. Features new all-metal light trap, precision construction. Hinge type; made of heavy materials for durability. Suitable for Speed Graphic, Watson, Eastman, and Korona cameras.

CELLO-LUME BRUSH ($.15): Cellulose fibers in aluminum tubular handle. Leaves no lint; especially recommended for cleaning photographic lenses.

PRINCETON SENIOR FLUORESCENT ENLARGING LAMP ($24.95): For use in enlargers taking negatives up to 5″ by 7″. Two-piece construction. Consume 40 watts of electricity. Average life 2000 burning hours. Grid contained in shielded metal housing 5½ by 7½ by 2 inches. Fitted with standard plug. Built-in equalizing screen. Transformer unit separate from light source because large size and heavy construction prohibits inclusion in enlarger lamphouse. Made only for 60 cycles, 110-120 volts, alternating current.

SPEED-EZ-EL PROJECTION EASEL ($.60 to $1.50): Takes ready-cut paper in five standard sizes, 2½ by 3½, 3½ by 5, 4 by 5, 5 by 7, 8 by 10 inches. Focusing directly on easel. All metal construction. Finished in light gray.

KODAK ALL-METAL PRINTER ($16.50): Takes negatives 4 by 5 inches and 3¼ by 5½ inches, with special provision for 35mm negatives in uncut strips, one frame at a time in sequence, on 35mm paper. Print sizes and margin widths (¼ to ¾ inch) adjustable by moving four independent margin masks. Masks of thin spring metal, each with black molded handle; scales provided for margin and print widths. Width and height scales of ruby transparent plastic trans-illuminated by lamps inside printer. Metal platen, hinged. Ruby safelight window in side of printer safelights work table.

BRITELITE UNIVERSALITE LAMP ($57.50): Outfit comprises stand, special focusing device, accessory reflectors. Specifications: lamp housing of aluminum alloy, taking pear-shaped bulbs from No. 4 Photoflood to PS 52—2000-watt movie flood; specially mounted socket on focusing device to center filament; positive acting clutch yoke connecting housing through swiveling device to stand, thus affording 360-degree field of focusing. Universal stand made of aeronautical aluminum in three sections, telescoping to height of 5 feet, with low of 18 inches. Demountable base legs have rubber-tired double-race ball-bearing thread casters. Wiring 20 feet No. 14, rubber-covered heavy-duty cable, with armor-clad plug. Switch mounted in detachable aluminum housing. Outfit weighs 16 pounds.

FRAME-A-CHROME KODACHROME FRAMES ($10 to $20): Available in sizes 4 by 5 inches, 5 by 7 inches, 8 by 10 inches. Consists of 24-karat gold-plate frame to hold enlargements made from 35mm or bantam size Kodachromes, together with shadow box for illumination. Light units alone available ($4.50, $5.50, $7.50).

LEITZ POLARIZING FILTER: Composed of clamping ring fitting over lens, and polarizing filter in rotating mount. Parts joined with pivot. Filter secured to lens through clamping mount. Viewing through filter above camera; filter then swung through 180 degrees to front of lens in same position as when adjusted visually. Filter made in several models: one for use with Leica lenses; special models for Summitar and Leitz Xenon lenses. Adapter available for Rolleiflex and Rolleicord cameras.

CONTRAMETER ($9.95); Exposure meter for enlarging, also serving as automatic paper grade selector, negative comparator, enlarging ratio comparator, integrating photometer. As negative comparator, gives numerical readings of two negatives, showing proportion of difference—for fast routine enlarging. As ratio comparator, registers readings of projected image in two predetermined positions, giving numerical difference as basis of exposure and proportional increase or decrease of light necessary. As integrating photometer, instrument used directly beneath lens for integrated readings.

GOLBLEND TONER ($1 for 2-ounce bottle): One-solution concentrated toner for chloride and chlorobromide developing out papers. Produces wide range of tones with single toning from slight "gold tone" warmth to rich brown without loss of gradation.

ACADEMY BABY SPOTLIGHT ($6.95): Uses 100, 150, or 200-watt T-8 bulb. Equipped with 3-inch Fresnel lens with attached slots for holding diffusion disk or filter. Weight 2¼ pounds. Push-pull adjustment lever facilitates change from spot to flood. Made of chrome-plated rustproof metal; Bahm crinkle finish metal. Used on stand that comes with light, on tripod or lamp standard. Completely ventilated.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

How to Make a Deer

RIFLE-RANGE shooting is fun, as any gun addict will admit, but a large percentage of run-of-the-woods shooters soon tire of garden variety targets and desire something a bit more exotic than manipulating bullet holes as closely as possible to bulls-eyes. To counteract this ennui on the part of some of its members, and to provide the deer-hunting lads with opportunity for constructive, helpful practice, the Cherokee Rod and Gun Club recently designed, constructed, and now successfully operates a life-size running deer target.

There's nothing new in the idea of moving game targets, but the Cherokees, symbolic of thousands of small groups of American sportsmen in that their treasury is habitually at low ebb, made news by making their own target. Calling on imagination, ingenuity, and a touch of inherent genius enabled them to enjoy one of the features of larger, more affluent organizations. Westchester County, just north of New York City, is the home of Cherokee members and one of the most populous sections in the metropolitan area. When, therefore, we tell you that this little group of sportsmen managed to obtain use of a few acres in this thickly settled region for rifle, pistol, and trap shooting at no cost to themselves, you'll admit that ingenuity was working overtime.

Deer at start of run

As the Cherokee range is a perfect amphitheater in shape, the encircling hills serve as more than adequate safeguards during shooting. This fortunate conformity of terrain also provides a perfect setting for the running deer target, for an end of the cable on which the deer travels is fastened to a stake atop one of the side hills and the other end is secured at the base of the opposite hill. Gravity and a gentle shove do the rest.

