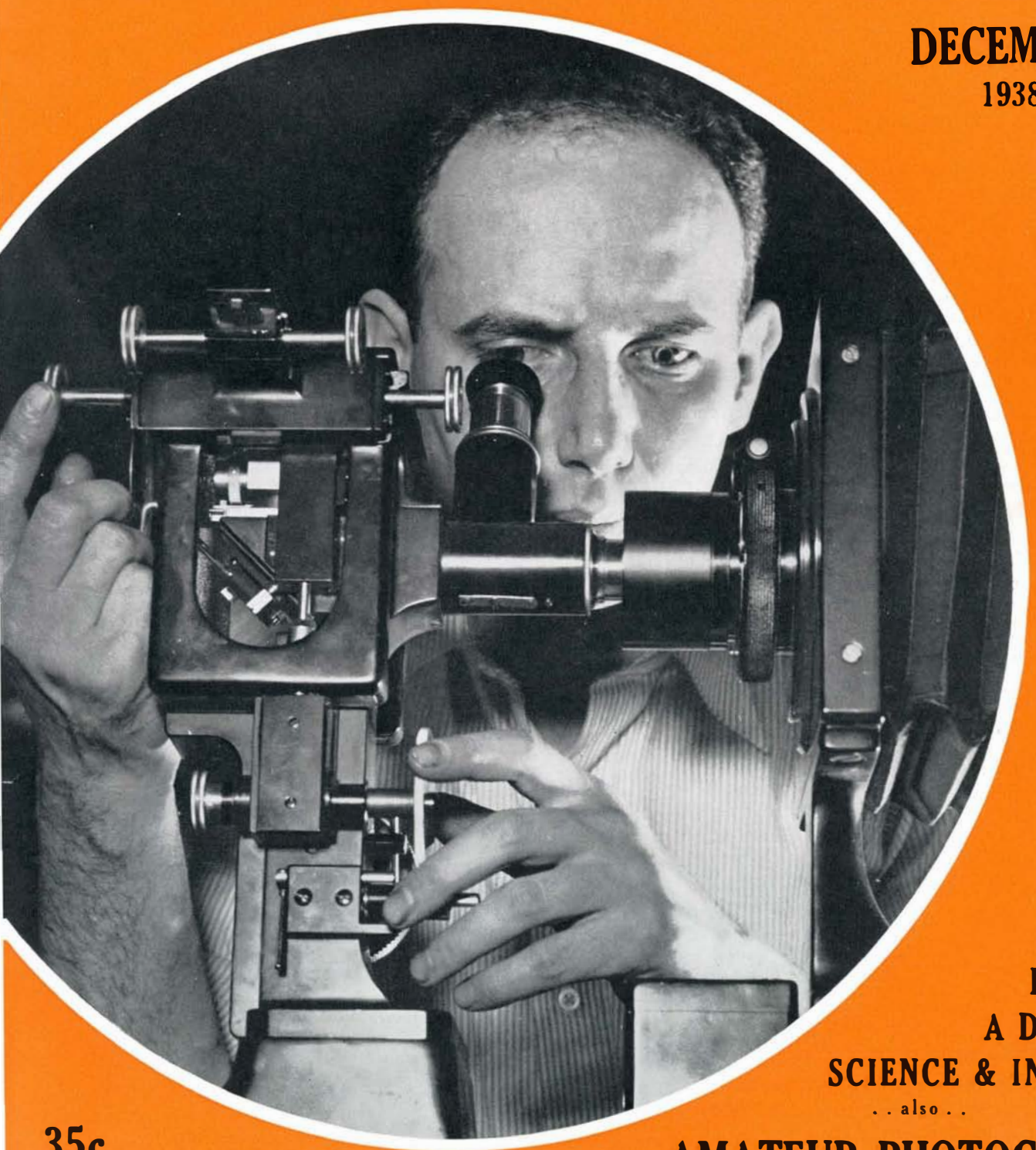
MUST WE GROW OLD?

By Barclay Moon Newman

SCIENTIFIC AMERICAN



DECEMBER
1938

Including:
A DIGEST OF
SCIENCE & INDUSTRY

. . also . .

AMATEUR PHOTOGRAPHY
By Jacob Deschin

35c
a Copy

Why Do So Many *Presidents* Enroll with the ALEXANDER HAMILTON INSTITUTE?

MORE than 50,000 presidents and owners of American business concerns have enrolled with the Institute for executive training.

Why?

Because they know that organized knowledge of business is an essential qualification to every responsible executive.

Because they know that modern business is too big to learn by personal experience alone.

Because they know that the Institute has gathered the experience of the most successful business men of America and the proved principles and methods of thousands of companies; formulated and organized this knowledge for their use.

Because they know that modern business has set new standards of executive competence and that the Institute training prepares them to meet these standards.

To Executives and Coming Executives
The Institute Offers
ORGANIZED KNOWLEDGE of BUSINESS

The Institute training is not for Presidents alone—but it *is* planned only for executives and *those who are determined to become executives.* The Institute offers the knowledge and training without which no man is qualified for executive responsibility.

For more than a quarter-century the Institute has been preparing men for business management, giving them the thorough, organized knowledge of production, marketing, finance, and accounting essential to competent administration. Many of those enrolled have been ranking executives who recognized their need for better equipment; many others have been far-sighted men, twenty-five years of age and upward, preparing in advance for the opportunities they know will come.

If you belong in either of these two groups the Institute offers you the ideas, experience, methods, and judgment of the most successful business men of America, formulated and organized to give you a confident mastery of tested, modern business principles and practice.

If you are determined to command a higher place in American business life, to qualify fully for executive responsibility, to win for yourself financial independence, then you will want to read "Forging Ahead in Business" with its important message to men who want to go far in business. A new edition of this famous book is ready and we will gladly send you a copy free. Just mail the coupon.

Modern Business

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

Please mail me, without cost or obligation, a copy of "Forging Ahead in Business."

Name.....

Business Address.....

.....

Position.....

Among the many American business leaders who have helped to build the Institute's Course and Service are:

C. M. Chester, *Chairman, General Foods Corp.;* Thomas J. Watson, *President, International Business Machines Corp.;* Alfred P. Sloan, Jr., *Chairman, General Motors Corp.;* Benjamin Rush, *President, Insurance Company of North America;* Frederick W. Pickard, *Vice-President, E. I. duPont de Nemours & Company, Inc.;* Fowler Manning, *President, Air-Conditioning Division American Radiator Corporation;* Robert H. Montgomery, *Lybrand, Ross Brothers & Montgomery;* John G. Lonsdale, *President, Mercantile-Commerce Bank & Trust Co.;* Clifton Slusser, *Vice-President, Goodyear Tire & Rubber Co.;* Samuel W. Reyburn, *Chairman, Board of Directors, Associated Dry Goods Corporation; and many more.*

ALEXANDER HAMILTON INSTITUTE, 137 ASTOR PLACE, NEW YORK

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

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

NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

CONTENTS • DECEMBER • 1938

POWERFUL microscopes are tools that find wide application in industrial laboratories as well as in the more remote corners of pure science research. Our cover illustration shows a microscope in use in the laboratory of the Chevrolet Forge Plant, where polished samples of steel forgings are examined to determine the molecular structure of steel before and after heat treating. Thus close control can be kept to assure that the heat treatment is giving the correct degree of hardness to the forging.

SCIENTIFIC AMERICAN, December, 1938. Vol. No. 159, No. 6, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City.

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

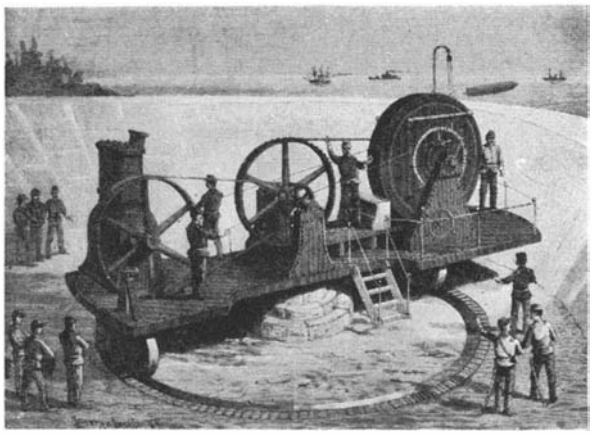
50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of December, 1888)

CANAL—"The telegraph brings the announcement of the financial collapse of the Panama Canal Company, due to its failure to negotiate the further sale of its bonds and its inability to meet the now gigantic calls upon it for interest and current expenses. Whether any new arrangements can be made to prosecute and complete the great work is questionable."

DYNAMITE GUN—"During the past eight years, the value of dynamite, gun cotton, nitro-glycerine, mercury fulminate, etc., for use in warfare, has been thoroughly appreciated, and the only problem to solve has been how to handle these explosives with less destruction to one's self than to the enemy. . . . In the gun which is illustrated . . . the danger of self-destruction from accidental explosion at discharge has been reduced to a minimum, as there is absolutely no shock, the shell being projected by the rotary motion of a revolving carriage. As this motion begins with a slow movement, gradually increasing in rapidity, there is no jar or shock until the projectile has been discharged and has come in contact with some obstructing object. . . . The rotatable carriage from which the projectiles are discharged consists of two steel disk wheels mounted parallel upon a shaft, which is provided with a pulley wheel for connecting it with a steam engine, or any high-power motor, by means of which the carriage may be set at a high rate of rotation. . . . The gun represented in the cut is constructed for carrying four charges at a time, each of which may be discharged in rapid succession."



BACTERIA—"In a recent paper on 'A Possible Revolution,' Dr. Austin Flint says that by a knowledge of the bacteria nearly all human ills of a physical nature may be cured or prevented."

ELECTROCUTION—"Some experiments on the effect of electricity upon animals, with a view to determining the best method of inflicting the death penalty on capital offenders, were performed on the 5th of December at Mr. Edison's laboratory in Orange."

VENEER—"The largest machine for cutting veneers in the United States is in operation in California, and shaves up logs ten feet eight inches in length with the greatest ease. The shavings which come from these machines are great, long sheets, in each of which is almost the entire wood of a big log, and from a single shaving is frequently made from 2,000 to 5,000 berry boxes."

BELLS—"Contrary to the popular idea, the exact musical tone of a bell depends neither upon the metal nor upon any change in it after being cast. If the bell should not be of the exact pitch, there is no alternative but to melt it over and recast it until the proper tone is secured. Hence, it is clear that the greatest care must be exercised, and the most thorough skill displayed."

PAVING—"The popularity of round block wood paving is steadily on the increase. A company has been formed at Mobile, Alabama . . . to put in machinery for making sapless blocks to pave the streets of that city, using juniper, cypress, and cedar. . . . Before it was decided to go into the paving business, extensive correspondence was had with residents of cities where wood paving is in use, the replies being uniformly favorable."

PLANTS—"From time to time, of late years, experiments have been made of the effect of the electrical light on flowers and plants, with results seemingly the same, to wit, feeble efforts of some plants to prolong their period of bloom into the night and then premature decay. One has only to study their actions, as observed, to conclude that even plants need rest, or, to be more precise, they seem to thrive best under the conditions which Nature has imposed."

LAUNCH—"At the American Institute Fair is being shown just now a novel type of launch, burning kerosene and with the boiler and engine at the stern of the boat. The method of firing the boiler is also new. Instead of atomizing the oil, as formerly, it is vaporized in a coil by heat, then driven out into the fire box and mixed with the air. The gas thus formed burns without smell or smoke and does not foul the tubes or sides of the boilers."

HEATING—"If some inventive genius will turn his attention to the contriving of a better apparatus for the heating of railroad cars by steam than is at present in use, he will stand a fair chance of making a fortune if he is successful. He will also save travelers from a great deal of suffering this winter, and thus earn the gratitude of the traveling public."

GAS—"People often talk of the advantages of natural gas as a fuel without having an adequate idea of its importance. It is today the greatest commercial wonder of the age. . . . It is only fifteen years ago . . . that natural gas was first used as a fuel, yet today there is required to pipe it 27,350 miles of mains. In Pittsburgh alone 500 miles supply 42,698 private houses, 40 iron mills, 37 glass works, 83 foundries and machine shops, and 422 miscellaneous industrial establishments."

TYPHOID—"The agency that milk may assume in the propagation of fatal diseases has received much attention during recent years. . . . A recent epidemic which occurred in a New Jersey suburb of this city goes far toward reducing the probability of milk acting as a disseminator of typhoid fever to a certainty."

AND NOW FOR THE FUTURE

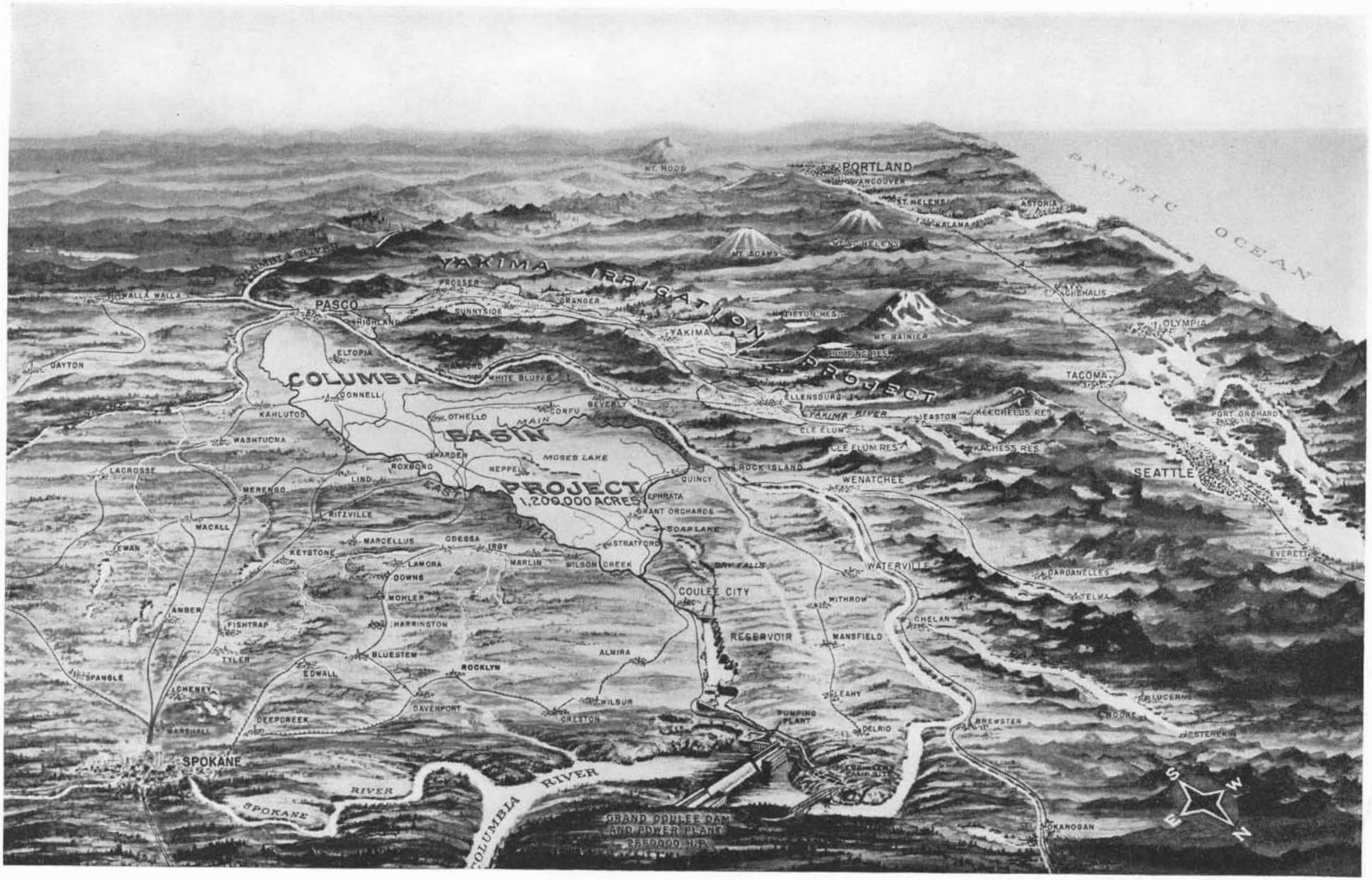
¶Dirtless farming—complete instructions that anyone can follow, by C. F. Greeves-Carpenter.

¶Science continues its winning battle against crime, by J. Edgar Hoover.

¶Everything flows—glass, rocks, rubber and so on—the science of rheology, by R. N. Traxler.

¶Research turns mineral wastes to profit, by Paul M. Tyler.

¶Marvels of structural steel work at the New York World's Fair.



TO BENEFIT BY A GREAT DAM

CLEAR visualization of the large section of the Pacific northwest which will gain by construction of Grand Coulee Dam. This great structure, shown near lower center, is discussed on page 296. The drawing, supplied by the U. S. Bureau of Reclamation, shows a large part of the state of Washington.

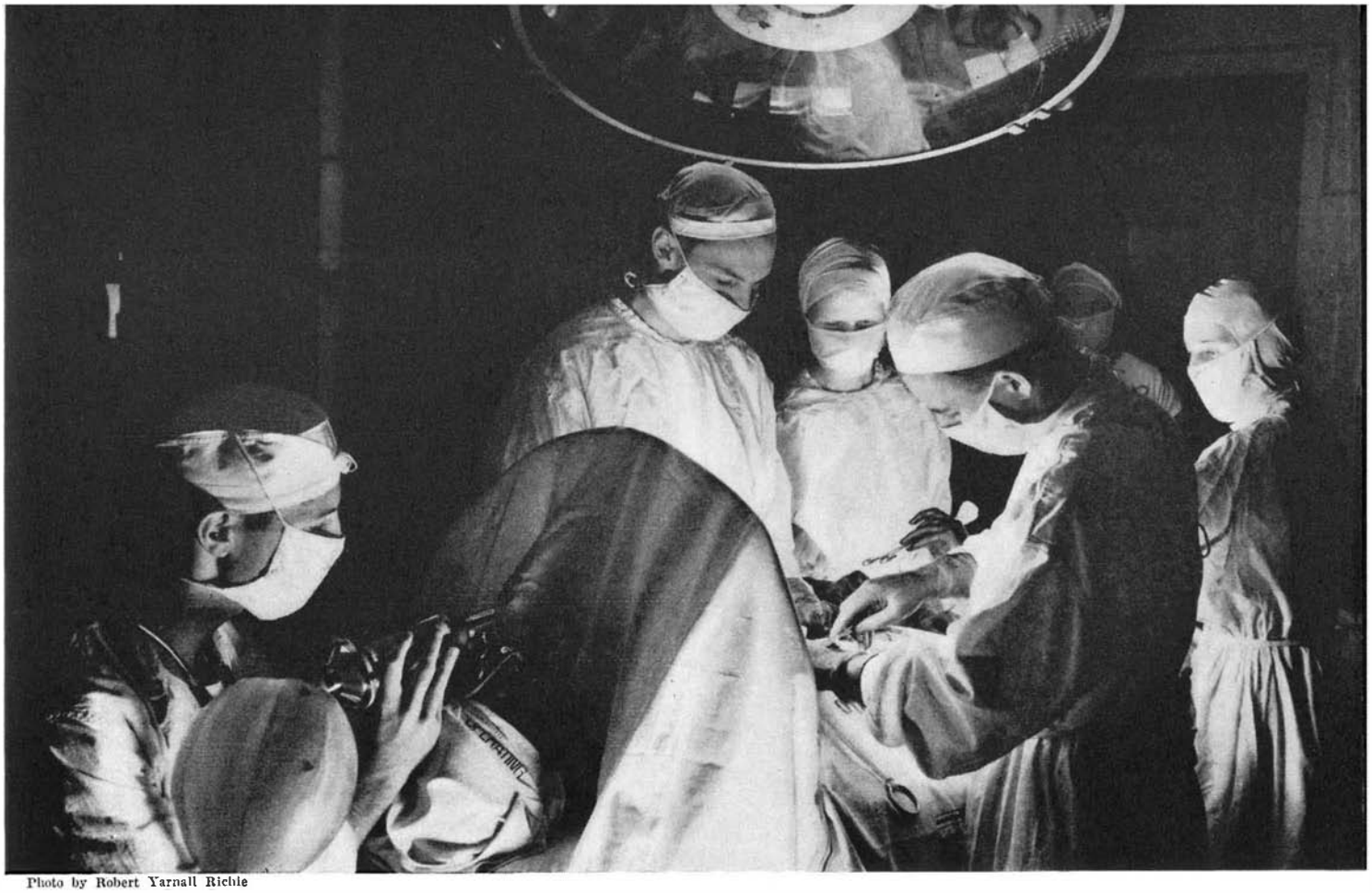


Photo by Robert Yarnall Richie

A modern hospital scene. By such operations, man's life is prolonged. Perhaps, in the future, a similar photograph may be taken of a transplantation in which old organs are replaced by new. Experiments in that direction are being made on animals

MUST WE GROW OLD?

Laboratory Research by Noted Scientists Gives Ground for Some Hope that We Shall Ultimately Learn to Forestall Old Age, Even Live Eternally

By BARCLAY MOON NEWMAN

IS AGING natural, unavoidable? Outstanding bio-scientists have long taught—perhaps merely upon a foundation of guesswork—that growing old is an entirely necessary concomitant of the peculiar living chemistry called human, and that it may, indeed, be the very basis of human being. Still, there is evidence that senility is only a fortuitous companion of life.

Not all life ages. One-celled animals, such as the paramecium or the ameba, are potentially immortal. A young paramecium observed under the microscope for long periods of time is seen to fatten after a while and divide in two. True, it loses its individuality, by becoming two organisms, but it has lost no part of its vitality. Each new organism, representing a growing portion of the original animalcule, in turn divides, to transform itself into two more organisms. So it goes, indefinitely. The paramecium cannot be said to age. Indeed, the first paramecium ever to appear on earth is in part before our eyes when we peer through the lens at any paramecium whatsoever. Thus, any 20th Century animalcule is a fragment of the world's earliest animalcule, and is potentially immortal. Here, then, is earthly immortality already embodied and made visible.

Certain cancer cells also have gained potential deathlessness, though here man's intervention is needed. First, cancer is induced in a mouse by continual application (over a period of months) of any one of numerous complex organic compounds, such as 1-, 2-, 5-, 6-dibenzanthracene. Then, as one mouse perishes, the still-living cancer is sliced from it and transplanted to become the live cause of death of a second laboratory mouse. This transplanting may be kept up indefinitely.

MOREOVER, we recall that cancer, so typical of aging bodies, represents exuberant growth, so typical of youthful cells. What restraining factor, developing during the aging process, holds waxing sway over the older body, but not over this body's cancerous tissue? Here is hid a profoundly vital secret, which engages many men working to force life-lore out of lethal manifestations.

Like all higher organisms, the barnyard fowl finally dies of old age. Nevertheless, Dr. Alexis Carrel has taught men how to annihilate time's effect upon at least individual portions of the chick. From a week-old, incubating egg, cut out a bit of chick embryo's heart tissue. Avoid microbic contamination, and keep the cardiac fragment imbedded in nutrient jelly—at 98.6 degrees, Fahrenheit. The fragment grows—and grows. It must be sliced in two every few days, and the halves separately cultured—in jelly constantly renewed. Obey such rules, and the steadily proliferating tissue is thereby given man-made immortality and has forever lost all track of time. And now even human fragments are similarly be-

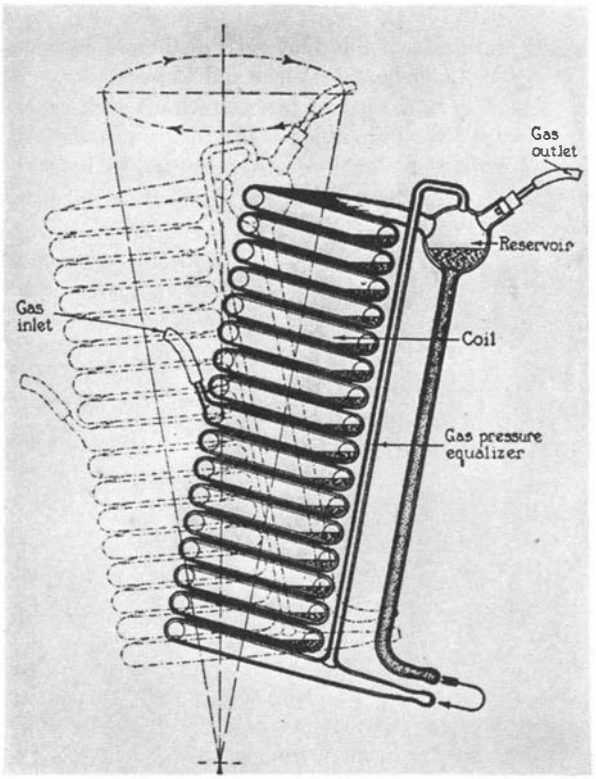
ing given laboratory agelessness—will be observable, quite alive, centuries hence.

If tissues—separate pieces of organs—are thus made ageless, why not whole organs? Today, entire organs—such as thyroid glands of cats or rabbits—are being cultured in glassware. The necessary equipment was originally described in 1935 by Dr. Carrel and Charles A. Lindbergh, and involves the "Lindbergh apparatus." This "artificial heart" pumps nutrient, oxygen-bearing fluid through the organ's blood vessels. Carrel reports: "It is certain that thyroid glands perfused in the Lindbergh pump remain alive." How long? Certainly for weeks. Minor improvements in technique should make whole organs timeless, free from age's influence, imperishable eternally—with proper care.

FROM tissue to organ to body entire—so naturally runs the train of thought. The factor of time, or age, has been removed from organ-phenomena. Logically, thought hurtles on to consideration of annihilating the temporal factor in the walking harmony of organs—the laboratory cat, and then the man in the street. Thus, Dr. William Marias Malisoff—like Dr. Carrel, eminent in experimental medicine—calls for a huge institute where all investigations upon the secret of terrestrial immortality are to be centrally organized. Concerning this proposed center, Carrel states: "The outcome of such an enterprise is not predictable. But we must remember that there is no example of a scientific search for truth which has not been rewarded."

Even the present haphazard enterprises, besides strengthening the evidence that aging is an unnecessary accompaniment of life, are in the very act of using death as a means to longer life, and therefore express more hope for the work of a future death-institute than does Carrel. Other experiments, pursued mainly by Russians, have established a new medical procedure: the use of tissues, including blood, eye-tissue, and skin, speedily removed from healthy persons who have suffered lethal disaster. Refrigeration preserves such cadaver-tissue—alive—for periods up to approximately two weeks. For more than ten years, the Moscow Institute has been transfusing conserved blood into patients, and so has saved hundreds of lives otherwise cut short. Hundreds of grafts from dead to living eyes have restored vision in some 50 percent of the trials. Though skin-grafting from dead men to live is newer, it is also proving successful. Thus, as already said, death can be—is being—used to prolong life, for a time.

Medical scientists, then, are preparing for the day when whole organs—livers, kidneys, spleens, perhaps hearts—may be transplanted successfully. But today: an organ transplanted from one warm-blooded body to another almost invariably degenerates, because it undergoes an ill-understood self-digestion or autolysis. Why? When the cause is found, and means of removing the cause is found, then old organs can be traded for new—new, healthy organs probably taken from the quickly dying.



A diagram showing the basic principles of the Lindbergh "artificial heart," an oscillating glass pump whose function is continuously to supply nutriment and oxygen to an organ in a nearby container

For bodies do not "die all over, all at once." Certain cells, tissues, or organs are killed—by accident or by disease (which may be considered accidental)—and drag the remaining body-life with them down into death's abysm of disorganization. This fact may be taken to mean that death is due solely to direct injury of a comparatively small part of the body and consequent indirect injury of the other parts.

In addition, this fact reminds us that the body does not age "all over, all at once." Like many a variety of death, aging may be due entirely to the summation of the effects of local injury—which effects glide from tissue to tissue until the whole system is turned into lethal chaos. Stiffness of joints is a common characteristic of aged people, but we all are familiar with quite old persons who are capable of athletic feats impossible for most younger persons. To age is often to bend, but every day we see old gentlemen who are as straight as ramrods. At 97, John D. Rockefeller died of an aged heart, yet other muscles were still young. In fact, nowadays most people die of degenerate—"aged"—heart, blood vessels, or kidneys—while major portions of the body are still in first-rate condition. And to be aged is not invariably to be wrinkled. If certain tissues and even certain whole organs keep their youth up to the day of death, though it be death from senility, why may not all tissues stay youthful?

There are new discoveries which give direct support to the theory that aging is accidental, the outcome of repeated local injury. Dr. William MacNider, dean of the Medical School of the University of North Carolina, has long been testing the action of poisons upon tissues of kidney and liver. Antedating his work, bio-students Whipple and Sperry demonstrated a peculiar action of chloroform. If a dog is given no food for a day, and next given chloroform by inhalation for an hour and a half, specific areas of the liver invariably perish.

THIS demonstration Dr. MacNider uses as the basis for his experimenting. With a definite quantity of uranium, he poisons a group of dogs. Some die, some survive. In the surviving animals, he finds that liver cells have been killed—but afterward are replaced by the formation of an abnormal type of cell: flat, instead of cube-like.

Dogs with such repaired livers he starves for 24 hours, and chloroforms for an hour and a half. Amazing result! Chloroform has lost its toxicity. The new cells are resistant and do not perish. Injury by one type of poison has stimulated the formation of abnormal tissue which is resistant to other types of poison. So, Dr. MacNider concludes, an organ responds to disaster by producing new cells, capable of life upon a different plane. Other experiments upon other organs verify this conclusion, and, moreover, indicate that the abnormal tissue is not as well suited to the body's healthy functioning as the old. That is, life goes on, as exhibited by the formation of new cells, yet it is life in novel guise—weird life, and unhealthy, though the best possible response to accident.

Now, MacNider continues, "A final group of experiments are of peculiar interest and importance as they take into consideration the factor of age. During the past 16 years of study in which the liver of the dog has been considered in certain experimental procedures, 24 ani-

mals have been used which may be considered senile both on account of their age, 8 to 23 years, and on the basis of certain superficial physical changes common to the senile state in any of the higher animals, including man. Nineteen of these animals have shown livers with a changed type of liver cell. The cells were not of a normal polyhedral contour, but were similar in configuration to those cells which had been made to appear as a repair process in the liver secondary to a severe injury from uranium. The cause for the occurrence of this type of cell in the livers of certain senile animals is entirely unknown.

"The question following this observation then quite naturally arose as to whether or not these atypical liver cells formed in the liver in association with the senile state were resistant to chloroform. Such animals, when starved for 24 hours and given chloroform by inhalation for one and one half hours, have shown a complete resistance against this chemical body which is certainly toxic for normal liver."

It is still more difficult to hold that senility is natural, unavoidable.

A race does not age "all over, all at once." There are always young members of the group, *Homo sapiens.* It is true that there are more extinct than living plant and animal species—millions more. Dinosaurs are extinct, but no one has been able to sustain the theory that their extinction was caused by racial old age. Belief in such a phenomenon as racial senility has no scientific basis.

So, in a remarkable sense, immortality on earth is already associated with—nay, clearly an attribute of—human life. For some 1,000,000 years, the human hereditary material—the human germplasm—has been transmitted from generation to generation and has endured unaging. In truth, for some 1,000,000,000 years, the life-stuff of which man is part has survived. And, in this billion years, not a break has there been in the flow of live plasm, no least halt in vital activity. Even now, at least part of the human life-substance transcends time.

Guesswork has asserted that the rhythm of reproduction is essential to lasting racial youth. It is hazarded that such periodic offspringing induces rejuvenation of the racial plasm. Yet concrete evidence is entirely wanting. It may be that reproduction must *naturally* precede rejuvenation—always; or be *naturally* a first procedure in the maintenance of racial youth. Still, the establishment of such a natural necessity would not preclude the possibility of the development of *artificial* means for staving off senility. And senility could still be a mere artifact of high-plane life. At any rate, we have this unforgettable information: the germplasm, at least a part of the human life-stuff, already transcends time—however dark our ignorance of this notable power.

Certain seekers after bio-secrets think that we have made a start—though surely an almost insignificant start—upon the immense problem of artificial rejuvenation. Not only have cells been made deathless in laboratory glassware, but also cells which have ceased to grow in the tissues of an aging body have been stimulated to youthful multiplication. In the test tube, adult tissue immersed in

Seven live specimens of paramecium, a microscopic water-dwelling organism which is potentially immortal. Often called also the "slipper animalcule"

juice from very young tissue remains for a time dormant, but after this lag period surges to fresh growth. Apparently, older tissue has accumulated within it chemical growth-inhibitors which a stimulant derived from young tissue can overcome. Tests, too, show that extracts from aging tissue retard the growth of young tissue maintained in laboratory ware. Further, Drs. Henry S. Simms and Nettie P. Stillman, of the College of Physicians and Surgeons, at Columbia University, have demonstrated that partial digestion of adult tissue with the well-known digestive ferment, trypsin of pancreatic juice, cuts short the lag period. Trypsin, it is thought, disintegrates the growth-inhibitors, and thus represents a very primitive means towards artificial rejuvenation. These investigators have found that blood's liquid fraction—plasma—also has a stimulant capable of shortening the dormancy of adult tissue, and that it is not trypsin or a related ferment—but an unknown substance, termed by them the "*A* factor." In the absence of this mysterious factor, no growth occurs.

AND in November, 1937, the discovery of a growth-promoting substance of the most dreadful potency was reported by Dr. Leonard Rowntree, director of the Philadelphia Institute for Medical Research. This substance is obtained by crushing wheat embryos and mixing the crushed material with ether, whereupon the potent stimulant goes into solution in the ether. Such extract, fed to albino rats, releases growth-inhibition of cells invariably of the abdominal cavity, and causes them to multiply wildly—so wildly that tumors, always fatal, take rise. Dr. Rowntree adds: "These tumors are transplantable in practically 100 percent of the cases. The implants retain the characteristics of the primary tumor through as many as 20 hosts. . . . Some progress has been made concerning the nature of the tumor-producing substance. . . . The new tumor-producing substance is apparently more active than any other known cancer-causing agent, in that it produces tumors more quickly. Because this is the first time that feeding a plant product has resulted in tumor formation, we are attempting to explore thoroughly the possibilities of the relation of vegetable embryos to tumor production." Other cancer-causing—growth-promoting—compounds have for years been studied. Most of these are coal-tar derivatives. As yet, however, no inkling has been gained regarding the mode of action of any cancer-inducing chemical. Nevertheless, work with such molecules confirms the thought that growth—youthful multiplication—may be, probably always is, chemically regulated. And however uncontrolled, however fatal, is proliferation thus stimulated, none can deny that a return to one significant feature of youth—rapid growth—is today a definite laboratory triumph. Future tinkering with the physical chemistry of the growing cell ought to bring other triumphs. Some aver that the secrets of cancer and of youth are one.

Beyond achievements in artificial rejuvenation and in turning tissues immortal in laboratory glassware, there are demonstrations wherein undismembered animals are made less dependent upon time. Here is one more hint that aging is accidental, not grimly, irredeemably yoked to time in flight. The span of life can be lengthened—longevity can be modified by environmental changes: changes in degree of activity permitted and in nutrition.

Using more than a score of thousands of mice, and several consecutive generations, Carrel has exhibited the different effects of a sheltered life and a free life. Sheltered mice are forced to lead an existence of quiet, inactivity, and regularity. Free mice are free to scamper, fight, burrow, and multiply at will—as a community. To mice, a protected life means an increase in longevity of approximately 34 percent.

Following in the footsteps of many other workers, Carrel shows that diet,

too, makes a difference. On lean fare, life is prolonged approximately 17 percent. Other diets—in which the proportions and types of food are varied—seem to increase (or decrease) the life span by as much as a third. He therefore can state: "Longevity, though being a hereditary tendency, can be artificially modified in large measure. Therefore we are not forbidden to hope that a wise handling of environmental agencies may lead to the prolongation of our existence."

As regards nutrition, the latest findings of Dr. Henry C. Sherman, of Columbia University, are yet more noteworthy —since far more exhaustive researches pursued through decades have turned them up, and since they point to definite molecules definitely reacting upon the aging process. In December, 1937, he and his collaborator, Dr. Lillian N. Ellis, fascinated a New York City symposium on vitamins:

"FOR the past five years, Columbia University, with the co-operation of the Carnegie Corporation of New York and the Carnegie Institute of Washington, has studied the question of optimal as distinguished from merely adequate intakes of several nutrients—including the substance which until recently we called vitamin G and now known as riboflavin, an important factor in good tissue condition and vitality in the body. . . . When these tentative findings of experiments still in progress with riboflavin are interpreted in connection with those of work upon calcium and other factors in the hands of Drs. H. L. Campbell, R. T. Conner, and C. S. Lanford of our laboratory, and the work with vitamin A by Dr. E. L. Batchelder, formerly of the same Columbia research group, it appears that food-chemistry conditions the life process to a more significant degree and in a more far-reaching way than has hitherto been supposed.

"Thus it is found that differences in the relative proportions in which we choose and use our everyday staple foods may make sufficient differences in the body's internal environment to influence measurably one's well-being, especially when such differences are continued throughout a lifetime.

"Experiments just completed in this laboratory indicate that calcium, vitamin A, and riboflavin or vitamin G are all concerned in the increased length of life which results from better adjustment of the relative proportions of food in an already adequate diet. The separate influence of riboflavin is now being studied upon the entire life cycle."

So Sherman and his colleagues upset the venerable hypothesis that chemistry of rat—upon which they experiment chiefly—or chemistry of man is fixed, with longevity fixed. Through generations of newer feeding methods, rat or man can be urged to greater longevity. The newer feeding has forced rat generation after rat generation to steadily lengthening life-spans. And the chemistry of rat is very like that of man: the precise reason why the rat is studied intensively. Meanwhile, milk—ever recommended as a good food—begins to show up as a still better dietary item: it contains calcium, vitamin A, vitamin G.

Both Sherman and Carrel realize that

Prof. Arthur M. Banta, Brown University biologist, who doubled the life span of tiny marine animals (Daphnia) by feeding them little in youth, generously after maturity

heredity is a basic factor in longevity—or at least apparently so. That is, man characteristically lives less than 100 years. Yet both bio-scientists show that inherited tendency toward senile death at a given age is no more than a tendency, subject to modification—especially if successive generations are tampered with. And what, at most, is heredity? It is a definite physico-chemical mechanism—machinery that the laboratory can already adjust, repair, accelerate (negatively and positively) and turn to new ends. Of course we know excessively little of such techniques. The point is that the laboratory has made a beginning. Indeed, novel artificial plant and animal types even thus early prove that evolution can be man-handled. Evolution is day by day altering heredity.

Is there not, in fact, evidence that to age is to meet with accident? Has not old age entered the laboratory to manifest itself more and more clearly as a phenomenon which intelligence—by science —can learn to forestall? A few speculative scientists hint as much. It may turn out that death by old age, today a certainty for those who live long enough, can tomorrow be made uncertain. There is no scientific reason why the imagination should flinch at the thought of reducing the odds favoring fatal outcome of life activity. During the past century, a score of years has been added to the average duration of civilized human existence, while experimental animals have even had their apparently fixed heredity, with apparently fixed life-span, shifted into new patterns. It is not altogether wild to guess that, already in 1938, the newer knowledge of vitamins and their consequent more efficient use will later be recognized to have stretched human longevity. Besides, where is the scientific evidence that aging is actually necessary?

In honesty, however, it must be admitted that, though we talk of and experiment with phenomena of senility, we do not know that of which we speak or that with which we deal. After all, what is senility? The truth is that nobody knows. We are reasonably sure that certain phenomena—wrinkles, physical and mental deterioration—usually become evident after an uncertain number of years. We are reasonably sure that the longevity of animals, perhaps including man, has been increased artificially. But now we are starting to think of aging as possibly accidental. Nevertheless, there is no scientific definition of old age—no unscientific definition without so many qualifications as to be meaningless.

CARREL suggests that, since the wounds of old men (often) heal slowly: "The measure of the physiological age of the body, as distinguished from its chronological age, is its regenerative activity (as in the healing of a wound)."

Next he considers the relation of growth of tissue to type of medium in which tissue is cultured in the laboratory: "Age can also be detected by certain changes that take place in blood plasma. We found that, under certain conditions, plasma has a restraining effect on the growth of cell colonies. This effect increases with age."

Other scientists do not entirely agree. There are many exceptions to Carrel's proposed rule of aging. Many a man, surely to be called old both in years and in appearance, can boast of quick-healing wounds. And the body does not "age all over, all at once"—which fact is to be admitted, whatever definition of aging is chosen. Perhaps not even individual, microscopic cells age "all over, all at once." No, the essence of senility is completely obscure. The years eventually, relentlessly, transport us to death—a peculiar sort of death, only to be told of in vague, popular, rule-of-thumb terms: death by old age.