Although life-sized lithographed posters of deer are available for pasting on heavy cardboard, the members chose to make their own. Projecting the picture of a running deer onto a sheet of wall board, they traced the outlines, cut out the wall board, and turned it over to an artistic-minded member who did an excellent job of coloring. To facilitate moving, handling, and storing the deer when not in use, they cut him in two vertically and hinged the halves with a glued canvas hinge so that he could be conveniently folded flat.

Deer midway on run. Retouched because of blended background

Using a jig saw, two wooden pulleys were cut through the simple expedient of sawing two circular pieces of wood, six inches in diameter and one with a diameter of five inches. When the smaller was sandwiched between the two larger pieces, the pulley came into existence. To permit the buck to dash down hill on his trolley wire at full speed, they secured an old ball-bearing roller skate, removed two of the wheels and inserted them in the centers of the pulleys in spaces cut to fit. Older skates, by the way, are better for this purpose than are new ones, for the wheels wear in a tapered fashion which makes them fit into the center spaces more snugly.

Meanwhile, the artistic member had inscribed over the heart of the deer a circle marked "10" and concentric arcs both fore and aft of the heart, which were numbered from "9" down to zero, according to the vulnerability of the position. It was discovered that a 400-foot length of ⅛-inch clothesline

cable would allow the buck an adequate "run," during which hawk-eyed members could see him emerge from behind the shoulder of the starting hill, could fire three carefully aimed shots and, unlike—or should we say comparable to—a live deer, see him disappear behind a clump of trees near the end of the run.

True, because of elevation necessary to provide speed, the deer apparently "flies through the air with the greatest of ease," rather than running along the ground, but the Cherokees, for a total expenditure of $2.95, have provided their members with a target which tests the most skilful shots and at the same time provides maximum safety standards. Working drawings of the Cherokee running deer are available at no cost, if you are interested.

It's Targo, Again

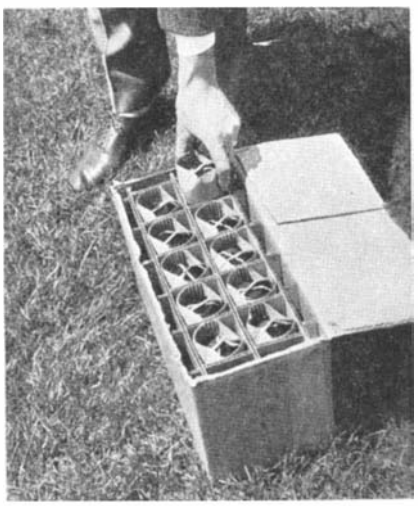
TARGO, that shooting innovation of the Mossbergs (August, 1940), has an accessory in the form of a hand-gun-trap for releasing the miniature clay targets. The Targo trap is easily removed from the barrel of the Targo rifle and screwed to the hand-gun frame, thus permitting targets to be released by another person without advance knowledge on the part of the shooter of the general direction of the target's flight. The frame of the hand-gun-trap weighs but a few ounces, costs less than a dollar by itself, is conveniently carried in a hip pocket. Unlike ordinary hand-traps for clay targets, the Targo trap operates with a simple pull of the trigger and no motion of the arm is necessary.

Targo is not a "cinch." It will test the skill of the best shooters, yet will provide good fun and excellent training for the novice at unbelievably low cost. To assist both beginners and old hands at the sport of smashing flying clay targets, the Mossbergs plan to publish a special booklet on how to shoot Targo. Study has shown that some shooters fail to shoulder and cheek the gun properly, which means they under or over shoot, mostly the

Targo hand-gun-trap

latter. Others do not shoot quickly enough, but ride the target out beyond the effective range of the .22 shot cartridge. Naturally, the tiny pellets of the .22 do not carry as far nor do they pattern as extensively as those of a .410 bore or larger gun, so shooting must be done faster and the target must be centered more closely in Targo, which means that gunners who master miniature target shooting have prepared themselves to become good skeet and field shots by learning the fundamentals of timing and co-ordination.

Conclusive evidence of Targo's popularity is found in the fact that several million of the little targets have been shipped to all parts of the country. Due to Mossberg's special packaging process, more or less a modern miracle, these fragile little flyers arrive safely and unbroken. Not one com-



Unique packaging of targets; insurance against breakage

plaint of breakage has been received at the factory. We still have some circulars describing the game of Targo and can also arrange to send you one of the new instruction booklets when it is printed. Want 'em?

Fish Cost Money

IF WIVES of fishermen realized that their angling husbands pay from 15 to 20 times as much per pound for the trout or bass proudly brought home as the ladies do for fish they buy in the neighborhood markets—well, you figure out the answer and be guided accordingly. One authority estimates that 12 million sports-fishermen spend $1,200,000,000 annually for the dual privilege of wetting lines and hoping the fish will bite. This figure breaks down into 10 millions for licenses, 35 millions for tackle and equipment, and the balance for transportation, sleeping accommodations, food, gasoline, boats, guides, clothing, tents, blankets, outdoor paraphernalia, and miscellaneous items of all kinds.

Despite the fact that these figures sound more like planetary distances than out-of-pocket expenses for the country's army of Izaak Waltons, the United States Bureau of Fisheries offers statistics to match. The Bureau boasts an annual production of eight billion fish and eggs, of which seven billion are commercial species against one billion of so-called game fishes.

At first glance these figures would seem to indicate that the men who make angling a business are getting by far the best of it. "However," says the Bureau, "the actual facts are these. Commercial species, with the exception of lobsters, are all planted in the fry stages, are not fed in our hatcheries, and in most cases are planted when only a few days old. The cost of production, therefore, is insignificant when compared with that of game fish which are distributed as fingerlings, in 6 to 9-inch sizes, a factor necessitating more expensive feeding, larger water areas, and of course, a longer period of retention in the rearing units."