And what is death? This, too, we do not know. We cannot define dying, because it is the negative of living, an unknown. Dusty ages ago, men became aware that life and death are a single mystery. Behind the veils secreting the shape of life is death too, including death by old age. Will man, in ages to come, pierce these veils? Who knows?

OUR POINT OF VIEW

Peace

WHAT a sorry sight this earth has been during the year now rapidly drawing to a close. Individually and collectively the peoples of the world have behaved very badly indeed. Spain is still involved in a blood-letting orgy which provides the stage for war rehearsal by outside nations and a training ground for their soldiers. In China there is constant enlargement of the "incident" in which Japan has killed hundreds of thousands of Chinese and destroyed the homes of millions. The year in Europe has seen the rape of nations by what has been called the new "stand and deliver" diplomacy, the scornful destruction of many treaties, and the humiliation of nations proud and powerful. Yet there is peace between all nations—peace at what a price! And how enduring!

From a distance, we can look upon the scenes of man's infamy with a certain degree of equanimity. To many of us there was evident in the European crisis not only a great deal of machiavellian bluff and a quite general horror of war based on tragic experience, but also a superabundance of fear on all sides. Each nation feared the might of its prospective antagonists; and each side, having enormous benefits to gain by a war victory, was more afraid of defeat than of war itself. So it seemed to some people. All the nations had armed well but each was deficient in some important detail. Hence the bluffers were successful despite their own national deficiencies that might have led to disaster even in a short war. The world may, therefore, rest easy as Christmas approaches, for the general European war has been postponed—for how many months no one dares predict.

Hearing the United States called "the most powerful nation in the world"—as praise was given us for the President's notes pleading for negotiations instead of war—should serve to cause deep reflection in this country. We want no further material participation in Europe's quarrels, we covet no part of another nation, and we will not fight when honorable diplomacy can settle any differences we may have with another. Yet as "the most powerful nation" it behooves us to keep others afraid of us. By building our military forces both in size and efficiency, we may yet become a powerful influence toward that permanent world peace all have sought for so long. By a strange perversion of human nature, that influence on other peoples would not be due so much to fear of our military prowess as to a desire to follow a mighty leader in the cause of peace and justice. If this may sound egotistical, think back to post-war days when our world's mightiest fleet so roused the nations that the naval disarmament treaties came into being. A similar situation and an equally praiseworthy result can be predicted if we work toward consummation of that ideal.—*F. D. M.*

Steam Again?

FROM New England come reports that experimental work is well under way with efficient steam power plants for automobiles. Preliminary investigations show a sincerity of purpose and an aversion to premature publicity that augur well for the future of the endeavors.

Most of our readers are undoubtedly familiar, at least in a general way, with the early steam automobiles. That these cars had faults cannot be denied and, with the major part of automotive engineering efforts directed toward the development of the gasoline engine, they dropped by the wayside mourned not a little by those who had driven them and were familiar with their many fine points. On the credit side of the old steam car ledger must be placed smoothness of operation, acceleration, power, and extreme simplicity of control. On the debit side were matters of insurance and local ordinances directed at steam power plants, the aversion of the timid to "sit over a steam boiler," the loss of steam pressure at critical moments, and so on.

Technical knowledge has come a long way since steam automobiles were in general use. We have new alloys, new materials; research in fields other than automotive has added greatly to available data on fuel combustion and boiler design. The home-heating oil-burner, for example, has reached a high point of perfection, and may have lessons to teach the designer of steam automobiles. What possibilities lie in a motor car that efficiently burns low-cost fuel oil to operate a flash boiler of refined design!

It takes an unlimited supply of optimism, courage, and technical knowledge to enter the automobile field with a "new" type of car and to compete with the sleek, smooth-running, powerful gasoline cars of the present day. But the possibilities of success are great if engineers are permitted to follow unhampered the logical paths toward technical perfection. In the field of steam lie possibilities of the simplicity of control that gasoline-car engineers are striving toward, but from which they are seemingly barred by the uncompromising relationship between torque and revolutions-per-minute of the internal combustion engine. The steam car needs no clutch, no gearshift. A throttle and a brake system, plus steering control, is all that the operator needs when on the road.

There is no doubt that a modern steam car can be built to overcome many if not all of the undesirable features and faults of the earlier vehicles of this type. Both the public and the automobile industry will profit if a successful steam car is introduced in this country. The intelligent competition which it will offer to the gasoline-driven motor car will react to the benefit of all—to the steady improvement of our present-day well-nigh perfect passenger vehicle.—*A. P. P.*

Let's Keep Cool

WHO among Europeans first discovered America? As has been pointed out by *The New York Times*, it detracts none from the credit due Columbus that Leif Ericson of Iceland arrived 492 years in advance of the Italian, since the Scandinavian found our continent by accident while Columbus knew exactly what he wanted, sought it and found it.

But now anthropologists and historians are offered evidence that other Scandinavians followed Ericson in the same century. An iron sword, an ax, and a shield handle stated to have been found 50 miles north of Lake Superior by a prospector and purchased by the Royal Ontario Museum are regarded as 11th Century workmanship. J. W. Curran, editor of the *Sault Daily Star*, Sault Ste. Marie, Ontario, has sent to scientific societies and periodicals a series of articles seeking to show that Scandinavians entered Canada by way of Hudson's Bay, and a bitter debate is likely to follow. This happened in the case of the Kensington Stone from Minnesota bearing evidence (if genuine) that a party of Scandinavians traversed that area in 1362. In that super-heated dispute scientific objectivity was sacrificed—almost lost sight of. Passions thus strongly aroused practically preclude a judicial weighing of evidence; people take sides instead and stubbornness supervenes.

It is therefore to be hoped that, as the more recent finds having similar purport are weighed, this kind of heat with too little light will be omitted. It would have been remarkable if the Icelandic colonists in Greenland, in the course of several centuries, did not enter Hudson's Bay and points south, not once or twice but repeatedly, and fresh finds are likely to turn up in future years. Our passions will not help us learn the truth; they obscure it.—*A. G. I.*

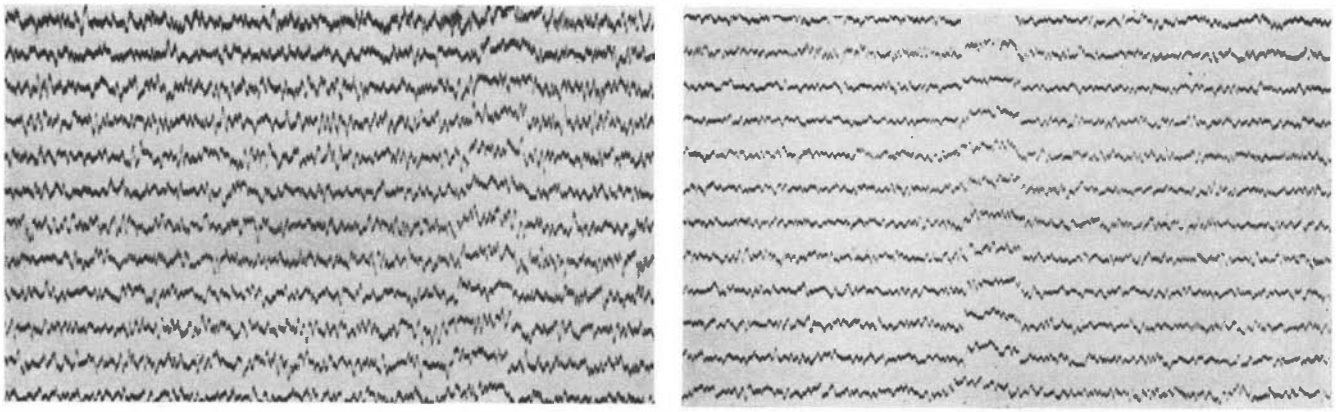


Figure 1: The earth beneath New York pulsates constantly, due to pounding of the surf, blasts, occasional distant quakes, and traffic. The traffic factor is contrasted in these two records, the one at left for Saturday night, that at right, Sunday morning

THE EARTH'S PULSE

How the Scientist Goes About the Interpretation of the Wavy Lines—Signatures of Earthquakes—Recorded on the Moving Drum of the Seismograph

By REV. JOSEPH LYNCH, S.J.
Director of the Seismic Observatory, Fordham University, New York, N. Y.

FIGURE 1 looks like a cardiogram. It is a cardiogram—a cardiogram of the earth's pulse at New York. It is the daily record of the vibrations of the ground under New York City and may be taken as a typical cardiogram of the ground under any large city. Some of the vibrations are caused by traffic, some by blasts, some by earthquakes and some by what we might call the natural heart-beat of the earth. However, if there were no traffic in New York and no inhabitants within miles of it, the ground would still have a certain throbbing—a continuous pulsation much like the heart-beat in the human body. The full cause is not known but the generally accepted cause is the action of the surf on the coast. The surf transmits to the ground a rhythmic vibration which is felt over the entire continent. The normal pulse of the ground under New York due to this surf action is about 33; that is to say, these natural throbs or microseisms occur at the rate of about 33 to the minute. Longfellow might well have been describing microseisms when he wrote

"My soul is full of longing
For the secret of the sea
And the heart of the great ocean
Sends a thrilling pulse through me."

WHEN the milk train is rushed into New York in the early morning, the New York pulse quickens in expectation and rushes to the alarming figure of about 200. The ground within an area of several square miles of the train pulses at the rate of 200 vibrations a minute. A distant quake in India nearly trebles the earth's pulse here in New York. A sudden cough or blast, such as might be caused by a few hundred pounds of dynamite being discharged in the earth's rocky gorge, would increase her pulse to about 60.

In a previous number of Scientific American (August 1936, pages 88-90) a description was given of the cardiograph which writes these cardiograms of the earth's pulse, the most sensitive seismograph yet developed—the Benioff seismometer devised by Professor Hugo Benioff of the California Institute of Technology. Briefly, the seismometer consists of a heavy horseshoe permanent magnet (Figure 2) with two soft iron pole pieces attached. Coils are wound around the pole pieces. The weight of the whole is about three quarters of a ton. This heavy mass constitutes the pendulum and is suspended from a spiral spring so that the pendulum oscillates vertically. The magnet supplies magnetic lines of force to the pole pieces. Under these pole pieces and attached to the ground is a soft iron bar through which the magnetic circuit is completed. An air gap of one millimeter separates bar and pole pieces. A vertical thrust in the ground caused by a quake changes this gap and consequently changes the magnetic flux through the coils. This starts a current through the coils, which are connected to a galvanometer. The mirror of the galvanometer, by reflecting a light beam to photographic paper on a recording drum, finally records the earth's thrust.

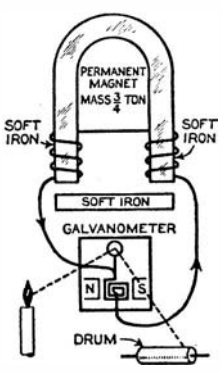


Figure 2: The working principle of the sensitive Benioff seismometer

IN the present article, we propose to show some of the unusual and interesting disturbances recorded at Fordham University by this supersensitive seismograph. Paradoxical as it may seem, the chief victims of this Benioff "earthquake trap" are local disturbances and the beginnings of very distant ones. Local quakes and the beginnings of deep-seated distant ones are alike, in that they are of short period. Hence the very short period (one half second) and high magnification (100,000) at short period (the magnification of any seismograph depends on the period of the earthquake wave it is recording) make the Benioff vertical seismograph especially suitable for detecting these two types of earth disturbance.

In the cardiogram in Figure 3 we have recorded side by side a New York Cen-

tral milk train and a distant earthquake which shook the Hindu Kush Mountains in India and, incidentally, stopped a cricket match which was in progress in Lahore. This double record is almost as incongruous as having the swell of the Pacific and the ripples of a swan on Central Park Lake felt equally by a person atop the Empire State Building. But, apart from this incongruity, this particular quake has a special interest for us. It gives an example of a phenomenon in seismology, the nearest analogy to which would be that of double refraction in optics. If we examine the print of this page through a piece of Iceland spar we see a double image of the print. This double image is due to the fact that the Iceland spar doubly refracts the light and each refraction gives us a separate image, as Figure 4 shows. Something similar to this double refraction occurs in seismology. Under certain circumstances, when a wave strikes the core of the earth, it is split up into two waves, as the Iceland spar splits up the light wave. One of these waves is refracted into the core while the other is diffracted 'round it. In Figure 5 two of these transverse earthquake waves have been plotted by the author for the Hindu Kush quake just mentioned. The curves were plotted with the aid of records of this quake borrowed from observatories all over the world. The waves were identified on each record and the time of arrival measured. The curves were then drawn by plotting distance of observatory from quake against time of arrival of phases at observatory. It is only in comparatively recent years that the double effect has been known in the case of transverse waves. Up till then the refracted wave (which is the stronger of the two) was misinterpreted as the ordinary wave, the travel time of which is quite different. This led to errors in the distances of quakes for stations where the double phenomena existed. Since seismology as an exact science is little more than twice the age of the now famous race horse Man o' War, we must not be surprised that the various phenomena of earthquake waves are only gradually being discovered.

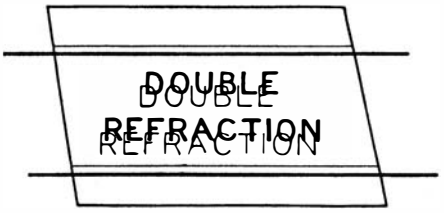


Figure 4: How Iceland spar acts on a ray of light—double refraction

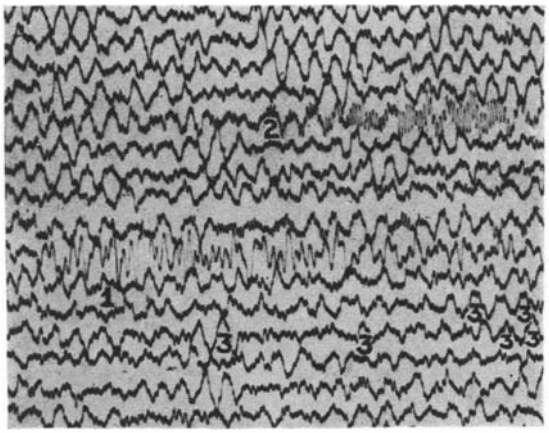


Figure 3: Above 1 is the record of an earthquake in Asia, pulse 60. Near 2 is that of a train, pulse 200. 3, 3, etc., microseisms, pulse 33

A recent disturbance of interest, recorded by the seismograph, was the explosion in the Horton Brewery in New York City, six miles away from the seismographic station at Fordham University. The explosion seems to have been definitely established as a dust explosion—a spark igniting some pitch dust near the pitch fuel hopper. The center of the explosion was in a room about two stories above ground level. As shown in the picture (Figure 6), the whole side wall of the building was blown out. The effect of the explosion on the ground underneath was that of a sharp but tremendous blow which sent ripples or earthquake waves traveling through the earth. There were two such ripples and they reached Fordham just one second apart, though they started out from the brewery together. The first ripple was a compressional or sound wave in which the earth particles were pushed ahead or compressed longitudinally, as are the air particles in an organ pipe. The second ripple was a transverse wave in which the earth particles were shaken from side to side, or up and down at right angles to the path of the wave—like the flapping of a bird's wings as it flies forward. If one should strike a bar of steel or any solid a blow at one end, two such waves—a compressional and a transverse—would travel along the bar and the compressional will always travel faster than the transverse. These two waves are due respectively to the elasticity of volume and the elasticity of shape of the steel or solid. Their velocity depends only on the material of the bar—not on the force of the blow but, as already mentioned, no matter what the material, the compressional wave travels faster than the transverse. It took the compressional wave about two seconds to travel the six miles from the brewery to our observatory. It took the transverse wave about three seconds. In the record reproduced (Figure 7), the beginnings of the compressional and transverse waves are marked and will be found to be about one second apart. Allowing for the clock correction, the actual times of arrival of the two waves at Fordham were 01.24.06 and 01.24.07, Eastern Standard Time.

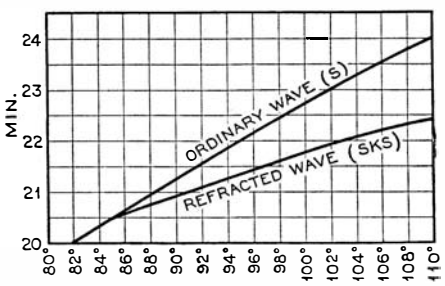


Figure 5: The ordinary and the refracted wave, plotted. See the text

THE next disturbance in order of interest was something very much farther away—the violent Banda Sea earthquake of February 1st, 1938. This earthquake was so violent that the waves or ripples it gave rise to apparently traveled back and forth through the earth several times. The Benioff instrument at Fordham recorded one such wave which started at the Banda Sea just north of Australia (Figure 8), traveled through the earth to a point almost opposite (166 degrees away to be precise), was reflected from the inside of the earth's crust at this point much as a light wave would be reflected from the surface of a concave mirror, back through the earth to a point not far from the Banda Sea (166 degrees away) and again reflected at the inside of the crust back to Fordham where it was recorded by the Benioff seismograph. On the record (Figure 9), $\varepsilon P'$ indicates the arrival of the compressional wave which traveled directly by the shortest path through the earth from the Banda Sea to Fordham. $P'P'P'$ indicates the compressional wave which arrived some 45 minutes later, after having traveled three times through the earth as just mentioned.

But how do we know that the wave

Figure 6: The source of the waves recorded in Figure 7 was a dust explosion in this building

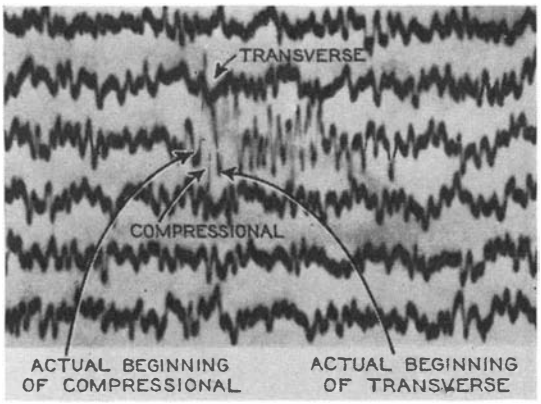


Figure 7: **A detailed study of a record that was made at Fordham, six miles from the source**

recorded followed such a path? We do not know with absolute certainty, but if a house has been burgled and finger prints have been found on the window ledge, the man whose fingers match the prints may reasonably be suspected of the burglary. The finger print left by this particular wave is the time it took to reach the observatory. When a boy arrives home from school an hour or so late one suspects he did not come straight home. So, when a compressional wave from the Banda Sea arrives here 45 minutes late, we suspect it did not come here directly. We know it was a compressional wave, from its period and certain other characteristics. We know the velocity of the compressional wave through the earth with fair accuracy from repeated observations. Hence the problem is: given the velocity of the compressional wave and given that it takes 65 minutes to travel from source to observatory, what path did it follow? The direct compressional wave, that is, the compressional wave taking the shortest possible path from quake to observatory (140 degrees), took slightly less than 20 minutes. How are we to account for the extra 45 minutes taken up by the second wave? The most likely, though not the only explanation would be that the wave, as in the diagram, struck a point on the inside of the earth's surface 166 degrees away from the quake. Here it was reflected to a second point 166 degrees farther away and was again reflected from here to Fordham.

"But how did you hit on 166 degrees?" someone asks. Fordham is 140 degrees away from the Banda Sea. If we add one complete circumference, 360 degrees, we get 500 degrees, and if we divide this by three we get 166 degrees, approximately, so that a doubly reflected wave going the long way 'round and reflected at intervals of 166 degrees would strike the earth at Fordham, and this path would afford the errant wave more travel time than would any other path with two reflections. Introducing a third reflection would delay the wave altogether too long, whereas a single reflection would be far too short.

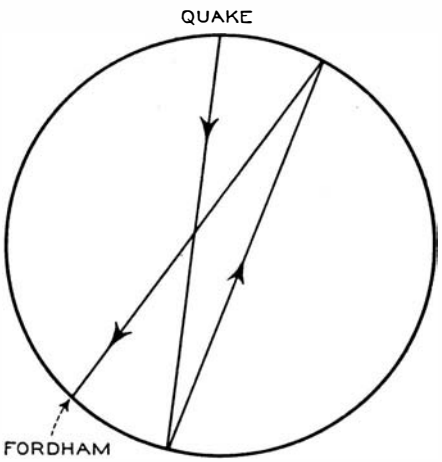


Figure 8: **Some of the more violent earthquakes bounce back and forth**

The time taken for such a doubly reflected wave would be 63 minutes, still a trifle shorter than our wave actually took —but the difference may readily be put down to our uncertainty of the absolute value of the velocity of the compressional wave over the path traveled. In the record shown in Figure 9, the wave discussed is seen to be quite distinct from the regular surface waves (the long sinuous waves) which travel around the outside surface of the earth, like waves on the surface of the ocean. They travel at a speed of about two miles an hour, less than half as fast as the body wave. Such triply reflected body waves have been observed and identified before, but never at such great distance. Hence the element of uncertainty in positively identifying the wave, but the evidence at hand seems to point to its being such a triply reflected wave.

Usually one associates earthquakes with the equator and the Pacific Basin, but our next and last record of interest takes us down near the South Pole. It is the record of a quake which occurred a little south of where Shackleton had to abandon his doomed ship, *Endurance*. On Saturday, August 8, 1914, Sir Ernest Shackleton sailed from Plymouth in the *Endurance*, hoping to be the first to take an expedition right across the Antarctic continent. On October 27, 1915, his ship, after having been locked in the ice for 281 days and drifting helplessly with it some 507 miles, was a victim of the ice pressure and had to be abandoned. She was crushed, literally, to splinters. Some miles south and east of where she was crushed in the Weddell Sea, on January 24, 1938, a very severe earthquake occurred, a record of which is shown in Figure 10. The unusual feature of the quake is its icy location—the only one ever recorded in this part of the Antarctic. It apparently occurred in the bed of the Sea.

No story, not even an earthquake story, is complete without a moral. As the duchess said to Alice in Wonderland, "Tut, tut, child, everything's got a moral if only you can find it," so we'll close with the lines on the observatory clock:

"Do not squander time.
For of all sad words
of tongue or pen
The saddest are these:
'It might have been.'"

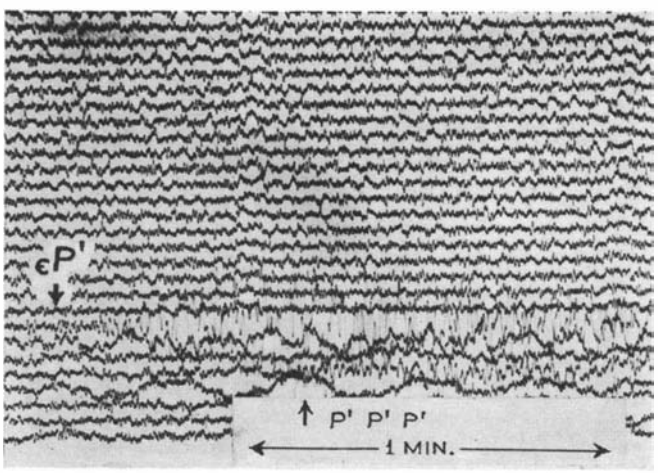


Figure 9: **How an earthquake that occurred in the Netherlands East Indies recorded itself twice in New York City**

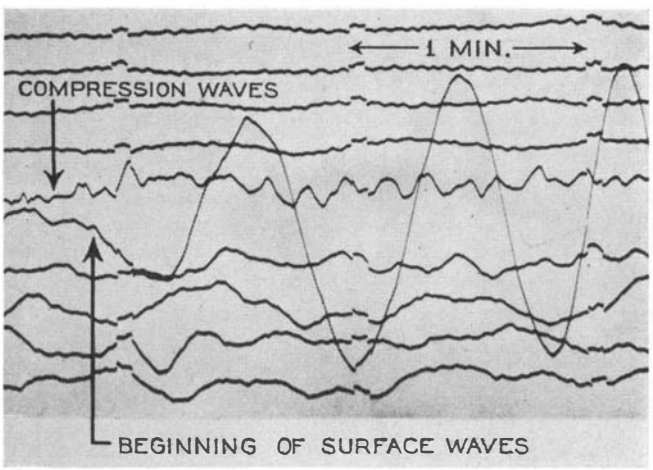


Figure 10: **A study of the record of an earthquake that occurred near Antarctica, far southeast of South America**

Indian Petroglyphs

Idle Scribblings?

CARVED and painted on the smooth faces of cliffs and boulders over most of the United States, but particularly in the Great Basin and the Southwest, are crude geometric designs and pictures of animals which are unquestionably of Indian origin and of considerable antiquity.

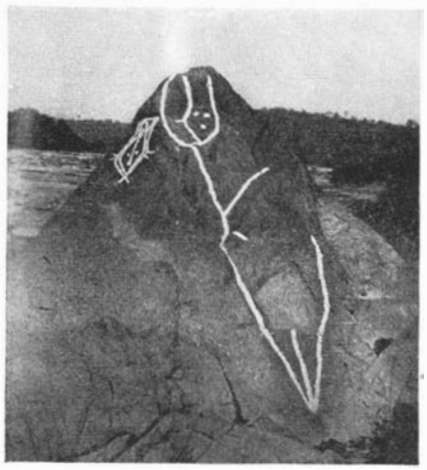
The Bureau of American Ethnology of the Smithsonian Institution states that it receives many inquiries concerning the meaning of these, but seldom is able to give any valid answer. Many theories are advanced to explain particular "petroglyphs." Many, totally unfamiliar with Indian ways of life, believe that they are cryptograms containing directions for finding buried treasure. These often are badly disappointed when told that the North American aboriginals attached no value whatsoever to "treasure."

Some believe that these petroglyphs constitute a lost written language in which the lore of the ancients was recorded, and that eventually somebody may find a key to this language. This is just as far-fetched as the first explanation. No North American tribe came any nearer to writing than the drawing of crude, realistic pictures of specific events —a practice which reached its highest development among the Plains Indians.

STILL others believe that they can see in the pictures the forms of European letters, and attribute them either to pre-Columbian white men, such as the Northmen, or to ancient invaders from the "lost Atlantis." Such assumptions are purely gratuitous. Actually the subject of Indian "rock writing" has not been sufficiently studied and only a few generalizations can be made about it. One of the chief studies has been made by Dr. Julian H. Steward, of the Smithsonian staff. A good many of the petroglyphs, he believes, represent just idle scribbling; others are representations of religious objects; still others may have been intended to describe events, and some may have been drawn to give directions.

In favor of the "idle scribbling" explanation, Dr. Steward says, is the fact that since the coming of the white man Indians have made hundreds of petroglyphs of men, horses, railroad trains, houses, boats, and other objects of civilization. He says: "In view of the great trouble which white men frequently take to deface rocks and trees with names and initials, especially where other persons have done so before them, it would be foolish to suppose that the motives of the prehistoric Indians were not sometimes equally trivial. It is a safe guess that a large number of petroglyphs were produced by persons amusing themselves during dull hours.

"Many pre-Columbian petroglyphs, however, must have been made for some definite and important reason, else the designs in each area would not conform

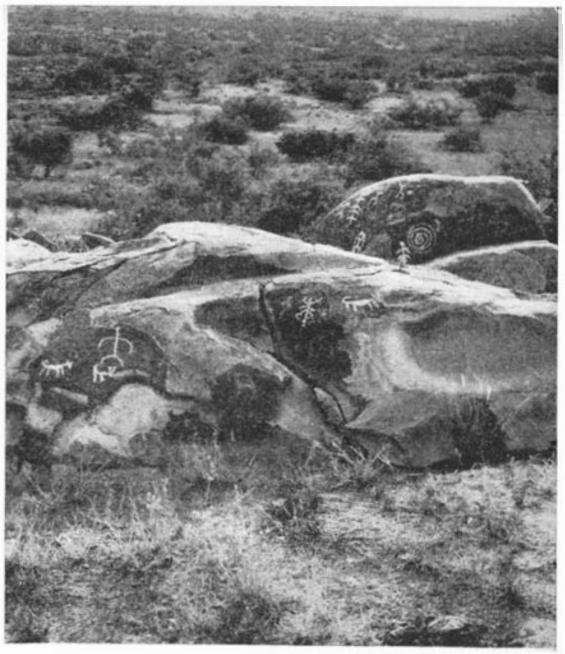


Petroglyphs—Susquehanna River

in such large degree to a prevailing style and would not have been worth the immense labor often required to make them. The testimony of modern Indians concerning petroglyphs is extraordinarily disappointing. They know of them as landmarks and sometimes believe them to have had a supernatural origin. But even where there is good evidence that the glyphs were made by the tribes now inhabiting the area, the practice seems generally to have been abandoned at the advent of the white men and most knowledge of them promptly lost. The explanation of this is undoubtedly that they were generally of interest only to the persons who made them and the knowledge died with these persons."

Many were made for religious purposes, Dr. Steward holds. The primitive Indians believed in many supernatural forces whose favor must be won. A god may be more successfully supplicated if his likeness is present. People the world over made wooden and clay images of their gods. Many of the rock pictures presumably were of this nature.

Some of the rock figures are undoubtedly very old. Now and then it is claimed that some one of them represents a now extinct species of bird or animal. Sometimes it is even declared that pictures of dinosaurs are found—an utter impossibility because the last of the monsters disappeared almost 100,000,000 years before the first men appeared on earth. That some of them might be intended to represent the mammoth, or an extinct variety of bison or camel, is by no means impossible, although quite improbable. Thus far none of these claims has been satisfactorily substantiated.



Petroglyphs—Arizona, 50 miles from Tucson

It is easy enough with a little imagination to detect forms of European letters in petroglyphs. It would be remarkable if there were not such coincidences. Isolated ones, of course, have no significance and nothing else of this sort has been found. Some of the rock paintings are clearly fraudulent, designed to draw the attention of the public to some particular place. On the whole, however, Dr. Steward urges persons running across such rock drawings to photograph them. What is without meaning now may fit into a comprehensive pattern later.

Petroglyphs—Maryland. (They are widespread)

INSIDE THE

There is Evidence that Matter Within Some of the Greater Planets Exists in Forms and Conditions that Would Seem Bizarre to Dwellers on Our Earth

THE astrophysicist has usually to deal with very hot matter—for the very good reason that only incandescent bodies are visible at even the smallest stellar distances. There are some interesting exceptions—the huge dust-clouds which form the dark nebulae, the masses of rarefied gas which shine in other nebulae, and the far more tenuous distribution of isolated atoms which produces interstellar spectral lines.

Within our solar system, however, and apart from the Sun itself we have to do only with cold—or at least, cool matter, and our methods of investigation are different.

The spectroscope, though still an invaluable aid, tells us less in proportion, not because of any inherent limitations of its own but on account of our own situation. Could we observe the whole range of the spectrum we would find that every constituent gas in even a cold atmosphere would reveal itself by characteristic absorption lines. But we have to look up through a great ocean of gases above us, and these absorb so powerfully that the whole ultra-violet region, except for a small part close to the visible, is utterly cut off. There is heavy absorption, too, in the infra-red, and it's only in the range which our eyes can see, and a little beyond it, that the earth's atmosphere can really be called clear.

THE characteristic absorptions of many abundant gases—hydrogen, nitrogen, helium, and neon, for example—lie entirely in the inaccessible ultra-violet. Other important molecules—oxygen, water-vapor, carbon dioxide, ammonia, methane—show up in the accessible spectral region. But, in all cases, the absorption of the observable bands is very weak—roughly from a thousandth to less than a millionth part as great as for the characteristic lines of atoms in the Sun, so that only abundant constituents can be detected. Nevertheless the presence of carbon dioxide in the atmosphere of Venus, and of methane and ammonia in the major planets, has been conclusively established. But this knowledge deals only with the outermost envelopes of the planets. What can we say regarding the main masses?

Here we must combine old astronomical data with new information from the physical laboratories. It has been known for more than a century that the mean density of the Earth is about twice as great as that of the surface rocks, and that Venus, Mars, Mercury and the Moon, though somewhat less dense, were all denser than common rock—while Jupiter was but little denser and Saturn on the average less dense than water. Later observations showed that Uranus and Neptune, in this respect, closely resembled Jupiter.

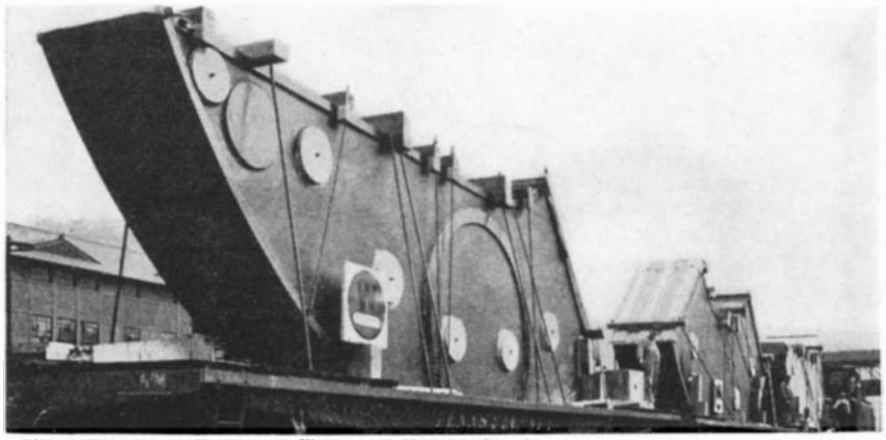
This did not exhaust the information which could be obtained by "classical"—that is, gravitational—methods. A rotating planet is bulged at the equator by the centrifugal force. For bodies of the same density and rate of rotation, the ellipticity would be the same, provided they were homogeneous; but if the central core is denser than the surface, the ellipticity will be smaller. In this way it can be shown that Mars is nearly of the same density throughout and the Earth considerably denser at the center, while for Jupiter and Saturn the central condensation is very great.

This evidence, combined with more recent seismological data, has led to a satisfactory picture of the Earth as a solid mass of rock, of types somewhat denser than the surface slag of granite, with a core of iron, probably still molten. Venus is presumably very similar, while the iron core must be much smaller in Mars, and absent in the Moon, and probably in Mercury.

THE greater planets may well have cores of rock and iron, but most of their bulk must be composed of matter of much lower specific gravity. Nearly 40 years ago Moulton suggested that they contained great quantities of hydrogen, as does the Sun, while the smaller planets had lost most of their hydrogen by diffusion into space.

The more recent discovery of hydrogen compounds in the atmospheres of the major planets fully confirms this view. It now seems quite clear that, if a mass of this order of magnitude and of composition similar to the Sun were permitted to cool from incandescence, the refractory constituents would settle out to form a dense core of metal and silicate rock. The outer gaseous portions containing oxygen, nitrogen, carbon, and so on, with an excess of hydrogen, would not condense till much later. The first compound to settle out would be water, forming an enormous ocean, which later would freeze into a thick layer of ice. Above this would be an atmosphere of hydrogen and perhaps helium and neon, containing such hydrogen compounds as ammonia and methane. At still lower temperatures the ammonia would freeze out. Uranus and Neptune appear to be in this stage, and Jupiter and Saturn in the preceding one. The finale, with only a transparent hydrogen atmosphere left, is not found in our system.

This would be a quite satisfactory representation if the cooling mass had been under low pressure: but it must not be forgotten that the force of gravity at the planetary surfaces is considerable, and the outer layers thousands of miles thick. A simple calculation shows that, even a few hundred miles below the surface, the pressure must already be so great as to reduce ordinary gases to about the density they have when liquefied, while, throughout most of the interior, the pressure far exceeds any which can be



Photographs courtesy Westinghouse Electric and Manufacturing Co.

The three segments of the horseshoe bearing at the north (upper) end of the yoke which will carry the tube of the 200-inch telescope. When bolted together these segments will take the form of a horseshoe weighing 317,000 pounds

GREAT PLANETS

By HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

studied in the experimental laboratory.

From the known data regarding the size, mass, and central condensation (or moment of inertia) of a planet, it is possible to work out a "model" compound of three layers of material of given density. This was first done by Jeffreys, assuming a core of rock, an intermediate layer of ice, and an outer atmosphere of compressed hydrogen. Wildt—one of our best authorities on planetary matters—has recently published a detailed discussion from which much of what here follows is taken. Repeating his calculations, with allowance for the increase in density by compression so that the rock is six times as dense as water, the ice 1½ times as dense, and the compressed gas ¼ as dense, he finds for Jupiter a dense core of diameter 43 percent that of the planet—37,000 miles—surrounded by a layer of ice about 13,000 miles thick, and then 12,000 miles of gas. For Saturn this core is 18,000 miles in diameter and the outer layers 15,000 and 12,000 miles thick.

THIS is too generalized a model to be exact, but it suffices to show that the internal pressures must be very high. At the bottom of the outer layer this comes out 940,000 atmospheres for Jupiter and 660,000 for Saturn: at the outer surface of the core 12,000,000 and 3,800,000 atmospheres, respectively, and at the center 59,000,000 and 16,000,000. In the upper tenth of the outer layer the pressures reach the highest value which has yet been studied accurately in the laboratory (about 50,000 atmospheres[1]). Below this, we have to rely upon extrapolation.

This is none too certain, especially for the ice layer, for ice is one of the substances which exists in several polymorphic forms, Bridgman having recently discovered a seventh, stable at pressures from 20,000 to 40,000 atmospheres. Whether still more changes occur at higher pressures, we do not know. We do know, however, that the distinction between liquid water and vapor exists only below the critical temperature of 374 degrees, Centigrade (or 647 degrees on the absolute scale). Above this temperature there is a continuous change of properties with increasing pressure and density without any separation of liquid.

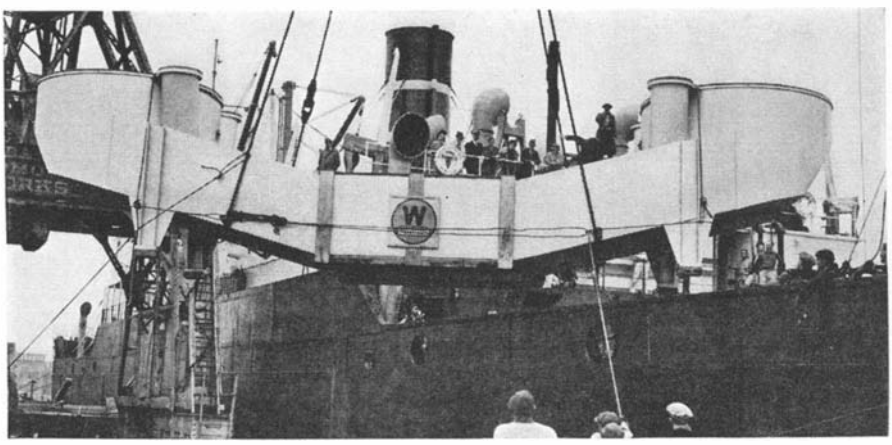
It is generally believed among physicists that there is no similar effect for the solid star. At any pressure there will be a definite melting point. From the existing data, Wildt estimates that the melting temperature of ice VII would be 374 degrees at a pressure of about 100,000 atmospheres. This is a rough value—an extension of the curve for ice VI from 300,000 atmospheres. But the pressure at the top of the ice layer, even in Saturn, is more than twice the higher figure. Wildt concludes that as these great planets cooled the water probably froze to a solid before it could condense to a liquid, passing directly from the superheated fluid to the solid states. The margin at the top of the layer is not large and he adds: "The transitory existence of a shallow sea cannot entirely be ruled out." In the deeper part of the ice layer, at a pressure of several million atmospheres, freezing may have occurred while the temperature was almost what we usually call "red hot."

What the temperature in this ice-layer is at present can hardly be estimated; it depends, among other things, upon the amounts of radio-active material in the core. But it seems clear that the ice must be in one of the high-pressure polymorphic forms, and much denser than ordinary water.

For hydrogen the critical temperature is so low that it can be reached, and the gas liquefied, only by special laboratory technique. But, at a pressure of half a million atmospheres, even this "permanent" gas may be solidified.

The idea that, above the shell of dense ice, there may be a thick layer of solid hydrogen—not cold, but hot, in the ordinary significance of these terms—sounds like the wildest of dreams. But the possibility is based upon the extension of a tested physical formula beyond the realm of observation. Molecular physics is not yet in a position to calculate from pure theory what the melting point should be, and the formula has therefore a certain empirical element, especially in the numerical values. But it is physically reasonable, while the older estimates, disregarding high-pressure effects, were not.