If you think we've been dealing in higher mathematics thus far, beware of the following. The Bureau states the cost of producing commercial fishes averages $21 per million, whereas game species average $6146 per million, and that, fellow anglers, is equivalent to .000021 per commercial fish against .006146 per game fish —and the latter are still separated from the angler's creel by the price of a license and the cost of the fisherman's equipment. (We refuse to consider the value of his time!) So, when next you're tempted to keep that little trout, remember that under the comparison of what you and your wife pay for fish, you are contemplating about a dollar's worth of fish. If you put him back and let him live, he might grow big enough to be worth at least a couple of bucks!

• • •

POT SHOTS

At Things New

SOUTH BEND BAIT COMPANY recently permitted us to pre-view their Trade Catalog No. 91, effective for the 1941 fishing season, and we're prepared to state it is one of the most complete and fascinating angler's tackle encyclopedias we've seen. This Trade Catalog, you understand, is the one that guides your hardware and sporting goods dealer. The customary catalog for the individual angler will be issued a little later, and we've been assured that it, too, will depict every fishing need, including many new and intriguing items. If, in happy anticipation of piscatorial battles to come, you would like to pore over the pages of South Bend's newest publication for angling customers while winter winds blow and lakes and streams are ice-bound, send us your name and address and we'll arrange to have a catalog sent to you as soon as they're off the press.

MARLIN FIREARMS COMPANY believes there is an unmistakable trend toward the over/under type of shotguns and cites as proof their own strenuously successful efforts to keep abreast of orders. They have prepared for further growth of demand for o./u. guns by making their famous Model 90 in .410 bore, in 12, 16 and 20 gages, in three types of rifle-shotgun combinations, and in the custom-made "Skeetking."

When the Model 90 was developed for a combination of .22-caliber rifle and .410-bore shotgun barrels, Marlin frankly admits it was in the nature of an experiment. Neither production nor sales officials looked for any spontaneous demand, while some of the old-timers at the Marlin plant regarded the new creation as a freak. The $40 price alone was viewed as a reason why sales couldn't be very great shakes, yet it was not feasible to produce a real firearm of rugged construction to sell in a lower price range.

However, almost from the introduction of the over/under rifle-shotgun combination the factory had to step up production to satisfy the demand. When the .410 bore shotgun barrel was offered in combination with the high velocity .218 Bee and .22 Hornet barrels, capacity to turn out these particular models was severely taxed within a few months. The combination guns have proved to be the answer to many a hunter's prayer—the .22 long-rifle high-speed barrel for his longer shots, the .410 bore 3-inch shot shell for closer shots, and a .410 bore slug for his larger game.

DELTA ELECTRIC COMPANY, in anticipation of pleasurable excitement to be derived from after-dark angling by thousands of fishermen who have never tried the sport between sunset and sunrise, have issued a 70-page booklet entitled "Night Fishing." It was written by Cal Johnson, one of the ace Waltonians of America and Angling Editor of *Sports Afield* magazine. Delta Electric's "Powerlite" electric lanterns, as well known as they are indispensable to fishermen, hunters and campers, are also fully described. But Cal Johnson's suggestions on where, how, and when to fish at night make mighty good winter reading preparatory to the opening of next year's fishing seasons. Want a copy?

THE NATIONAL WILDLIFE FEDERATION'S chart of 30 common fresh water fish, accurately lithographed as to natural color, proportion, and ichtyology, from paintings prepared by Andrew Jansen, has proved a useful, instructive reference for anglers, conservationists, schools, and colleges. The chart measures 26 by 40 inches, includes, among others, the golden shiner, muskalonge, pike, eastern pickerel, wall-eye pike, large and small-mouth black bass, lake, brook, brown and rainbow trout, with explanations and descriptions prepared by the United States Bureau of Fisheries printed below each fish. The charts, framed or unframed, are obtainable only from The National Wildlife Federation, sponsors of National Wildlife Restoration Week, nationally observed in the early part of each year.

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OUR TREMBLING EARTH

By Joseph S. Lynch, S. J.

CHATTY, friendly, frequently narrative chapters by the noted Fordham University physicist-seismologist, who explains numerous aspects of earthquake science, but mercifully hops, skips, and jumps clear over its more abstruse technicalities; also about its personnel, their experiences, and other items of general background interest. That inevitable question asked by the puzzled layman—why the Jesuits go in so strongly for earthquake science—is answered in detail. The chapter on how to build an amateur's seismograph would be much more valuable if accompanied by drawings. Good reading. (202 pages, 5¾ by 8½ inches, 59 illustrations.)—$3.10 postpaid.—*A. G. I.*

PUTTING WORDS TO WORK

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SUBTITLED "A lively guide to correct and vigorous English," this useful volume is not simply a reference but a discussion which will add immeasurably to one's word-power after a single reading. Chapters range from Why Grammar?; Analyze and Master; Choosing a Dictionary; Using the Dictionary; Finding Words, Spelling Reform; Splitting Infinitives; Copy for the Printer; The Apostrophe; to Diction, Plurals, and Punctuation. It should prove helpful not only to would-be writers but to college students. (344 pages, 5½ by 8¼ inches.)—$2.60 postpaid.—*F. D. M.*

A SURGEON'S AUTOBIOGRAPHY

By Hugh Young, M.D.

NO BOOK for the prim or the squeamish is this. The author is a famous urological surgeon at the Johns Hopkins Hospital in Baltimore, and has led a notable career among notable people. His story is remarkably candid, and rather lively in numerous spots, such as those pertaining to his famous patient, Diamond Jim Brady and, especially, to his service with the A. E. F., where he went everywhere, saw everything and participated in everything urological because he was in charge of that phase of work for the whole Army. This includes 130 pages dealing with prostitution in France, much of it sprightly. The open account of President Wilson's last illness is revealing, as the author was his physician. In addition to the long fascinating narrative, there is a special section of 122 pages containing a lucid, popular exposition of the surgical methods used in dealing operatively and otherwise with enlarged prostates, bladder tumors, stone, floating kidney, and prostatic cancer (also hermaphroditism), and accompanied by 91 clear illustrations. For a man having reasons for wanting to understand these matters, this section gives what might require long questioning to learn from his own busy surgeon—though suggestable, nervous types of sufferers possibly should not pore over its details. On the whole, this might be called a frank, and candid, man's book. (554 pages, 6 by 9½ inches, illustrated.)—$5.10 postpaid. —*A. G. I.*

HOW TO TIE FLIES

By E. C. Gregg

BEGINNING with tools, hooks, and materials used in tying one's own fishing lures, the author presents in practical simplicity the pleasure to be derived from making wet flies, dry flies, nymphs, bass flies, feather streamers, floating bugs, and anglers' knots, and lists standard dressings for 334 varieties of lures. (83 pages, 6 by 9 inches, 27 plates.)—$1.10 postpaid—*A. D. R., IV.*

WEBB'S ATLAS OF THE STARS

By H. B. Webb

NOT to be confused with the well-known, earlier, and no longer available atlas entitled "Webb's Celestial Objects for Common Telescopes," is this entirely new one by another and an unrelated Webb—the widely known variable star observer and member of the Chart Committee of the A. A. V. S. O. It is nothing like a beginner's wonder-book atlas but is adapted to amateurs who have had a little experience, mainly with telescopes equipped with setting circles. It covers an area from the North Pole to 23° S. Dec. First, this total area is broken into nine large-scale finder charts, and these in turn are keyed, by means of massive numbers for better visibility in dim light, to 126 full-page detail charts showing coördinates. The detail charts indi-

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Edited by Thomas O. Sheckell

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By Glenn M. Hobbs, James McKinney, Revised by J. Ralph Dalzell

CRUTCH books on mathematics, for "helping lame ducks over stiles," are always perfectly lucid—to other mathematicians. But many of them still are too sketchy. This one, on elementary mathematics, seems more sympathetic than most, and almost takes the lonely, bogged-down sufferer by the hand to encourage him along—something which most mathematicians refuse to do, usually because, themselves being equipped with first-class intellects, they apparently can't believe anyone should really have these troubles. This book

——OUR BOOK CORNER——

is mainly on arithmetic, but includes logarithms, a touch of simple algebra, and those parts of geometry likely to have practical value. (If your youngster is having trouble, or if you are having trouble with the forgotten mathematics you are trying to recall well enough to help your youngster out, this book, secretly run over after he is in bed, might save your reputation.) A good book. (597 pages, 5¼ by 8¼ inches, illustrated.)—$2.50 postpaid.—*A. G. I.*

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By Henry Borsook

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

THERE never has been a perfect telescope. Can't be made. Can't even be designed. Design of any telescope involves making compromises with several cramping factors, or devils, yclept aberrations and coma, which science knows no way to wipe out entirely. Farthest, however, in that direction are the aplanatic family—the Schmidts, the Schwarzschilds, the Ritchey-Chrétiens, and the Wrights. Frankly, these telescopes (usually used photographically) aren't tyro work, but the average amateur telescope maker, being everlastingly ambitious, secretly harbors the intention of tackling one as soon as he has proved his steel on a few ordinary reflectors and a refractor. A number have done this already, and with success. This month we have items regarding aplanatics, from two amateurs who became professionals, respectively as optician, astronomer.

SCHMIDT wide-field camera-telescopes heretofore could not be used visually. Moreover, their adjustment has been a bugbear, requiring the patience of Job, because it had to be done photographically and piecemeal. In the following item, contributed by Russell W. Porter, these bugbears disappear: it describes a new Schmidt that may be used either visually or photographically.

"Dr. John Anderson," the executive officer in charge of the 200" telescope project, "has suggested a modification of the Schmidt camera," Porter writes, "which is shown in Figure 1. He thinks that this type, which includes the Schmidt principle, may appeal to amateur telescope makers, in that, by the additional reflecting surface, the focus of the camera is brought out into the open where it can be more easily collimated. Moreover, with the focus outside the camera box, the instrument may be used visually as a telescope.

"If an *f*/3 ratio is adopted, and the aperture is 8", then the two mirrors will be of 12" diameter, and the focal length of the instrument 24". Eyepieces of any *e.f.l.* may be used.

"By jack-knifing a Schmidt, as shown, it is set at 60°, which is about the angle required to prevent light that enters the correcting plate from striking the photographic film.

"The camera box could be put together with ¼" and ½" plywood, the corners reinforced with small angle irons. It may be mounted in a fork and used as an alt-azimuth or equatorial.

"The cells of all the optical parts should have push-pull screws for adjustment."

FIRST to make the aplanatic reflector proposed in "Amateur Telescope Making—Advanced" by Franklin B. Wright, and by him modestly called the "short" telescope, though the name "Wright" telescope is suggested now, instead, is Robert T. Smith, night assistant at the Lick Observatory, Mt. Hamilton, California. Smith took astronomy at the University of California, made telescopes as an amateur (6" Newtonian, 6" Cassegrainian, 4" semi-RFT), then lost his pure amateur status by working at the Tinsley Laboratories where he made 200 eyepieces. For the past year he has been at Lick, where he wrestles with the large telescopes at night, and on his own time has worked on his Wright telescope in the basement of the dormitory where the astronomers sleep. "My little telescopes look insignificant," he says, "beside the big instruments I work with every night, but I still have TN blood in my veins and intend to push pieces of glass for some time to come." Smith's description follows:

"I have just completed an 8", *f*/4, flatfield 'short' telescope (Figure 2), as described by Mr. Franklin B. Wright in 'ATMA'. As far as Mr. Wright and I know, it is the first one to be completed to his specifications. Mr. Wright himself has one of a slightly modified form very nearly completed, the optical parts of which were made by Mr. Carl Wells, of Roseville, California. Mr. Wells had completed the oblate spheroidal mirror before I started mine, and I am indebted to him for several hints on the figuring of such a curve.