SUCH theory as exists at present suggests a still more picturesque possibility. All students of chemistry recall that hydrogen comes in the same column of the periodic table as the alkali metals—lithium, sodium, and so on, and the question, "Why is hydrogen not a metal?," is an old one. We may say now: "Because its atoms tend to pair off into molecules instead of forming a crystal-lattice with freely moving electrons, as do those of lithium," and recall that a similar tendency to form diatomic molecules makes nitrogen an almost inert gas of very different properties from its homologue phosphorus. Certain theoretical calculations of Wigner and Huntington indicate that at pressures of a few hundred thousand atmospheres, hydrogen might pass over into a crystal-lattice, that is, into a metallic state. It would then be more than half as dense as water, and conduct electricity freely. Whether this can actually happen, 10,000 miles beneath the surface of Jupiter, no one can yet say. But the possibility is good evidence that the advance of physical theory has not taken the picturesqueness out of astronomy—any more than steam has spoiled romance at sea. The more we know, the more remarkable, as well as the further-reaching, are likely to be our conclusions.—*Mount Wilson Observatory.*



Loading the south (lower) cross-member for the yoke of the 200-inch telescope on a freighter near Philadelphia for shipment to California. This big member is 46 feet in length, 10 feet in width, 12 feet in height, and weighs 90,000 pounds

[1] In the article by Bridgman. Scientific American, August 1938, p. 80.

GRAND COULEE PROGRESSES

Monster Dam and Appurtenant Works Will Cost Over 376 Millions . . . Dimensions . . . Components . . . Progress of Work . . . Difficult Problems Met

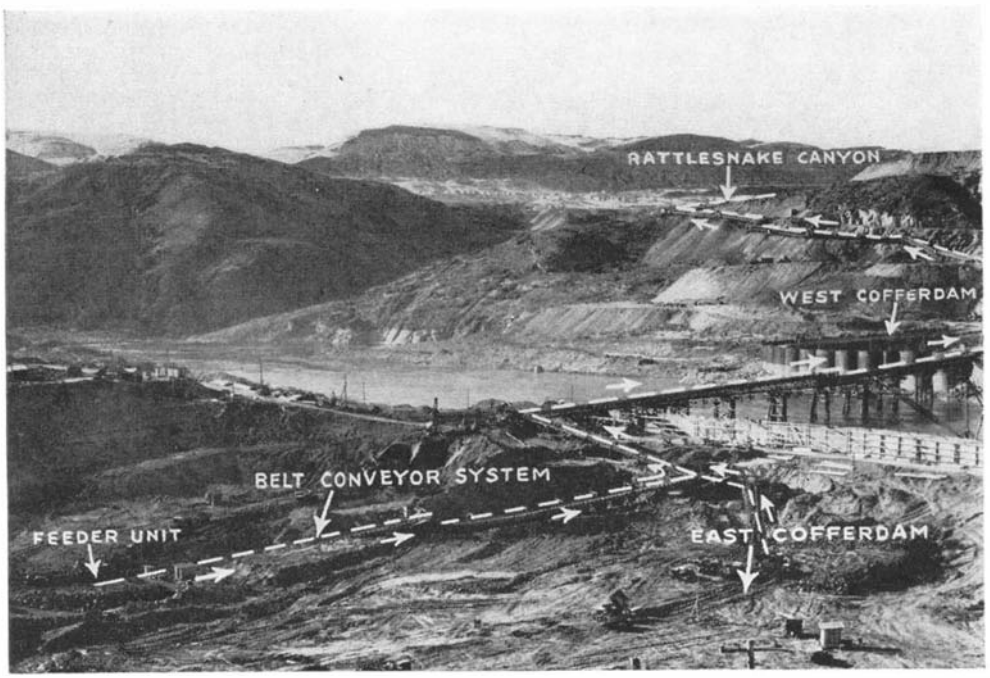
By R. G. SKERRETT

GRAND COULEE DAM, in the state of Washington, is being steadily reared from the depths of the Columbia River Canyon toward its ultimate maximum height of 553 feet. Work on this tremendous undertaking has been divided into two major contracts: one embracing the building of the so-called "low dam," rising well above the high-water level of the river; the other calling for the completion of the integral but surmounting section, which will carry the dam upward to its prescribed final crest line. The low dam section was finished in January, 1938, and work on the remainder of the gigantic concrete barrier was started during the first half of the current year.

The low dam was authorized in 1934 because it would give relief to the unemployed and the structure, when finished, would make it possible to generate a large block of marketable electricity when plant for that purpose should be installed. The building of the high dam, now underway, will serve much broader fields, because it will make possible generation of a considerably greater amount of power and render practicable irrigation of 1,200,000 acres of rich but now virtually arid lands in the Columbia Basin. Indeed, the fundamental purpose of the Columbia Basin Project, of which the Grand Coulee Dam is the key feature, is the agricultural development of this particular region. Any surplus electricity may be distributed to consumers located within a radius of 300 miles from the dam site. The lands to be benefited by water pumped from the river will provide home sites for some 150,000 persons and will, in addition, support on the project an urban population of 150,000 people. The fruits of the soil will, of course, be distributed throughout a far wider territory and contribute to the sustenance and well-being of a great many more thousands of our citizens.

WHEN the Columbia Basin Project was described in these pages, early in 1935, some emphasis was laid on the geological happenings that brought about the erosion of the deep, broad, and long Grand Coulee which, for 25.2 miles, is to be used as a balancing basin to store, for a prompt draw-down, 329,000 acre-feet of water that can be fed by gravity flow whenever needed for irrigation. But nothing was told in our earlier article about what the same stupendous forces did 25,000 years ago in the canyon of the Columbia, where the Grand Coulee Dam is building. The invading ice sheet, which blocked the canyon below the dam site, raised the level of the river about 1500 feet, and detoured the stream westward where it eroded the Grand Coulee and, incidentally, overlaid the bed of the Columbia with a deposit of glacial drift, or till, that attained a vertical thickness of 500 feet. What happened afterwards, when the river worked ceaselessly to readjust itself and to burrow downward toward its ancient level, brought about conditions in the canyon that have presented major problems to the dam builders.

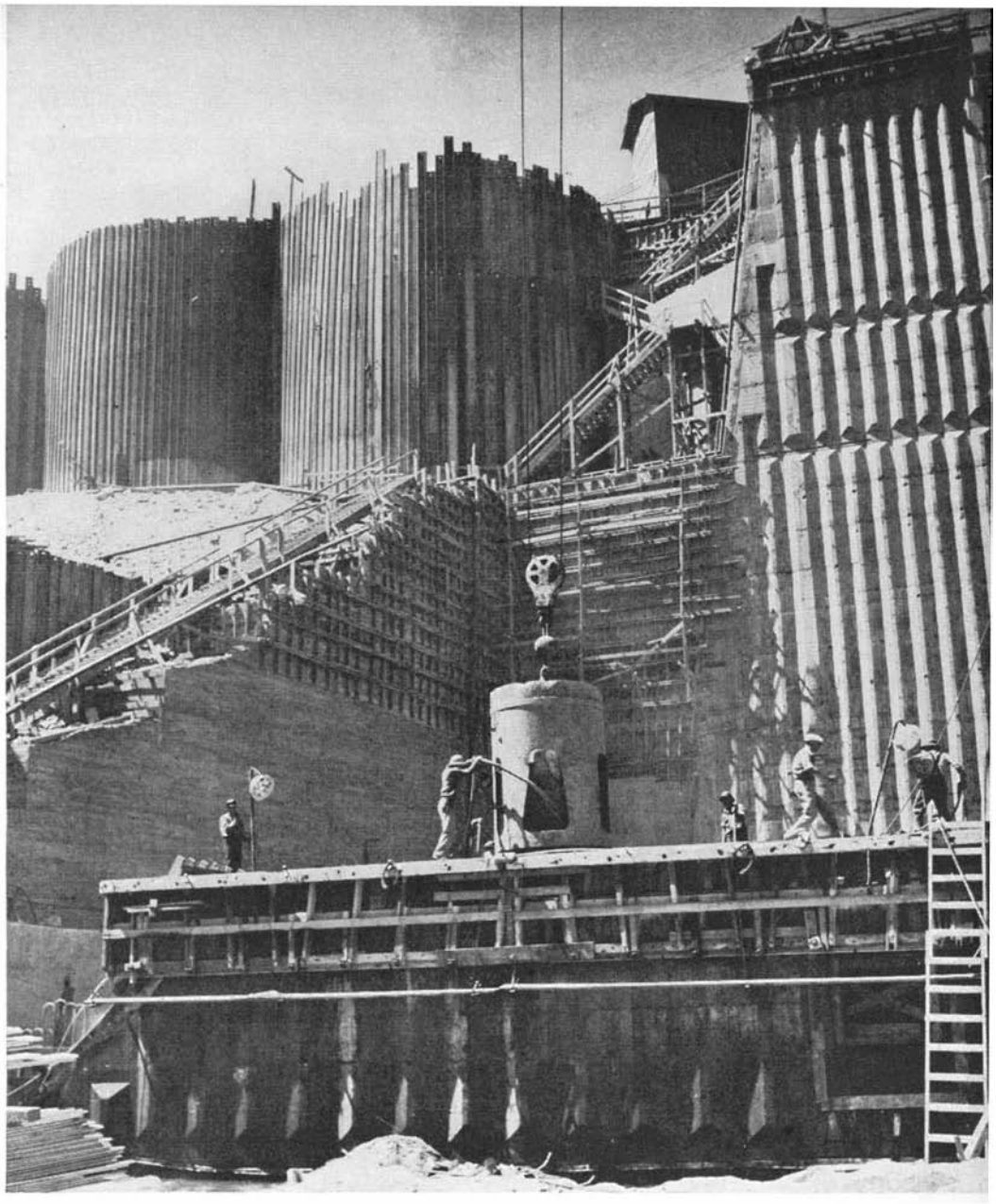
When the Cordilleran ice sheet retreated, and the Columbia was free to resume its ancient course, the river proceeded to dig into its new bed of glacial material and to scour restlessly an ever-changing channel until it worked its way to the course traced by it in modern times. At the dam site, in midstream, the bed of the river is now from 40 to 50 feet thick over the underlying and far-reaching basic granite. From the center of the stream, outward and upward throughout the length of the dam, the overburden, of glacial origin, increases in depth to a maximum of 200 feet, but beyond that range the depth is greater. The canyon slopes are blanketed to a height of 500 feet with material that formed part of the river bed laid there by the Cordilleran ice sheet. As the river worked its way downward, its banks were successively undermined and the disturbed silt and drift slid and readjusted themselves before coming to rest. Some areas finally attained a measurable degree of stability, while others, even today, are insecure. It was because of this condition, a heritage of many centuries, that slides have occurred repeatedly during the excavation of the dam site. In the earlier stages of the work.



The extraordinary belt conveyor system which transported excavated material from both sides of the river to Rattlesnake Canyon, hundreds of feet higher, where it was then dumped

while excavating where the west abutment of the dam was to rise, a single slide of 2,000,000 cubic yards moved down and athwart the roads built by the contractor to give him access to his operating area. That slide cost time and money to stabilize and to reconstruct the damaged roadways, and, with some lesser slides, influenced the Government in its decision to abandon the idea of a low dam, as such, and to go forward, instead, with the erection of the high dam now in hand.

The low dam was designed to serve, in part, as the foundation for a future high dam, and the latter structure would have required additional and somewhat extensive excavation to afford the necessarily broader base contact with the foundation bed rock. The engineers of the U. S. Bureau of Reclamation realized that later operations might invite renewed and possibly very costly, if not menacing, slides. Therefore, it was the part of wisdom to build a high dam at an early date. Furthermore, there were involved some uncertainties concerning the effectiveness of the bond that could be made between the supporting surfaces of a completed low dam and the superposed concrete mass that would form the body of the high dam. It was feared that the vibrations that might be set up at flood stages, with the pool at its maximum elevation, would weaken and perhaps overtax the bond between the old and the new concrete. Accordingly, a change order was issued by the Federal authorities in June, 1935, and construction of the much desired high dam—urged consistently by the Columbia Basin Commission of the State of Washington—was started. The preparatory work up to that time made that course feasible.



Pouring concrete within the towering east cofferdam for the central section of dam. Each bottom-dump bucket such as the one shown holds four cubic yards, or eight tons, of concrete

THE contract for the original low dam, made with the Mason-Walsh-Atkinson-Kier Company in 1934, called for a structure that would contain 3,600,000 cubic yards of concrete. For the agreed sum of $29,339,301, the contractor stood ready to build the substructure to a height of 177 feet above bed rock and rising well above flood-water level—that substructure ultimately to be surmounted by a contemplated much higher dam. The low dam section was finished in January, 1938, and contained the required 3,600,000 cubic yards of concrete; but the high dam, with its appurtenant structures, will bring the total amount of concrete placed up to 10,250,000 cubic yards—a volume of concrete 2⅓ times greater than the amount used in building Boulder Dam and its various associate features.

From its lowest contact with bed rock to the top of its crest, Grand Coulee Dam will rise 553 feet. From wall to wall of the canyon, the structure will have a maximum length of 4200 feet. Where it rests on the sustaining granite, the dam's base has a transverse spread of 500 feet. Along its crest, which is 30 feet in width, there is to be a roadway 26 feet wide connecting with a highway on each flank of the canyon. The spillway, centrally located, will be 1650 feet long and 47.6 feet lower than the crest of the dam. That spillway is to be equipped with 11 steel drum gates, each 135 feet in length; when those gates stand up to their full height of 28 feet, the level of the impounded water will be 357 feet above the Columbia River at low stage. The basin, when filled to capacity, will hold 10,000,000 acre-feet of water, and the back-water will extend upstream to the Canadian border, 151 miles distant. When the spillway gates are lowered into their recesses in the crest of the spillway, the 11 openings will permit the escape of water at the rate of 1,000,000 cubic feet per second—a volume more than twice as great as the recorded maximum flood discharge of the river at the dam site. The pool above the dam will provide a storage of 5,200,000 acre-feet of water which can be withdrawn, as needed, for irrigating the lands of the Columbia Basin Project.

The body of the spillway section of the dam, below the crest of the spillway, will be pierced at three different levels, 100 feet apart vertically, by a total of 60 gated outlets 8½ feet in diameter, through which water can be released into the river below the dam to maintain a regulated flow for purposes of power development and navigation on the river below the Grand Coulee Dam. On each side of the river, at the downstream face of the dam, there is to be a power house in which will be installed nine prime turbines, each of 150,000 horsepower. In the west power plant there will also be three smaller service units. All told, the ultimate generating capacity of the two power plants will total 2,182,500 kva. The generating capacity of the Grand Coulee Dam will be about 50 percent greater than that of Boulder Dam.

The average annual flow of the Columbia, at the dam site, is 109,000 cubic feet of water per second, while the corresponding flow of the Colorado River is

not much more than one fifth of this. Grand Coulee Dam will be the means of increasing by 100 percent commercial power development between the new structure and the point where the Snake River joins the Columbia, and will add 50 percent to the potential power development below that point.

On the upstream side of Grand Coulee Dam, at the western abutment, there is to be constructed a pumping plant in which will be placed 12 big electrically driven units having a combined discharge of 19,200 cubic feet a second. Each pump will force the water up hill to the western crest of the canyon through a pipe 10 feet in diameter; depending upon the level of the pool, the pumps will raise the water from 295 to 367 feet, in order to deliver into a canal 1.7 miles long leading to the northern end of the Grand Coulee reservoir. Grand Coulee Dam, when finished, and equipped with all its turbines and generators, will cost $178,790,000. The pumping plant and the supplemental features of the irrigation system of the Columbia Basin Project will entail an added outlay of $197,841,000. Thus the total will be $376,631,000, according to the estimates of the U. S. Bureau of Reclamation, which has designed the dam and the other features of the comprehensive project, and is directing the present work.

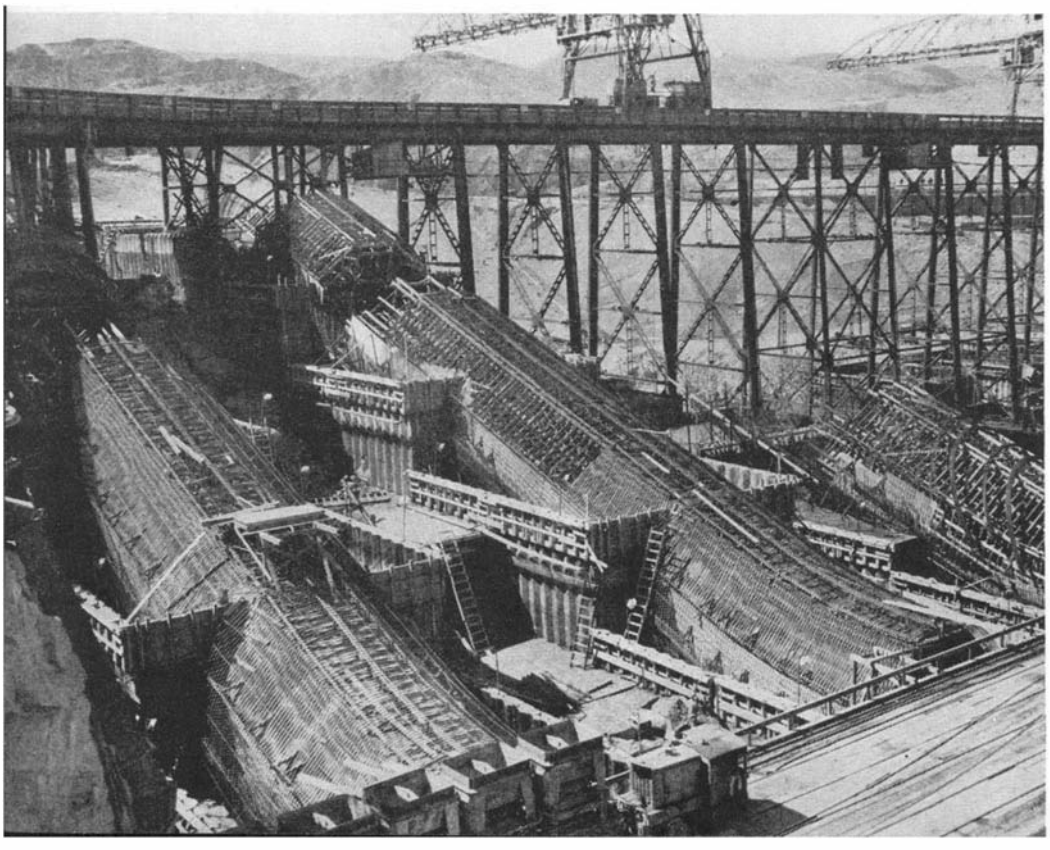
The first great problem confronting the contractor was how to dispose of approximately 15,000,000 cubic yards of earth and rock that would have to be excavated in clearing the dam site in advance of starting actual construction, after the Government had made the location accessible by building a branch railroad 32 miles in length. The canyon, adjacent to the dam site, offered no low ground for a dump within several miles along the river, and to build roads and to use motor trucks to haul the soil away would have imposed prohibitive costs. Therefore, the contractor developed a flexible and efficient belt-conveyor system that could carry the muck from the first scene of operations, on the west flank of the river, accommodate itself to the steep and changing contours of the canyon for an ultimate distance of 1½ miles, and climb approximately 500 feet to dump into an immense pocket known as Rattlesnake Canyon. That belt conveyor has moved in the course of a working day nearly 51,000 cubic yards of spoil. The feeder belts, that delivered to the main belt, radiated to the active points of excavating so that the motor trucks and tractor trailers had to move only a short distance in carrying their loads from the power shovels to the feeder units. This belt-conveyor system first served the excavation within the west cofferdam and then transported selected material for ballasting the cells forming the walls of the west cofferdam. Later, with a suitable extension, the system moved spoil from the east cofferdam and carried the waste material across the river and thence up to the main dump in Rattlesnake Canyon. The installation operated night and day, in fair and foul weather, saved months of time and a large amount of money. It was an adaptation of a system used in 1932, during the driving of the Boston vehicular tunnel under a section of that city's harbor.