"About 60 or 70 hours were spent on the 10", *f*/3.2, Pyrex oblate spheroid for this telescope. A micrometer-screw knife-edge tester was made that reads to thousandths of an inch. Diaphram openings 0.4" wide and 1" high were used for zonal testing — the smallest zone easily observed with the naked eye according to Gaviola and Platzeck *(Journal of the Optical Society of America,* Nov. 1939). The diaphram openings were spaced 0.4" apart and two alternate diaphrams were used, so that the whole surface was tested.

"The oblate spheroid is a very difficult figure to achieve. Since it is a fourth degree curve, the slope becomes rapidly steeper as you go from center to edge, and such a curve is extremely difficult to figure with a full-sized solid (pitch) lap. One's first thought is that an inverted, rose convexing lap would produce the required curve, but, although it does produce the necessary high center, the slope is greatest at the center instead of at the edge. In figuring the oblate spheroid I first obtained the high center with a full diameter inverted rose with six petals removed. I then proceeded with laps ranging from 1" to 4" in diameter, all circular (that is, no star or rose-petaled shapes). These were all worked with tangential strokes with the mirror face up, with care that an even number of revolutions were made around the mirror. If zones began to appear they were smoothed off with the 4" lap stroked radially, or at right angles to the zone. Although this local figuring has a tendency to produce ring zones, no great trouble is experienced if one proceeds slowly and cautiously. The mirror was figured until all zones approximated the error of observation.

"The correcting lens (Figure 3) was made of Pittsburgh's Crystalex or 'Water Clear Plate,' 17/64" thick and 9" in diameter (the 9" being dia-

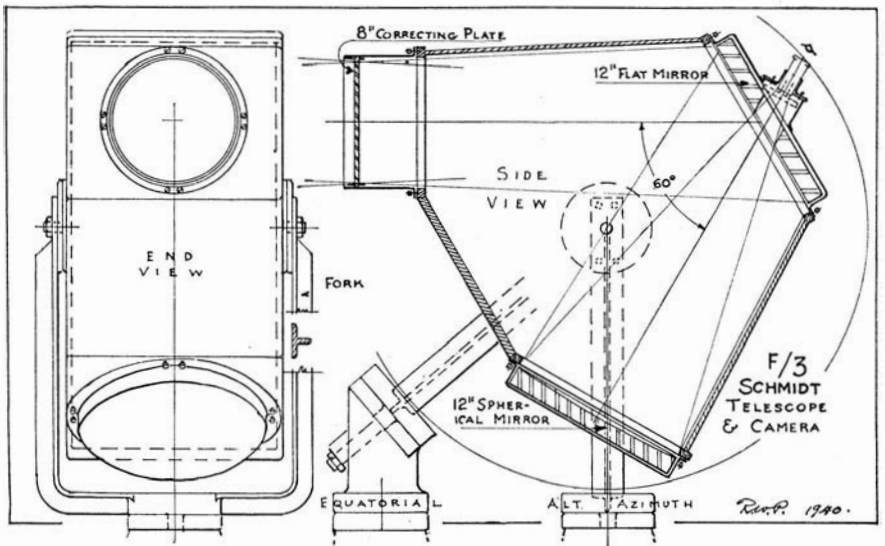

Figure 1: **The Anderson, visual Schmidt telescope**

phramed to 8″ in the camera, which is the usual practice with Schmidt correcting lenses). The index of refraction was determined to be 1.515 by measuring the difference in focus of a microscope with and without the glass. Both surfaces were tested against a sphere for flatness, and one surface was found to be flat within one wave, so I decided to work only one surface. It might be argued that one wave is not flat enough, but I may

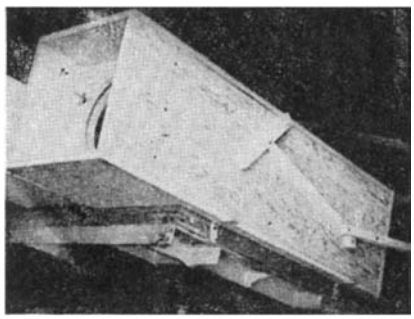

Figure 2: **Smith's Wright camera**

explain that the deviation from flat, curiously, was concentric with the edge and amounted to a uniform concavity of one wave or less, so that, as long as the correction on the other side was figured to take care of this, no harmful results could be expected. The side on which the correction was put had ridges several waves high, slightly curved, about ½″ wide and about ½″ apart. These were apparent as dark bands across the lens when the lens was viewed in front of the mirror under test, when the knife-edge was parallel to the ridges. They undoubtedly were due to the large circular polisher used at the factory for polishing the glass after it is

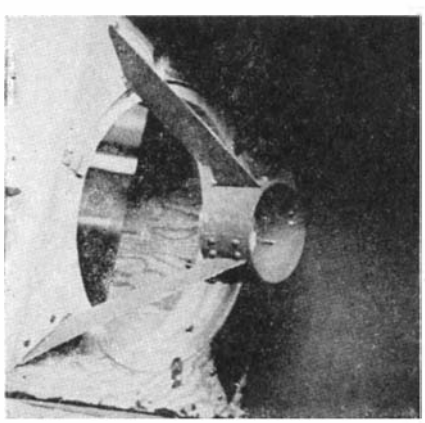

Figure 3: **Corrector, spider**

rolled, and they might well be looked out for. The glass was checked for striae and strains under polarized light and none was found, so work proceeded.

"Grinding and polishing were both done on mobile laps made of sponge rubber cut from ordinary kneeling pads. The grinding facets were cut from projection slide cover glass 1/16″ thick, and were fastened to the rubber base with Goodrich Running Board Matting Cement, which proved very

satisfactory and is recommended. The polishing laps went merely one step further, in that HCF squares were cemented to the glass facets. I have now given myself away in the mention of HCF, and must admit that it was used entirely for polishing and figuring both the mirror and the correcting lens. I realize that HCF is not approved of in the best circles

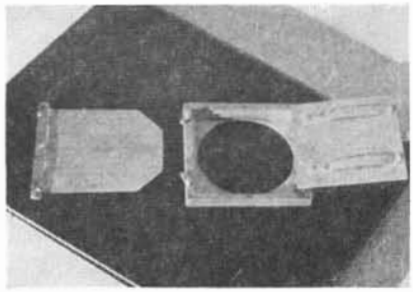

Figure 4: **The plate holder**

[for final figuring.—*Ed.*], and I freely admit that it does not produce the satin-smooth surface that pitch does. But it does work glass faster and is much easier to handle. Therefore, since the tolerances in a photographic instrument are greater than in a visual, and because I am fundamentally lazy, I was induced to use HCF.

"The grinding of the correcting lens was done with American Optical's emery, a finer grind than usual being desirable in order to facilitate testing while still in the fine-ground stage. I found that the ring lap usually recommended for correcting lenses produced one deep zone rather than the necessary curvature. So the ring, which was of 1" square facets, was modified with ½" square facets placed by trial and error until the correction moved in the right direction. The first attempt at correction was made with M302, but this took away far too much glass and the surface had to be brought back to flat by grinding on a flat piece of plate glass. The correct depth of curve was roughly reached with M303½ and was smoothed off with M304 and M305. With a surface finished with M305 a Ronchi test can be made through the lens placed in front of the mirror. Five minutes' polishing was sufficient to make a rough zonal knife-edge test to determine the approximate extent of the correction. The same diaphrams were used that served to test the mirror.

"The lens was brought to a polish with a full lap of 1" squares of HCF, with the lens face up and the lap on top, and with no backing to the sponge rubber. A lap with the rubber base cemented to a wooden backing tended to polish some parts more than others. The unbacked lap seemed better able to conform to the curvature without changing the correction. The final figure was obtained with small laps used in the same manner as on the mirror. However, these laps were mounted on rubber the same as the full diameter lap. The last two hours were spent in polishing with the tip of my index finger, since the zones to be corrected were so narrow.

"One curious thing was noticed in testing the correcting lens. Although the difference in radii between zones was the same for all diameters, the whole set of readings fluctuated up to ten-thousandths of an inch for different diameters. That is, the readings for one diameter varied up to ten-thousandths from those of any other diameter, although the difference between zones was right. Just what this fluctuation for different diameters really means regarding the shape of the lens, I don't know, but apparently it should be avoided, since it does have a small effect on some of the images. The effect on the images, fortunately, is not troublesome and is explained in a later paragraph.

"The appearance of the mirror under test is that of a paraboloid turned inside out, and because of the 3.2 focal ratio the shadows are very pronounced. A Ronchi test shows the grid to be 'knock-kneed' in contrast to the parabolic bowing, rather gently curved near the center and the curvature becoming more pronounced as the edge is approached. With the correcting lens placed in front of the mirror, the appearance is almost exactly reversed. The knife-edge shows the familiar parabolic doughnut, although it is not quite the usual form, and the Ronchi grid is bowed, gently near the center and strongly at the edge. All the tests on the correcting lens were zonal tests of radii of curvature, the readings being calculated from the formula on page 409 of 'ATMA.' I am indebted to Mr. Wright for his counsel and advice during the figuring of the mirror and lens. He was most helpful in converting his theory into actual practice. One should be thoroughly familiar with the theory behind this camera before attempting one, and he was most patient in explaining its details to me.

"The two optical parts are now mounted in a square wooden tube made of ¾" five-ply wood, 13" wide and 44" long. The mirror is mounted in a machined brass cell held to the end plate of the tube with three clamp and three butt screws, which serve also as collimating screws. The correcting lens is mounted in a cell of plywood. The plate holder (Figure 4) clamps to one end of a piece of 3" brass tubing, 2" from the back of the lens (Figure 3). Focusing is done by means of the collimating screws that hold the lens cell in the tube. Thus, in focusing, both the correcting lens and plate move together. In the middle of the main tube, between the plate and the mirror, is a diaphram, in front of which is a hinged flap used for opening and closing the exposure. A trap door in the side allows one to reach the plate holder. The plate holder was made especially for the camera, and takes glass plates

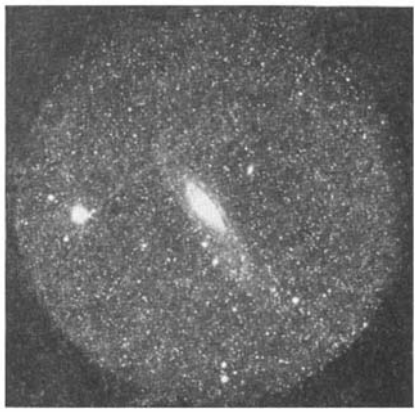

Figure 5: **Good images, 4.2° field**

2½" square. The exposed area is circular and 2⅜" in diameter, which is just over 4°.

"Collimation of the two optical parts cannot be stressed too strongly. The most important thing is to have the optical axis of the mirror pass precisely through the optical center of the correcting lens. I did not realize this until after I had taken innumerable plates and found plus sign images instead of round dots. I tried all manner of means to cure the plus sign images but with no results. I finally talked it over with Mr. Wright and he suggested that the collimation be adjusted even more accurately than I had done. I did, and found that the plus sign images disappeared over most of the plate, but remained to a slight degree in two small areas diametrically opposite on the plate. By rotating the correcting lens in its cell the two small areas are found to rotate by an equal amount. This apparently means that the correcting lens is possibly not a true figure of revolution, or that the unfigured surface is slightly cylindrical in shape. There is probably some connection between the fluctuations noticed in testing the lens and the two small areas of plus sign images. However, this condition does not seriously affect the performance of the camera, since the plus sign images are burned out with normal exposure. Accordingly, there seems to be no necessity for refiguring the lens. The images (Figure 5) produced by the Wright camera are very good over a 4.2° field after the collimation, focus and tilt of the plate are accurately adjusted, and have been pronounced satisfactory for photometric work, which requires extremely good images.