Excavating the site for the western abutment of the dam was done within a cellular type cofferdam 3000 feet in length, for the most part parallel with the river, but with the ends of the structure turned more or less inshore. All told, 13,000 tons of steel sheet piling were used in constructing the cofferdam, and the piles ranged in length from 35 feet to 80 feet. The piles for a cell were assembled on the surface of the ground, like a towering fence, and then driven, against increasing resistance, with the aid of four steam hammers equipped so that each could drive two piles at a time—the hammers being suspended from a gantry that made it feasible to shift them easily so that piles could be driven successively around the rim of the cell. The novel arrangement of the gantry enabled the contractor to do his work with speed and to complete the structure in three months during a winter when the thermometer dropped to 20 degrees below zero. Haste was essential in order that advantage could be taken of the low stage of the river and so have the cofferdam ready for service in advance of the succeeding months of high water. At flood stages, the river rises from 40 to 62 feet above the winter or low-water level.

THE east cofferdam, within which most of the spillway section of the dam and the east abutment have been constructed, utilized much of the main river section of the erstwhile west cofferdam—an area over which the diverted river flowed while the east cofferdam was in use.

A leak developed when excavation of the eastern area was well below the river level and in the vicinity of one of the two major cell groups that had first served for the west cofferdam. Some of the deeply driven piles had penetrated a layer of coarse sand; water, under sufficient head, followed upward around the piles when the work required the removal of an embankment that had been placed about those cells. The invading water increased in volume until it was flowing 35,000 gallons a minute. Before that stage was reached, a dike was built around that corner of the cofferdam to confine the inundation, and then the next problem was to seal the leak. Despite feverish efforts to arrest the inflow by dumping earth, riprap, and other obstructing materials on the riverside bases of the cells, large volumes of water still came in. Then the engineers determined to do the unusual—tried to shut out the water by blocking it from the inside of the cofferdam. The first thing was to locate the channels in the sand stratum through which the river was making its way. That was ascertained by numerous exploratory drill holes. Next, a filtering layer of broken rock was dumped on the leaking area. Then, upon that rock was laid a thick blanket of gravel heavy enough to resist displacement by the pressure of the outlying and higher river. The stage was then set for sealing the filter bed by dumping into the sand seam and the broken rock, under pressure, a

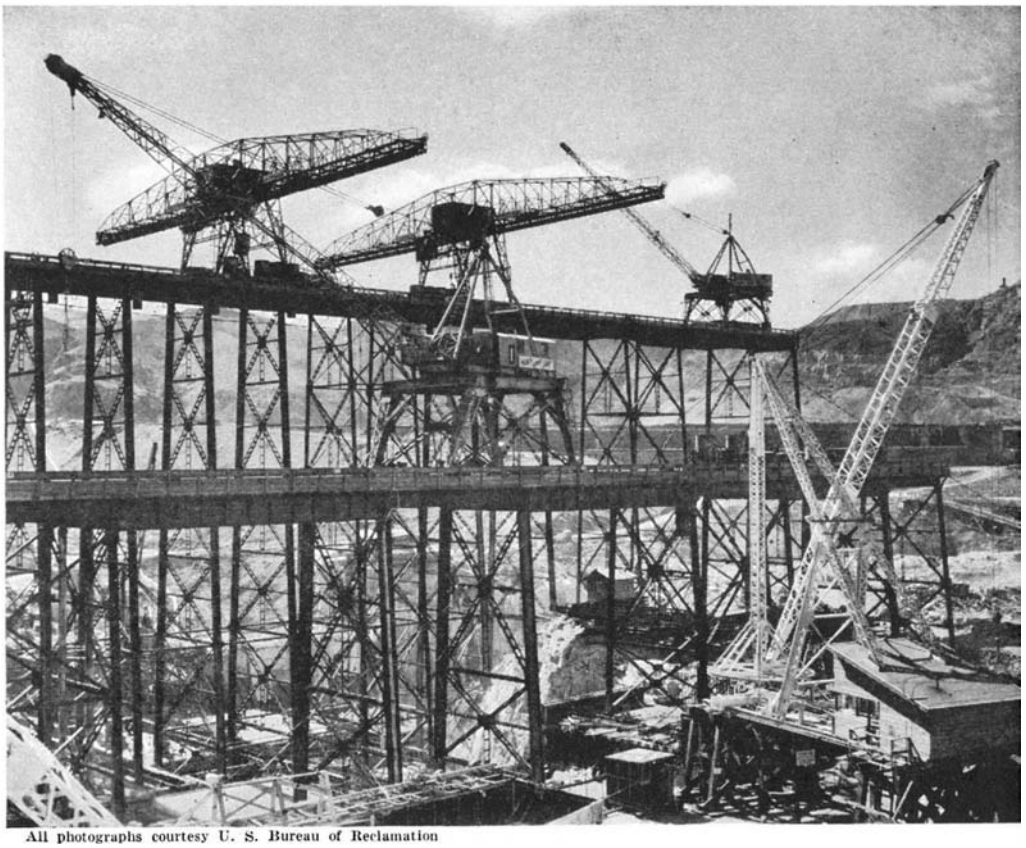
Constructing forms and placing reinforcing steel bars of the great 18-foot penstocks that will deliver water to each of the 150,000 horsepower turbines, of which there will be a total of 18



grout composed principally of cement, sawdust, shavings, and Bentonite. Bentonite is an earth that, when saturated, expands from 10 to 30 times its original volume and becomes a gelatinous mass. The Bentonite, combined with the other ingredients of the grout, plugged successively the gravel and the rock of the filter bed and then sealed the sand stratum through which the water had previously worked its way into the cofferdam. To do the trick, more than 12,500 sacks of cement, 125,000 pounds of Bentonite in lumps and pulverized, 4600 cubic feet of sawdust, and more than 6800 cubic feet of shavings were used. In three days, an inflow of 8000 gallons per minute was cut down to less than 1000 gallons per minute; and it took only a short time more to reduce the leakage to as little as 200 gallons a minute, which was easily kept under control.

Midlength of the eastern cofferdam, and athwart the axis of the dam, there was exposed a narrow ravine that dropped abruptly to a depth of 120 feet below the general surface of the bared bed rock. That ravine had to be excavated, but before it could be cleared, a slide started toward it from a flanking area. The contractor reared in the bottom of the ravine a concrete arched dam and mounted upon it a rock-filled timber crib which was to be backed on the pressure side with heavy riprap. The slide immediately afterwards resumed its advance, buried the man-made obstruction, and poured into the ravine too fast for a good-sized power shovel to overcome it. The slide was halted effectually only by freezing about 3000 cubic yards of wet and fluid earth and creating a dam from side to side of the ravine. The freezing was accomplished by pumping brine from two ammonia compressors, the total capacity of which was 80 tons of ice per day, through 377 freezing points—pipes driven into the damp earth.

IN handling bulk cement, the contractor profited by what had been done earlier at Boulder Dam. The cement reached the western slope of the canyon by a branch railroad and was there stored in capacious silos. From the silos, the cement was blown by compressed air through two 11-inch pipe lines. One of these, 2000 feet in length, delivered the dry cement to the west-side concrete mixing plant, and the other pipe line carried similar cement to the east-side mixing plant, 6000 feet distant. Each mixing plant, several stories high, and itself elevated, fed the concrete and the aggregates by gravity to the batchers and mixers, and the concrete thus prepared was dropped into bottom-dump buckets, set on flat cars which hauled the concrete to the points of placing. Each dump bucket was of four-cubic yard capacity—that is, eight tons; and the batching, mixing, and discharging were virtually under automatic control subject to the master direction of a centrally located dispatcher who, in turn, was linked by telephone with foremen at the different pouring points throughout the various parts of the widespread scene of operations. The highly mechanized facilities made it possible to pour in a single month more than 400,000 cubic yards of concrete. No wonder the work of building the low section was completed some months sooner than called for under the contract.



All photographs courtesy U. S. Bureau of Reclamation

Steel trestle 3000 feet wide and 175 feet high paralleling axis of the dam and used for trains and cranes handling concrete and steel. It will be embedded in the concrete of the completed dam

The body of Grand Coulee Dam, from bed rock upward, is composed of a series of great interlocking blocks of concrete, with intervening contraction joints that have been successively filled with grout to unify the structure. The blocks in the spillway part of the dam are 50 feet square in plan, but elsewhere the blocks are of lesser unit dimensions to meet differing structural requirements. The blocks have been uniformly poured in lifts of not more than five feet in height during a given 72-hour period; and on top of each completed lift or block has been laid parallel lines of 1-inch pipe in advance of pouring the concrete for the superposed block. These pipes, which have been filled with grout after serving their purpose, carried river water that was pumped through them to absorb the heat induced by chemical action while the concrete was setting. That cooling offset the expansion of the concrete and prevented the development of disruptive forces that have often cracked and seriously damaged large masses of concrete that were not so cooled.

In January of the present year, an aggregation of experienced contractors was awarded the job of completing the surmounting body of the high dam. That work is now going forward in the hands of the Interior Construction Company at an award cost of $34,443,240. The contract calls for placing 5,250,000 cubic yards of concrete, containing 160,000,000 pounds of reinforcing steel; installing 10,000,000 pounds of piping, 50,000,000 pounds of gates and operating apparatus, 24,000,000 pounds of trash-rack metal; and proper placing of penstocks having a combined weight of 16,000,000 pounds. The Government will provide the electrical plants in the two power houses; the generators will have a total capacity of 2,700,000 horsepower when all the units are in place. The Government will also equip the great pumping plant on the west side of the valley which will lift water from the river and start it on its journey toward the lands of the Columbia Basin Project. The distributing canals will reach to all parts of an area about 100 miles in length and 60 miles in width; in dropping from the initial reservoir to the lowest level of the farmlands, there will be sufficient head to generate power to operate pumps and so raise a part of the water a maximum of 100 feet to irrigate about 200,000 acres that could not otherwise be brought under cultivation.

The Columbia Basin project is, indeed, an engineering undertaking of splendid proportions and of major importance. When brought to its designed consummation, the enterprise will no doubt amply justify outlays that will total, according to present estimates, $377,000,000—$179,000,000 for the dam and power plant and $198,000,000 for the irrigation system. Work on the Grand Coulee project is under the direction of Mr. John C. Page, commissioner, U. S. Bureau of Reclamation.

Tools Must Be Fit

Hard Alloy . . . Cobalt, Chromium, Tungsten . . . Welded to Wearing Edges . . . Resists Wear . . . Withstands Heat . . . In Tools, Cuts Faster, Lasts Longer

By E. E. LeVAN

SEMI-PRECIOUS metals used in farm implements? Although seemingly unreasonable from either a useful or an economical viewpoint, it is actually being done. And because a special alloy of these metals is used, the farmer's cost of plowing, cultivating, and harvesting is substantially lower. The paradox is easily explainable.

As might be anticipated, only a relatively small amount of special alloy is used, and it is used only where it does the most good. Actually, it is a very wear-resistant, stainless alloy of cobalt, chromium, and tungsten, and it is welded only to those edges or surfaces of implements which receive the brunt of the wear. Thus, a few ounces of the alloy protect an expensive implement, and the protection afforded makes the whole part last much longer.

Farm implements are only one application of this principle, for industry as a whole makes wide use of this alloy to protect wearing parts.

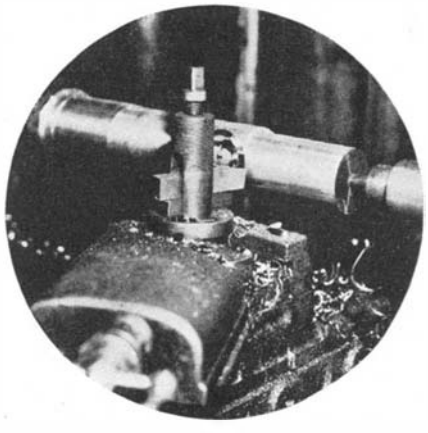
Steel mills use it on enormous shears which clip off steel billets as easily as a tailor cuts cloth. Automobile manufacturers protect countless metal-working dies with it. Power plants, developing steam pressures of 1000 pounds per square inch and higher, use valves having seating surfaces "hard-faced" with this alloy. And, now, most large bus and truck engines are equipped with exhaust-valve seat inserts protected by a layer of the same wear- and corrosion-resistant materials.

This alloy is no new discovery. Its history dates back to the period before the World War, when Elwood Haynes was manufacturing "horseless carriages." Haynes, a mechanical genius, was also an eminent metallurgist. He was always interested in chromium alloys and had done considerable work on stainless steel. At this time, however, he was searching for a stainless material from which to make tableware and cutlery. Several alloys of cobalt and chromium, which he made, were non-tarnishing, silvery and, on the whole, very suitable. On further experimentation, however, he added tungsten to his mix and the resulting material on solidifying was so hard that no ordinary tool steel would cut it. Observing this, Haynes decided that the metal might be adaptable as a cutting-tool material in his automobile plant. It worked splendidly.

Development followed rapidly. During the War, when production of machine parts was at its peak, Haynes Stellite, as the alloy was named, was an invaluable aid. Cutting at higher speeds, it increased production far above the level obtainable with ordinary steels. Because of this fact too, Haynes Stellite cutting tools began to be employed in machining operations throughout the manufacturing world.

SOON after the War, the process of applying this hard alloy as an abrasion-resistant coating on other metals was perfected and generally adopted by industry. In 1924, this process was first introduced for protecting the drilling and reaming edges of oil-well drilling tools. Although drilling bits are subject to terrific abrasive action, the Stellited edges proved their economy by preserving the bits to several times their former life. Although oil-well bits are now hard-set and hard-faced with an even more wear-resistant cast tungsten carbide diamond substitute, the silvery, hard, cobalt-base alloy is the standard hard-facing material wherever both surface smoothness and abrasion resistance are required.

The years from 1920 on have seen an enormous increase in the number of applications for which this alloy is used. Typical examples of hard-faced parts are: plowshares; metal stamping dies; hot-metal shears; automotive, aircraft, and steam valves; excavating bucket teeth; glass shear blades; road graders; brick molds; pump shafts and pulverizer hammers. The list now includes equipment used in every industry.



High-speed cutting of steel is easy for cobalt-chromium-tungsten alloys

Specific examples of hard-facing will illustrate how this alloy has been used to overcome specific problems of wear under extreme conditions.

Steel jaws for holding two pieces of metal to be welded in an electric flash-welding machine are subjected to severe operating conditions. Suddenly they are clamped, vise-like, into the work. A heavy current is applied through them, as contactors, to the steel parts to be welded. The full discharge of the welding current through the jaws produces a considerable amount of heat. As the weld progresses, flying sparks of hot metal strike the jaws, and, while the jaw surfaces are still hot, the finished work is quickly released. Naturally, steel jaws cannot last long under such service conditions. A company manufacturing ½-inch steel pipe couplings, recently found that if the jaws were hard-faced by oxy-acetylene welding a layer of the cobalt alloy to the jaw-gripping faces, they lasted 10 times as long as new steel jaws.

Hard-faced valve at right after 650 hours; center, steel after 150 hours

This principle has also been carried out on a larger scale at one of the large middle-western steel plants. Here, the bits of grappling tongs for raising hot steel ingots from the blooming mill soaking pits were surfaced with this alloy. The application has been very economical. Where, formerly, 19,000 bits were kept on hand continually, a large reduction in inventory is now possible since tong bits with hard-faced points last over six times longer than new steel bits.

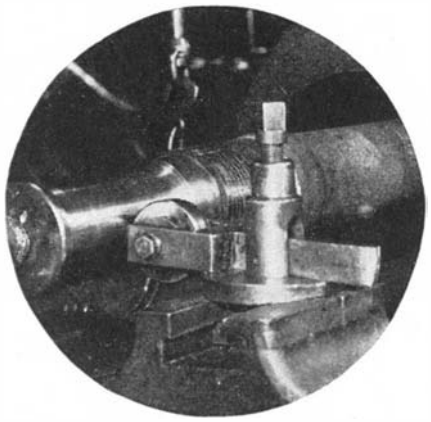
In hydro-electric plants using very high heads of water as a source of power,

The dough scraper, hard-faced, in long service without reconditioning

the directing nozzles and valve needles have to be extremely accurate so that peak efficiency of the turbines can be maintained. At one installation in California, the water, under a head of 2200 feet, travels at a rate of over 400 miles per hour through the nozzle. It is only natural that even hardened steel nozzle throats and needles should be severely eroded in a short time. Hard-facing increased the life of these parts from three months to over six years.

IN making bread, the dough is kneaded in a molding machine. By passing the dough through a series of rollers and then over curling rolls, the texture is improved and all the air bubbles are pressed out. Naturally the machines must be kept as clean as possible and the dough must run through evenly. To prevent it from sticking to the rolls, it is scraped off by blades held by springs against the rolls. Originally, molding machine manufacturers employed hard steel scrapers. These presented a problem, however, because of their tendency to cut and sometimes scratch the rollers. Softer scrapers were then tried, but wore out rapidly.

Recently, however, a New York City bakery solved this problem by hard-facing the wearing edges of the scrapers by oxy-acetylene welding. Because of



A cobalt alloy roller is used in this machine to burnish freight car axles

its low coefficient of friction and the high polish taken by the hard-facing alloy, it does not scratch the roller. In addition, since the alloy surface is perfectly stainless, the scrapers are easy to keep clean. But the principal advantage gained is that the former difficulties with steel scrapers are now entirely eliminated. While steel scrapers had to be refinished every three months, hard-faced scrapers have now been in service for many more months without showing the least sign of wear.

Grinding the valves used to be a frequent expense on the old family car. The accompanying photograph of valves tells its own story. The steel valve head is burned completely through after only 150 hours of service, while the hard-faced valve is still in excellent condition after over 650 hours.

High-pressure, high-temperature steam valves serve in much the same manner, and, for this reason, it is only natural that they, too, should likewise be protected. Numerous installations have proved the value of hard-facing steam valves, and have shown clearly that, when the seating surfaces of valves for high-pressure, high-temperature steam service are hard-faced, they last from six to ten times as long as ordinary steel valves.

Protective coatings applied by hard-facing do not represent the only use for cobalt-chromium-tungsten alloys. Their principal use is that which Elwood Haynes foresaw 30 years ago—metal cutting tools. "J-Metal" and "2400," the grades used for cutting tools, are daily performing machining miracles in automotive plants. They are used for turning, facing, boring, and milling nearly all grades of cast iron, malleable iron, and steel, as well as for performing certain operations on specialized high-production jobs.

Railroad shops are also reducing machining time and costs with cutting tools of this material. Pistons and piston rings, valve bushings, and air-pump cylinder bushings are only a few representative parts now being machined with cobalt-chromium-tungsten alloy cutting tools.

After car and locomotive axles are rough-turned on a lathe, they are rolled or burnished to smooth out the bearing surfaces. This is done on a lathe where the axles revolve while a burnishing roller, pressed tight against the bearing surface, rolls out imperfections and produces a mirror-like surface. Because of the hardness and extreme smoothness required in a roller for such exacting work, rollers of this same cobalt-chromium-tungsten alloy are employed by leading railroad shops. In one shop, where special steel rollers develop irregularities after burnishing less than 2000 axles, rollers of this cobalt alloy have burnished over 21,000 axles in five years of maintenance-free service.

THE economy of hard-facing is well illustrated in the case of farm plowshares, which have been studied by several state university agricultural experiment stations. The results of these surveys indicate that hard-faced shares ultimately cost the farmer only one-third to one-half as much to use as plain steel shares. These figures are averages of results obtained in different states throughout the country. Including intangibles, the savings made by using hard-faced plowshares are even greater, because there are only one-fifth as many stops to change shares and fewer trips to town for resharpening service—a substantial time saving. In addition, the hard-faced shares are found to "scour" and stay in the ground well, plowing to a more uniform depth.

Similar results are being obtained in machine shops using tools of this alloy. The initial cost of tools is slightly more, but production is increased—in many cases, up to 150 percent—because of the increases in speeds and feeds made possible by the unique qualities of the alloy. In addition, the number of pieces turned out between tool sharpenings is substantially increased—insuring more continuous production as well as lowered ultimate tool costs.

The adaptation of the alloy to such a variety of uses affects almost every commodity we buy. Consider the family car again. From bumper to bumper it has been shaped by dies and tools hard-faced with or made of solid cobalt-chromium-tungsten alloy. Many parts of the engine and transmission have been machined with tools of this alloy. Many of the body stampings have been made of the same alloy, which is also used in the knives to cut the upholstery cloth and tire fabric. The oil and gas on which the car operates have been produced from wells drilled with hard-faced tools and handled in the refinery by means of Stellited pumps and valves. And finally, even the cement in the concrete road upon which the car runs has been ground in mills of this wear-resistant alloy.