"I have mounted the camera on the Crocker telescope here at the Lick Observatory in order to try out its performance. The Crocker telescope is in a 10′ dome and consists of a mounting with a large flat plate at the end of the declination axis, to which moderate sized cameras can be bolted. The clock is weight driven and the guiding telescope is a 6½" refractor with illuminated cross wires.

"I would be very glad to correspond with anyone who is interested in making a Wright camera."

LEGAL HIGH-LIGHTS

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

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

Interpretation

IF A recording of an orchestra leader's interpretation of a musical composition is sold with the consent of the orchestra leader, he has surrendered his property right to the particular interpretation and no valid restriction can be placed on the use of the recording, according to a recent decision of a Federal Circuit Court of Appeals. This decision reversed the decision of a lower court which was discussed on this page in the February 1940 issue of Scientific American.

The facts involved in the case were as follows:

A record manufacturer made recordings of a prominent leader's interpretation of musical compositions and the recordings were sold to the public with a notice affixed thereto stating that they were to be used "only for non-commercial use on phonographs in homes." A radio broadcasting station purchased some of the recordings and in spite of the notice appearing thereon, broadcast the recordings over the radio. The record manufacturer brought suit against the radio broadcaster to restrain further broadcasting of the recordings and the trial court granted an injunction. In granting the injunction, the trial court held that the orchestra leader had a property right in his interpretations of the musical compositions, that he had transferred the property right to the record manufacturer, and that the manufacturer as the owner of this property right could control the use which was made of the recordings.

When the case was reviewed by the Circuit Court of Appeals, the decision of the trial court was reversed on the traditional principle of American law that literary property rights are destroyed when they are published without copyright or other statutory protection. The Court of Appeals pointed out that the recordings were sold with the knowledge and consent of the orchestra leader without copyright protection for the orchestra leader's interpretation. The sale of the recordings constituted a publication which destroyed any property right existing in the orchestra leader's interpretation. Since this property right was destroyed, no valid restriction could be placed on the use which was thereafter made of the recordings.

This decision is of importance because it is in direct conflict with the decision of the highest court of the State of Pennsylvania. The principles involved are of great importance to the musical industry generally and for this reason it is probable that an attempt will be made to obtain a review by the United States Supreme Court.

Fashion Boycott

THE acts of an association of dress manufacturers formed to protect members against piracy of original designs were held to constitute an illegal boycott in restraint of trade.

For many years the piracy of designs in the textile and garment industry has presented a serious problem. To combat this evil, a group of dress manufacturers formed an association and agreed among themselves that they would refuse to sell dresses to retailers who purchased or induced the manufacture of dresses which the association considered to be copies of the designs of its members. The association employed shoppers who visited retail stores in various parts of the country to determine whether they were selling infringing designs and also established a so-called "piracy committee" which acted as judges to decide whether any of the dresses complained of by association members embodied infringing designs.

The Federal Trade Commission charged that the agreement among its members to refuse to sell dresses to any retailer selling copies constituted an illegal boycott in restraint of trade. The Commission ordered the association to cease and desist the practices complained of and the association then applied to a Federal Court of Appeals to review the order. The Federal Court affirmed the order of the Federal Trade Commission, stating that a boycott is prima facie illegal and it must be justified by the persons practicing the boycott. The court pointed out that the members of the association would have the right to refuse to sell to retailers who bought dresses from manufacturers who had stolen unpublished designs or who had gained access to the designs through a criminal act. However, in the present instance, the boycott extended far beyond an attempt to suppress illegal or criminal acts. Under our law, anyone has the right to copy the design of a dress

which has been published or sold in the absence of patent protection. Since it was legal to copy the published designs of members of the association, the Court ruled that the association could not resort to a boycott in restraint of trade in attempting to suppress the copying.

Pyrex

THE manufacturer of the well-known heat-resisting glass may still continue to designate his products by the trade mark "Pyrex." The right of the manufacturer to use the trade mark "Pyrex" was challenged in a recent suit brought by a competing manufacturer who owned the trade mark "Rex."

The competing manufacturer, who was the plaintiff in the suit, had used the trade mark "Rex" from the year 1896 to designate glass prescription bottles which were sold primarily to the pharmaceutical trade. The defendant in the suit adopted the trade mark "Pyrex" in 1915 as a trade mark for products made from the heat-resisting glass which it had developed. Originally the mark was applied to heating equipment and cooking utensils, but in the year 1922 the defendant started to make nursing bottles for infants and designated them by the trade mark "Pyrex."

Up to the year 1928 the plaintiff and defendant were not selling directly competing articles under the trade marks "Rex" and "Pyrex" respectively. However, in the year 1928 the plaintiff began to manufacture nursing bottles under the trade mark "Rex." These nursing bottles were made of ordinary glass and were much less expensive than the bottles made from Pyrex glass. Finally, the owner of the trade mark "Rex" brought suit against the owner of the trade mark "Pyrex," claiming that the trade marks were confusingly similar to each other and that they were used on goods of the same descriptive properties.

The Trial Court sustained the contention of the plaintiff and ordered an injunction restraining the further use of the trade mark "Pyrex." An appeal was taken to the Circuit Court of Appeals and the decision of the Trial Court was reversed. The Circuit Court of Appeals held that there was no trade mark infringement, and accordingly refused to grant an injunction.

In reaching its conclusion the Circuit Court of Appeals pointed out that a great deal of time had passed since the defendant adopted the trade mark "Pyrex," that "Pyrex" was different in sound and appearance from "Rex," that the only directly competing merchandise upon which both marks were used was infants' nursing bottles and that on this product the defendant used its trade mark "Pyrex" before the plaintiff used its trade mark "Rex."

CURRENT BULLETIN BRIEFS

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

DUPONT MINIATURE CAMERA FILMS is an 18-page pocket-size booklet describing 35mm film for all kinds of amateur and professional photography, including two special-purpose films—Infra D and Microcopy. Infra D is sensitive to infra-red and Microcopy is an ultra-fine grain film of high contrast. Included in the booklet are processing formulas, filter factor tables, and other data. *Du Pont Film Manufacturing Corp., Inc., 9 Rockefeller Plaza, New York, New York.—Gratis.*

THE AMERICAN LINE is an illustrated catalog of modern foundry equipment. Also presented are operating views of typical installations in industrial plants. Request catalog No. 60. *The American Foundry Equipment Co., 574 S. Byrkit Street, Mishawaka, Indiana.—Gratis.*

FOREST OUTINGS is a 311-page book by 30 foresters, discussing in a friendly, informal manner a wide variety of aspects of the national forests and parks, such as camps, winter sports, timber, fires, game, miners, primitive areas. A book to make people want to understand the forests by revealing their attractions in a partly informative, partly romantic way. A folding map of the national parks and forests is included. *Superintendent of Documents, Washington, D. C.—75 cents.*

THE USE OF THE RESPIRATOR IN POLIOMYELITIS explains the proper use of the "iron lung," with surrounding facts about this type of treatment of infantile paralysis. *The National Foundation for Infantile Paralysis, 120 Broadway, New York.—Gratis.*

DOMESTIC PRODUCTION OF ESSENTIAL OILS FROM AROMATIC PLANTS is a compilation of research papers on six new varieties of plants—coriander, caraway, fennel, angelica, licorice, anise—which could be introduced into this country with a promise of high profit. Growing and extraction of the oils are covered. *National Farm Chemurgic Council, 50 W. Broad St., Columbus, Ohio.—50 cents.*

THE TENDERIZATION OF MEAT is a 6-page pamphlet that describes the Tenderay ultra-violet and heat treatment. *Industrial Fellowship on Meat Merchandising, Mellon Institute, Pittsburgh, Pennsylvania.—Gratis.*

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION, 1939. This uninviting title conceals the fact that, buried behind the 20 percent of this annual which actually is a stuffy "annual report" is a 400-page appendix which is the tail that wags the dog: a collection of the year's outstanding articles on all branches of science, easily the equal of a science best seller but sold at cost because government printed. Readers of scientific leaning should get the annual habit. *Superintendent of Documents, Washington, D. C.—$1.50.*

HURRICANE FLOODS OF SEPTEMBER 1938 is an immense, 562-page, detailed compilation of authentic, United States Geological Survey data on the precipitation, stream discharge, sea wave crest level, and Long Island ground-water recharge, pertaining to the great flood of '38, illustrated with photographs, charts, maps. *Superintendent of Documents, Washington, D. C.—$1.25.*

LAFAYETTE CAMERA CATALOG No. 81R contains listing of complete stock of cameras, enlargers, film, printing paper, chemicals, and many new photographic accessories. Printed in gravure. *Lafayette Camera Division of Radio Wire Television, Inc., 100 Sixth Avenue, New York, New York.—Gratis.*

THE STORY OF PHILCO PROGRESS is a 14-page booklet that delineates the growth of this organization from its parent company in 1892. A record of achievement. *Philco Corporation, Tioga and C Streets, Philadelphia, Pennsylvania.—Gratis.*

DON'T PLANT GOOD SEEDS is a 32-page booklet that shows the disappointments that a gardener will encounter if he plants seeds in soil unfitted to the growth of the plant. It then goes on to show how to condition soil so as to obtain the best possible results. *Sudbury Soil Testing Laboratory, South Sudbury, Massachusetts.—Gratis.*

ILLYNE'S STAR CHART, measuring 30 inches square, is a naked-eye chart for learning the skies. It and the 24-page booklet in which it is folded include four special charts, one of the South Polar region, also tables and explanatory matter. *Weems System of Navigation, Annapolis, Maryland. —$1.00.*

PHOTO RELAYS, THEIR THEORY AND APPLICATION, by F. H. Shepard, Jr., is a 28-page pamphlet that describes the photo-electric phenomena, amplifiers for photo-electric circuits, other equipment used in this work, and applications of photo-electric cells to a wide variety of duties. *Allied Control Company, Inc., 227 Fulton Street, New York, New York.—25 cents.*

THE OZALID FAST-PRINTING MODEL "F" WHITEPRINT MACHINE is a large folded sheet that describes equipment for producing whiteprints in quantity. The folder shows the details of this new model and shows how it can be used to provide short cuts in drafting rooms. *Ozalid Corporation, Johnson City, New York.—Gratis.*

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William Saroyan's new book, MY NAME IS ARAM—coming soon—is a delightful puckish picture of a small boy which, we have a hunch, may go the way of Clarence Day's *Life With Father*.

Franz Werfel's new novel EMBEZZLED HEAVEN, is the Club's December book—a quiet, deeply thoughtful work in an entirely different vein from the exciting *The Forty Days of Musa Dagh*.

Willa Cather's new novel, SAPPHIRA AND THE SLAVE GIRL, will also be distributed by the Club soon; scene is pre-Civil War Virginia; it is in the mood of *Death Comes for the Archbishop*.

Hans Zinsser's book, AS I REMEMBER HIM, was a Club choice just prior to his death; if any book deserved its present place, among the top best-sellers in the nation, it is this.

Jan Struther, with MRS. MINIVER, is a new author to Americans—instantly and widely introduced, as so many authors have been in the past, when her book was chosen in August.

Gontran de Poncins, a Frenchman, has written KABLOONA, an extraordinary book about Eskimos—beautifully translated and strikingly illustrated. It too will appear very soon.

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