MAKING NEW ATOMS

Many New Forms of Matter are Being Produced by Modern Research in Nuclear Physics, but Science Knows no Way to Transmute Matter Economically

WITH the pioneer experiments in artificial transmutation of the elements less than seven years old, research in this field of nuclear physics is now being vigorously pursued in many physical laboratories. In consequence, hardly a month goes by without the announcement of the discovery of some new kind of atom in some laboratory. It appears that probably before long every kind of chemical element will be prepared in an artificially radio-active form, as in the case of those to be described, and that we are just at the beginning of a long and fruitful period of research into the applications of this host of new substances.

Let us recall the general ideas involved in producing new kinds of matter by transforming the nucleus. Each atom consists of a central nucleus which carries a charge of positive electricity surrounded by enough outer electrons (negatively charged) to make the whole atom neutral. The central nucleus also carries most of the mass of the atom, for the electron weighs only 1/1800 as much as the lightest nucleus, that of ordinary hydrogen.

In order to transmute an atom from one kind into another it is necessary somehow to affect the central nucleus, and this is not easy to do; first, because it is very small and so it is hard to hit and, second, because it is very tightly bound together and so it must be hit hard in order to break it up. A glance at Figure 1 will remind us of the scale of distances involved. Opposite the arrow at the top, is indicated a space which actually is exactly one centimeter in length—about four tenths of an inch. Going down the scale, each division corresponds to taking a length one tenth of the preceding amount, so the bottom of the ladder, which is 13 steps down, corresponds to a length of 1/10,000,000,000,000 centimeter. Opposite various places on the ladder are written the names of things whose size is appropriate to that place in this scale of lengths. Plainly, if the diameter of the nucleus is only 1/10,000 that of the atom, its cross-sectional area is only 1/100,000,000 that of the whole atom, so if we shoot a projectile into the atom at random (and we know of no way to take a better aim) there is only one chance in 100,000,000 of hitting the nucleus.

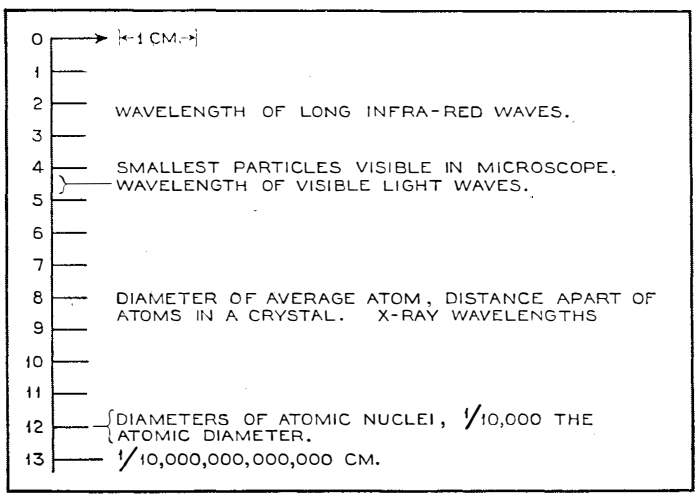


Figure 1: **Each vertical step downward corresponds to a length one tenth that of the previous step, starting with one centimeter (shown full scale at top) and extending down 12 steps to the atomic nucleus—the smallest thing known to science**

Hence a great many of the projectiles shot in will generally be wasted. Suppose, for example, we have accelerated a hydrogen atom nucleus or proton by letting it fall through a potential drop of 1,000,000 volts, and that it then strikes a target of matter which we wish to transmute. A competition begins. The proton, being charged, attracts the electrons of the atoms in the target, setting them in motion and thus losing some of its energy. By rare good luck it may hit a nucleus in the first layer of atoms in the target. But, if it does not, it goes on to the second layer; however, with diminished energy because of what it has lost to set the electrons in motion. In the second layer it again has a very small chance of hitting a nucleus and it continues losing energy to the electrons. In general, if it does not hit a nucleus it will penetrate about 100 atomic layers before being slowed down so much that it would be unable to make an effective hit. In each layer its chance of success is one in 100,000,000, so in all 100 layers it is about one in 1,000,000.

This, in a nutshell, is the reason why it has not been possible to make the new transmuted elements on a large scale: *We do not know how to aim the projectiles in order to increase the percentage of hits.* Thus a great deal of the energy supplied to the suppositious transmutation machine goes into accelerating projectiles which never do anything effective. That is why physicists generally feel that this kind of research is not going to give any new source of power in a form useful for heavy industry, even though immense stores of it are latent in the atomic nucleus. But that does not mean that the new nuclear physics is without value, for the new materials that are being produced are already finding wide application in biological and medical research.

BUT let us consider more in detail what happens in those rare events in which a successful hit is made, to see why it is that physicists everywhere are devoting their whole attention to these studies. To appreciate the situation, we must remember that the central nucleus is believed to be built of two kinds of particles, the proton and the neutron. The proton has unit atomic weight on the chemist's scale (approximately) and is positively charged with what we shall call unit charge, the same degree of charge as the negative charge of the electron. The neutron has essentially the same weight as the proton but carries no charge. So a nucleus gets its total charge from the protons contained in it and its mass comes from the joint contribution of the protons and the neutrons.

We may make a graph in which there is a place for every conceivable kind of nucleus by plotting the number of neutrons on a vertical scale and the number of protons on a horizontal scale. This has been done in Figure 2 for the chemical elements of low atomic weight.

In this diagram the kinds of atoms which are known to exist stably in nature

IN THE LABORATORY

By E. U. CONDON, Ph.D.
Associate Director, Westinghouse Research Laboratories

are indicated by solid circles. It will be noticed that these occupy the central part of the diagram, corresponding to equal numbers of protons and neutrons or only slight departures from this rule. The part of the diagram corresponding to very heavy hydrogen, say of atomic weight ten—one proton and nine neutrons—is blank, and so is the part corresponding to nuclei containing many protons and few neutrons. There must be something about the forces holding nuclei together which favors the nuclei having equal numbers of neutrons and protons and makes the others unstable.

In the diagram will also be found two other sets of circles, some containing plus signs, the other containing minus signs. These represent the new kinds of atoms, all of which have been discovered in the last few years by research in nuclear physics. Why they were not found in nature is also clear, for they are all radio-active —that is, unstable—and disintegrate in periods from a few minutes to a few days; at any rate, so rapidly that none could survive geological epochs even though some supplies of them were initially present.

These radio-active atoms all disintegrate in one of two ways. Those marked with a *minus* sign shoot out electrons spontaneously and thus, in effect, gain a positive charge without appreciable loss of mass. It is the same as if one neutron changed into a proton by splitting off and ejecting a negatively charged electron. This results in forming as a product nucleus the kind that is downward and to the right one place each way, as indicated in Figure 3. Similarly, those in Figure 2 which are marked with a *plus* sign shoot out positrons or positive electrons spontaneously. This process is the same as if a proton in the nucleus changed into a neutron by splitting off and ejecting a positron.

It will be noticed in Figure 2 that all the electron-emitting elements are on the neutron-rich side of the stable elements and all the positron-emitting elements are on the proton-rich side. Not only are the elements which occur naturally the only stable ones, but the way in which the unstable ones break up is just that which results in a product of stable type. If the instability is due to an excess of neutrons the nucleus corrects this by shooting out an electron, while if it is due to an excess of protons the correction is made by shooting out a positron.

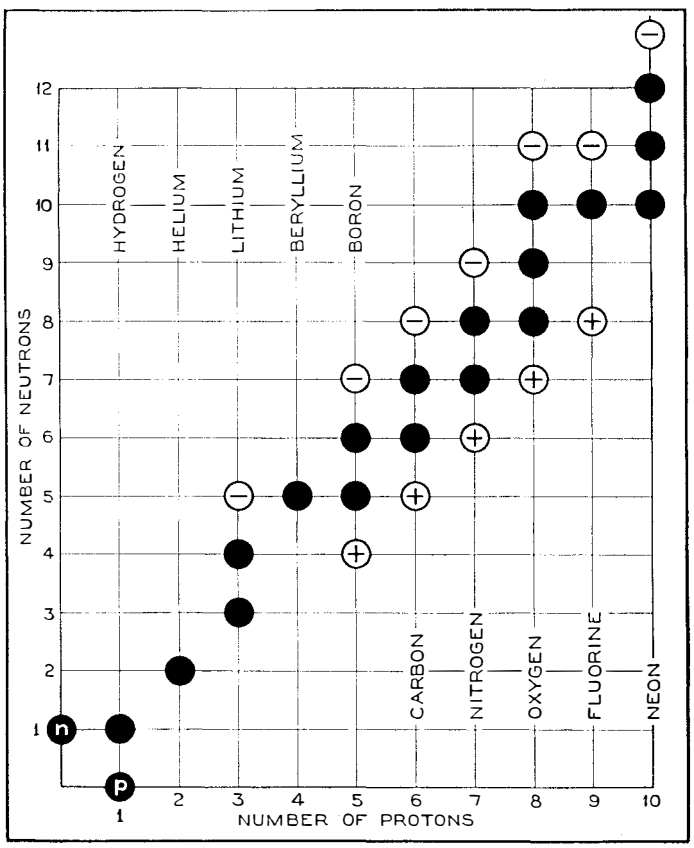


Figure 2: **In the lower left-hand corner, marked *n* and *p*, are the simple units out of which the nuclei of all atoms are built. The shaded circles show the kind of nuclei occurring in nature for the ten lightest chemical elements. Circles with + and — signs inscribed within them correspond to the newly discovered radio-active species of the same elements which spontaneously emit positrons and electrons, respectively**

So far we have not spoken very much about the nature of the projectile but that is important too. Nuclear transformations can be produced by hitting nuclei with:

a. Gamma rays or X rays of high frequency (short wavelength).
b. Protons obtained from high-voltage discharge tubes operated by a Van de Graaff machine or from a cyclotron.
c. Deuterons, or nuclei of heavy hydrogen, obtained in the same way as *b*.
d. Alpha particles, or nuclei of helium atoms, obtained from high-voltage discharge tubes or from the cyclotron.
e. Neutrons — which are themselves obtained from nuclear reactions in which targets are bombarded with one of the four preceding agents.

One might think that they could also be transformed by bombarding by high-voltage electrons, but this appears not to be the case. At least, there is no certain evidence for such processes, which means that electrons are much less effective than the agencies just listed.

GAMMA rays are least effective and the over-all process is especially inefficient, as strong sources of the gamma rays are not available. They have been shown to eject a neutron from the nucleus when they are absorbed by a process that has many points of similarity to the ejection of electrons from a metal by ordinary light in a photocell. The use of gamma rays is principally of theoretical interest in learning about nuclei and does not seem likely to be an important means of producing radio-active materials.

Neutrons are interesting projectiles with which to make nuclear changes. As they are uncharged they are not repelled electrically by the positively charged nucleus, so they do not have to hit it hard in order to penetrate. As a result, even a neutron that is going very slowly, comparatively speaking, is able quietly to fall into a nucleus and be captured by it. With the development of powerful sources of neutrons now in progress, this means of making active materials will probably be of greatest importance in the future. The ease with which neutrons are

captured, even when going slowly, is what accounts for their absence as free particles in nature. If a neutron is produced in any manner whatever, it will go through matter until it is caught by some nucleus within a very short time.

A great advance in our understanding of what happens in a nuclear collision has been made by Prof. Niels Bohr, of Copenhagen, the same man who, more than 20 years ago, pointed the way to understanding how the outer part of the atom is built. He points out that the various particles in a nucleus attract each other so strongly that, the instant the projectile enters, its energy is divided up among all the particles and capture is thereby effected because then no one particle has enough energy to escape from the attractions of the rest. This situation is in sharp contrast to what would happen, for instance, if a star were to enter the space occupied by the solar system. The solar system is such a wide-open structure that, although the star would undoubtedly set up great disturbances in the planetary orbits, it would be very unlikely to lose enough energy in this way to be captured and remain with the Sun to make a double start.

After the projectile is captured and its energy divided up among the other particles we are left with an intermediate or compound nucleus which contains all the particles that were originally in both the struck nucleus and the projectile. But it differs greatly from an ordinary nucleus, in that it has a great deal more energy than a stable one. This energy is in the form of energy of motion that is distributed among the various particles. After a time, more or less by chance (that is, by such a complicated sequence of events that we do not know how to calculate them), some one particle will get enough energy to escape from the attractions of the others and so will be expelled.

WHEN this happens, the product that results is in a more or less stable condition. If the material bombarded, the nature of the projectile, and the nature of the emitted particle, are such that the resulting atom is of the stable kind, then nothing further happens. A transmutation of the atom from one kind to another has been effected, but that is all. But if the atom is of an unstable kind then, after a comparatively long time—some hours or days—the nucleus will readjust itself by emitting an electron or positron, in an effort to change into a stable kind of atom.

So rapid has been the progress in this field that now literally hundreds of different cases are known in which different atoms are subjected to different transmutations by different kinds of projectiles. Right now a great deal of effort is being devoted to more exact study of the details of the processes—how they depend on the energy of the impacting projectile and details about the energy with which the emitted particles are sent out.

It will perhaps make the discussion clearer if we explain briefly the meaning of the symbolic equations which the nuclear physicist uses to describe atomic transmutations. It is now customary to denote one atom of a substance by the same symbol that the chemists use, prefixing it with a subscript that tells the

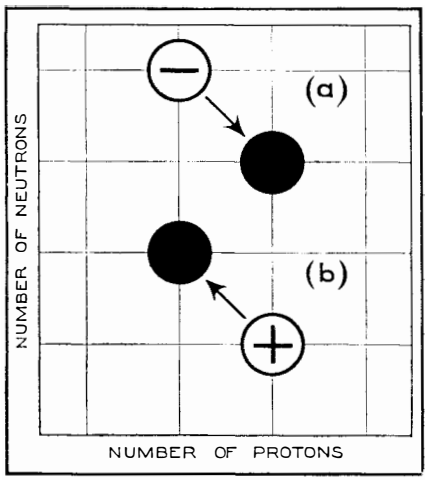


Figure 3: **When an electron is emitted the change is as shown in (*a*), with one neutron changing into a proton. When a positron is emitted the opposite is true, as shown in (*b*)**

number of protons in the nucleus and adding a superscript that gives the total number of neutrons and protons. Thus ${}_4Be^9$ stands for a nucleus of the kind of beryllium atom which has a total of nine protons and neutrons and contains four protons. The changes taking place when one atomic species is bombarded by another can then be indicated by equations, in much the same way as the chemist is accustomed to indicate the reactions between atoms in order to form molecules.

As an example, consider the equation

$${}_4Be^9 + {}_2He^4 \rightarrow {}_6C^{13} \rightarrow {}_6C^{12} + {}_0n^1$$

This expresses the fact that, when a target containing beryllium is bombarded with alpha-particles or high-speed helium nuclei, in some cases the alpha-particle will be caught and fused in with the beryllium nucleus, giving temporarily an "excited" (or surplus-energy-containing) nucleus of the isotope of carbon which contains seven neutrons and six protons in its nucleus. Reference to Figure 2 shows that this is a kind that occurs stably in nature, but here it is formed with so much excess energy that it is not stable and very quickly (without any measurable delay) breaks up, as indicated, into a carbon nucleus of atomic weight 12 and a neutron. This particular equation is historically important, as it corresponds to the process by which neutrons were first discovered by Prof. J. Chadwick, who was then at the Cavendish Laboratory at Cambridge University, England.

There are quite a number of reactions of this same type, in which, when an element is bombarded with alpha-particles, the alpha-particle is captured and a neutron is emitted. Evidently the product nucleus thereby formed has two more protons but only one more neutron than the original nucleus, and this tends to make it too rich in protons; that is, tends to put it on the side of the stable elements in Figure 2 where the positron emitters lie. It was, in fact, through the study of reactions of this type that this kind of artificial radio-activity was discovered in 1934 by Irène Curie and her husband, F. Joliot.

PROCESSES of just the opposite type were discovered and first studied by Fermi and his colleagues at the University of Rome. He bombarded targets with fast neutrons and found that alpha-particles were emitted. The first reaction of this type was studied by Feather, who found that boron (B) is produced from nitrogen (N) by bombarding with fast neutrons. The equation is

$${}_7N^{14} + {}_0n^1 \rightarrow {}_7N^{15} \rightarrow {}_5B^{11} + {}_2He^4$$

As it happens, in this case as in several others, the nucleus produced is a stable one. But in this reaction the net change from the struck to the product nucleus is to rob it of two protons while taking away only one neutron. This change tends to make the product lie outside the group of stable elements of Figure 2, and in such a way as to leave the product having too many neutrons. Therefore, one might expect sometimes to produce unstable elements in this way, and that when he did so they would always be the kind which emit electrons and not positrons. That is exactly what Fermi and his associates found.

Now we may consider a specific instance of a radio-active element that is formed in two different ways. Thus, for example, Fermi found a reaction of the type just considered when phosphorus (P) was bombarded by fast neutrons to give radio-aluminum,

$${}_{15}P^{31} + {}_0n^1 \rightarrow {}_{13}Al^{28} + {}_2He^4$$

The aluminum atoms of this variety are unstable (ordinary aluminum is ${}_{13}Al^{27}$) and disintegrate by converting one of their neutrons into a proton with ejection of an electron. This process happens at such a rate that the average "life" of such an aluminum atom before it is converted into a silicon atom is 137 seconds.

On the other hand this same kind of radio-active aluminum may also be produced by bombarding aluminum of the ordinary kind with neutrons. In this case the neutron is simply captured on striking the aluminum nucleus, according to the reaction

$${}_{13}Al^{27} + {}_0n^1 \rightarrow {}_{13}Al^{28}$$

The radio-aluminum produced in this way is found to disintegrate in the same way as the other and in all respects seems to be the same stuff.

DIRECT CURRENT SUPER-POWER

Is High Tension D.C. Transmission Coming Soon? . . . Engineer Discusses Its Advantages . . . Awaits Only Perfection of Apparatus . . . Almost Ready

POINTING out that power use in this country has increased ten-fold in less than 18 years, J. D. Ross predicted in a recent address before the Engineers' Club of Seattle a similar further increase in less than 20 years (to more than a thousand million kilowatt-hours) and advocated inter-tying the great federal plants in the country with a network of direct-current transmission lines. Bonneville, Grand Coulee, Boulder, TVA, and the "million horsepower" Skagit, of Seattle, are foundation stones for this super-power era. Power from these plants, from great hydro and steam plants yet to be built, would be distributed on transmission lines a thousand or more miles long cross-cutting the nation at intervals of 250 to 500 miles.

Direct-current transmission now awaits only the development, in enormously increased capacity, of tubes similar to those small ones now made for radio. These tubes would be used as rectifiers to convert A.C., after its generation and stepping up to a high voltage, into D.C. Then at the receiving end, other tubes would convert the power into A.C. again so as not to disturb existing community systems.

The present method of transmission using A.C. is subject to severe limitations, one of the most important of which is an electrical effect which causes great loss of power but which does not affect D.C. transmission. Hence "the practical transmission distance for A.C. for very large blocks of power seems to be about 300 miles," said Mr. Ross. He then contrasted A.C. and D.C. by means of a specific example. "An ordinary three-phase A.C. circuit that will transmit 48,000 kilowatts 300 miles with 5.66 percent power loss, if used with D.C. with one wire removed, will transmit 68,500 kilowatts with the same percentage loss. This means that a two-wire D.C. line will deliver 43 percent more power than the three wires of an A.C. line, using the same size conductor and the same insulation. With longer distances, the comparison is still more favorable to D.C. transmission.

"It is customary, in order to insure continuity of service, that duplicate lines be used. Ordinarily that would require four wires. Here comes a tremendous saving in cost. By making one wire positive to earth and one wire negative to earth, we can use one wire for each circuit, and use only two wires instead of four. . . .

"Two such circuits of only one wire each would deliver 684,000 kilowatts per wire 100 miles away, or a total of 1,368,000 kilowatts. If these two wires reached from the Columbia River to Chicago, they would deliver in Chicago about 760,000 kilowatts. If the voltage of each wire were raised from 400,000 to 500,000 volts, the wires would deliver Chicago's total need of 1,000,000 kilowatts.

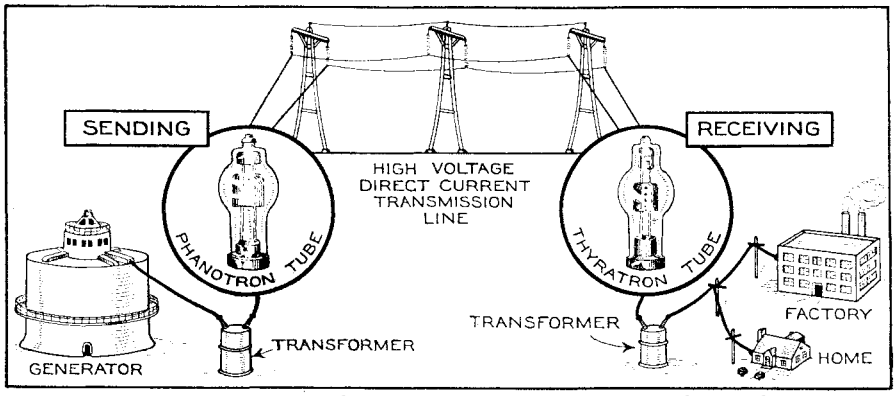
"IF the wires were carried on to New York at 400,000 volts, the Columbia River would deliver to that city about 516,000 kilowatts. If the voltage were raised to 700,000, the wires would deliver New York's demand of 1,500,000 kilowatts."

The apparatus for rectifying the high voltages necessary for D.C. transmission "will be slowly perfected over the next few years," predicted Mr. Ross. "Some of our brightest engineers are hard at work on this problem. Already it is possible to use three 50,000-volt rectifiers in series, delivering 150,000 volts (D.C.) on the transmission line. What we need, however, for 1000- or 2000-mile lines is not 150,000 volts, but 400,000 or 500,000 volts, or higher."

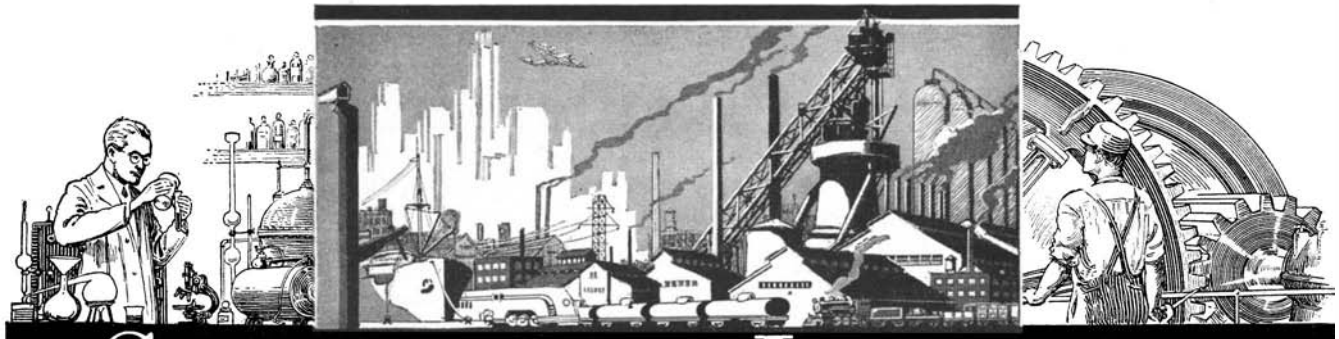
Mr. Ross said further that with the coming of D.C. transmission, huge generators with higher efficiency will make their appearance. Treated poles, instead of towers, would be used to carry the wires. The saving in copper due to the use of fewer wires or cables would partly be offset by the high cost of the tubes at each end of the circuit. However, the fact that the generating can be done at the source of cheapest power will bring a much lower generating cost so that the cost of electricity to the consumer can be lowered.

The system now proposed contemplates use of most if not all the undeveloped water power totalling, according to the United States Geological Survey, over 52 million kilowatts, and the construction of steam power plants near coal mines and in lignite fields. The coal reserves of the nation are estimated at about three thousand billion tons, and there are enormous lignite fields in Dakota and in Texas. On the average, each pound of coal will produce one kilowatt hour, while low grade lignite will produce somewhat less than one kilowatt-hour per pound. Utilization of these sources together will, however, supply the demand for electricity for many years to come, the drain on no one of them being unreasonable.

But what are the economic possibilities of D.C. transmission? Costs throughout the country would be largely equalized. There will be no isolated power plants. Irrigation and manufacture could be carried on with equal ease in any part of America, whether it be in the dust bowl or on tidewater. Industries could be located anywhere and congested areas could be decentralized. Most important, perhaps, is the fact that power could be delivered from a distance of 1000 miles at about the cost we get it from 100 miles distance today. In addition, the greater flexibility of transmission, allowing huge amounts of electricity to be sent over long distances by D.C., will tend to promote greater use.



Alternating current is stepped up to a high voltage, converted into direct current with a tube, then re-converted to alternating current at the point of use



SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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

D. H. KILLEFFER
Chemical Engineer

Tractor for Comfort

HAVE you heard the latest one about this farmer's daughter? Well, her Old Man got one of those new Minneapolis-Moline de luxe tractors and she did all the plowing. Reason enough: the tractor has all the comforts of home—and a few others besides.

Radio; self-starter; an enclosed, all-steel cab; safety glass; comfortable, cushioned seats for two; complete lighting system; self-energizing brakes—it has them all. Furthermore, it is lined with sound-absorbing material, and is air-ventilated. Temperature is controlled with a hot-water heater in winter and air circulation in summer.

All the comforts of home

The new vehicle amounts to a dual piece of equipment for it can haul plows and harrows in the field or roll along the highway as a truck, pulling a heavy trailer-load of produce to market at 40 miles an hour. Capable of pulling four 14-inch bottoms in average soil, it has a maximum draw-bar pull of 5270 pounds in low gear. It has five speeds forward and one reverse.

Specialists Should Advise on Hearing Aids

DEAFENED persons should seek the advice of doctors specializing in ear diseases when they choose hearing aids, Drs. Horace Newhart and Henry E. Hartig of Minneapolis stated recently. They warned against "racketeering instrument salesmen" who "exact high prices for instruments which rapidly wear out, batteries which run down quickly, and provide no means for servicing the instrument in order to keep up its efficiency."

The final test of a hearing aid is intelligible, clear speech. Magnifying all sounds for people who are only deficient in certain parts of the scale creates unbearable noise, the two doctors pointed out. Ear specialists can check on this point and also can advise the kind of hearing aid needed by those deafened persons who require sound conduction through the bone back of the ear drum in order to hear.

One guard against the "racketeering instrument salesmen" is seen in the standards for hearing aids set by the American Medical Association, standards to which all reputable manufacturers now adhere.—*Science Service.*

New Flame-Proofing Compounds

THE ammonium salt of sulfamic acid is a valuable flame-proofing agent for use on fabrics, paper, and other combustible materials. It has the advantage of causing no stiffening of fabrics to which it is applied, nor does it effloresce and whiten the surface. Fabrics treated with it can be dry cleaned without losing their resistance to flames.

Sulfamic acid is made by dissolving urea in sulfuric acid and adding sulfur trioxide. It is now produced on a commercial scale. —*D. H. K.*

Night Blindness Determiner

A NEW scientific instrument requiring only eight minutes to ascertain whether a person is deficient in vitamin A and afflicted with night blindness, now recognized as a major factor in night auto accidents, has been announced by the American Optical Company. Clinically tested and approved, this instrument, called the Adaptometer, is the first ever developed to detect night blindness in a few minutes.

Night blindness is the inability of the eye to adapt itself to dim light. It was responsible, according to Dr. J. F. Neumueller, director of the optical company's bureau of visual science, for many of 1936's 22,000 auto fatalities which occurred during hours of darkness when only 20 percent of the total traffic was on the road.

It is claimed the Adaptometer with its quick and sure test for vitamin-A deficiency will be of great value to doctors, eye authorities, school dietitians, the Army and Navy, industrial concerns, transportation companies, insurance firms, railroads, air transportation companies, and motor vehicle commissions.

Night blindness is definitely associated with various organic and functional disorders, Dr. Neumueller stated. It is usually caused by a deficiency of vitamin A. This essential vitamin is called upon by Nature to regenerate visual purple, a substance found in the retina of the eye and necessary for seeing in dim light. Exposure to glare or strong light bleaches out the visual purple. A partial blind period results, lasting until the regenerative process restores the retina to normal.

The operation of the Adaptometer is quite simple. The subject is seated in a dark room facing the instrument. His eyes are fixed on a strong light in the upper part of the in-

To detect night blindness

strument. This light bleaches out the visual purple in his retina. After a three-minute exposure, the bright light is turned off and the subject is apparently in complete darkness.

However, when the bright light is switched off a very weak test light is automatically switched on. The test light becomes visible to the subject only after sufficient regeneration of visual purple. The time of regeneration in normal cases should not exceed five minutes. If a longer time is needed, the subject is considered deficient in vitamin A and has night blindness.

Hard Crystals from Boric Acid

PERVERSENESS of scientific research and laboratory use of a tin can gave to the world recently a new dress for an old substance, changing boric oxide from a glass to a crystal as hard as rock.

This new member of the crystal family has the same fundamental chemical properties as the boric acid from which are made eye washes and antiseptics, but it promises new controls in the manufacture of glass.

Scientists had sought in vain for years to discover a formula to change the glassy oxide to a crystal. They had used elaborate laboratory paraphernalia and vacuums in their futile attempts. But it remained for Leon McCulloch, a research engineer and chemist in the Westinghouse Research Laboratories, to make the revolutionary discovery—all because one of his experiments turned out exactly contrary to his hoped-for result.

Mr. McCulloch was working with boric acid fused in loosely covered quart tin cans under atmospheric pressure in an oven which was heated to between 225 and 250 degrees, Centigrade. "I wanted the mixture to stay liquid so that it could be used to impregnate electrical coils, serve as insulation," he explained. "But the mixture turned white and milky, and then pasty. Finally it became stone-like, something I had never seen happen before. In fact, it was something that no other scientist had ever recorded before."

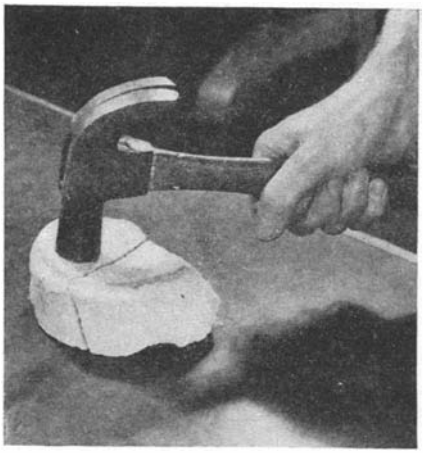
The engineer "weighed" this strange mass. Its specific gravity was a third again as great as a similar lump of boric oxide glass. It was so hard that several blows of a hammer were required to shatter it. Its hardness was comparable with Portland cement.

Then he melted the mass and discovered that it had a definite melting point at 470 degrees, Centigrade. Its relative, boric oxide glass, has no definite melting point, making the transition from a solid to a liquid in a gradual process of heating.

First step in producing rock-hard crystals from powdery boric acid

Mr. McCulloch also demonstrated that the new crystal could be prepared at temperatures around 250 degrees while the glass had to be fused at 900 degrees.

By adding "seed," or small pieces, from crystalline oxide previously obtained, Mr. McCulloch was able to induce boric acid fusions to crystallize immediately. "By this method," he explained, "the oxide can now be prepared in large quantities."



Repeated hammer blows are necessary to break boric oxide crystals

Boric oxide glass plays an important rôle in the chemical and industrial fields because of its high resistance to heat shock.

Because of its controllable melting point, the new laboratory discovery should prove helpful in commercial glass manufacture, supplanting boric oxide glass in a number of processes, Mr. McCulloch stated.

Three official witnesses certify to the packing of the Westinghouse Time Capsule, the "cross-section of our civilization" buried, for the benefit of archeologists of the year 6939 A.D., at the New York World's Fair. Grover Whalen, President of the Fair, signs the document which is to go into the capsule, while the other two witnesses—F. D. McHugh (left) of Scientific American and C. G. Weber (right) of the Bureau of Standards—await their turn. David S. Youngholm, Westinghouse vice president, stands behind Mr. Whalen. On the table before the group are some of the numerous articles that went into the capsule, which hangs in the rear (left). The eight cans of films reproduce millions of words in print

Plastic Seals

LEAD seals used to prevent tampering with instruments, packages, freight cars, and so on, may be replaced by a new type of plastic seal now being used in Germany. The new seals have the advantage of being applied by hand without the use of tools; once in place they cannot be removed without destroying the seal.—*D. H. K.*

River in Submerged Grand Canyon of Pacific Coast

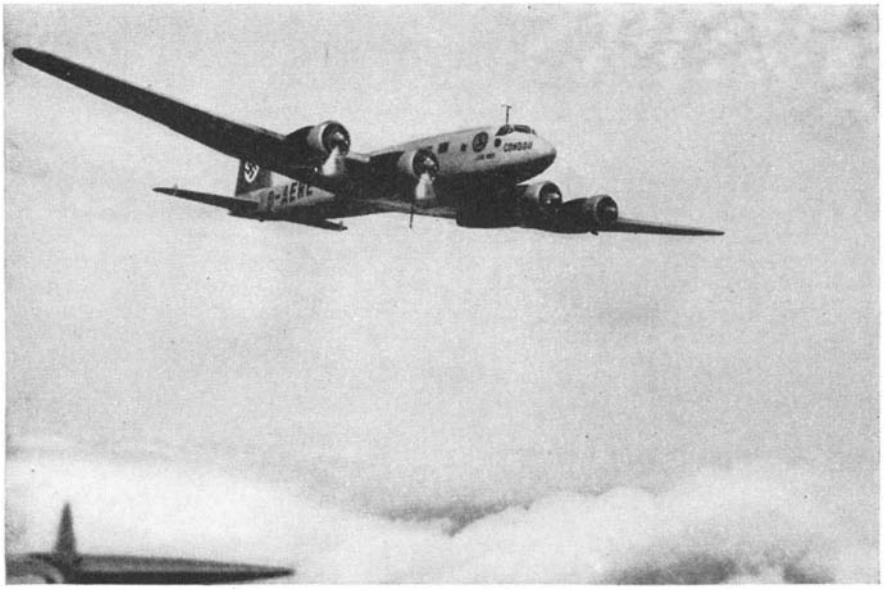
THE Pacific Coast's submerged Grand Canyon has a swift river that flows along its bottom, Prof. Francis P. Shepard of the University of Illinois has reported upon his return from an exploration of its course for 30 miles, off shore from Monterey, California.

The great submarine canyon [see also September, 1938, Scientific American.—Ed.] which goes to depths of 6000 feet and is actually contoured like the Grand Canyon of Arizona, causes a river-like flow by capturing and channeling ocean tides, Prof. Shepard discovered through the use of a current meter.—*Science Service.*

Slow Propellers for Stratosphere Planes

ACCORDING to Charles H. Chatfield of United Aircraft, speaking at the Fifth International Congress for Applied Mechanics, stratosphere airplanes will be equipped with propellers 20 feet in diameter or about twice the size of the airscrews in general use today.

The prediction is sound, and our readers



The *Brandenburg*; it has made significant ocean flights

may be interested in the scientific reasons which justify it. When the airfoil or the propeller blade approaches the speed of sound it loses lift and efficiency. But the speed of sound diminishes in air of low density, which is encountered at great altitudes. Therefore the "compressibility burble" effects of propeller tips revolving at high speed will be augmented in stratosphere flying. The remedy is to make the propellers revolve much more slowly. But if the speed of the propeller is much slower it will not be able to absorb the engine power.

Hence the logical conclusion: a propeller revolving much more slowly, but having a much greater diameter than the airscrews now being used on our transports.—*A. K.*

A Significant Ocean Flight

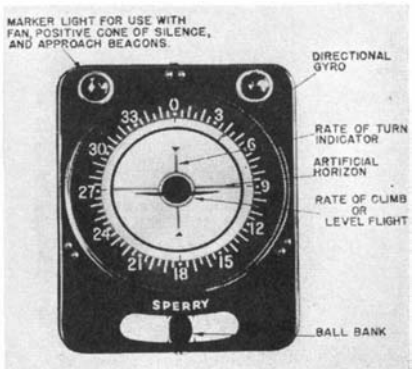
NON-STOP flights across the North Atlantic do not now carry the thrill that they once did. Corrigan was a nine days' wonder, but the memory of his flight will last but a fraction of the time that Lindbergh's exploit will continue to be recalled. The exploratory crossings of large seaplanes are taken for granted. The recent exploit of the Lufthansa Focke-Wulf Condor *Brandenburg*, on the other hand, has a special significance. It was the first non-stop flight between Berlin and New York, on the difficult westward crossing, in which contrary winds are the general rule. The *Brandenburg* is a landplane, and its flight will confirm many in the belief that multi-engined planes can be used for over ocean flying, particularly when it is intended to serve inland centers.

Records of this kind generally are achieved with specially constructed aircraft, but this great four-engined Condor was one of a fleet of Focke-Wulf machines ordered for the Lufthansa, and was to all intents and purposes in standard condition except for the extra fuel tanks installed to increase the range. On landing in New York it was discovered that an oil lead to one of the four engines had fractured. This delayed the return trip a day, but also showed that modern aircraft are much less handicapped by the occurrence of minor mishaps than the airplanes of a few years back. Finally, it is most significant that the flight was kept a complete mystery to the last, and that no reports were received from the crew during the entire two flights. The supposition is that the radio direction finding equipment on board the aircraft functioned admirably without aid from a special organization. This indicates far greater independence of radio aids to navigation than is generally believed to be possible.

To Americans the flights were gratifying for two reasons. The fine engines employed were Hornets, developed by Pratt & Whitney, even though built by the Bayerische Motro Werke in Germany. Secondly, the appearance of the trim looking *Brandenburg* is in every respect a derivative of American practice, although this in no way detracts from the credit of the German designers and constructors. After a certain stage of development has been passed, all vehicles of transportation tend to assume similar characteristics.—*A. K.*

Simplifying the Pilot's Task

NUMEROUS engineers and inventors have given thought to the problem of simplifying the airplane pilot's task by assembling the indications of a number of instruments at a single point of observation. It is gratifying to learn that the Sperry Gyroscope Company, which has developed so many instruments for the pilot to observe, has now brought out a practical method of reducing the pilot's work along these lines. The device, termed the "Flightray," makes use of a cathode-ray tube, upon the luminous screen of which the various indications are assembled in a standard pattern. The multiple indicator reproduces indications from the artificial horizon, directional gyro, turn indicator, and altimeter. It may also be used to show position on the glide path and the localizer radio beam for instrument landing. The Flightray has undergone severe tests successfully at the Indianapolis Airport, and many blind landings were made using solely the indications of the Flightray. Pilots will give thanks when the instrument is available for service use.



Simplified flight instruments

The photograph gives an idea of the manner in which the instrument works. The horizon indications are shown in the conventional manner. The rate of turn is shown by side-to-side movements of the vertical bar. When the instrument is set to show level flight at cruising altitude, the concentric circle encloses the miniature airplane as long as level flight is maintained, and the position of the circle thus indicates deviations above or below the desired altitude. With the aid of a selector switch the Flightray may be changed from a flight indicator to a landing indicator.—*A. K.*

Women at the Air Races

OUR readers must have been pretty well jaded with the usual graphic newspaper accounts of the National Air Races, so we will not risk boredom by telling of the records achieved, of the dramatic way in which Roscoe Turner won the Thompson Trophy, and so on. But there are two things which will remain in our memory of this year's great Cleveland contests. One is the remarkable way in which women can beat men at the very masculine game of flying. The other concerns the flying characteristics of the Fieseler-Storch plane, which makes more poignant the regret that America has never taken kindly to the Handley-Page slot.

Miss Cochran, 1938 winner of the Bendix Trophy race, with Major de Seversky (right) and Ray Brown

The Bendix Trophy, the classic transcontinental speed race since 1931, was won by Miss Jacqueline Cochran, famous pilot who flew a superb race from Burbank, California to Cleveland (covering the distance in 10 hours, 7 minutes, 10 seconds) and beat

nine competing men. She flew a Seversky single seater, powered with a Pratt & Whitney Twin Wasp engine. The Bendix Trophy and an important sum in cash were her rewards.

Again, in showing what a Handley-Page slot with flaps and proper design can do, Fräulein Hanna Reitsch, a diminutive young woman of 25, performed amazing acrobatics and astounded the general public and the experts by her ability to fly very slowly in perfect control and to land on the proverbial dime.

As shown in our photograph of the Fieseler-Storch ship, the slot or movable airfoil is placed ahead and along the entire length of the leading edge. The rear flap also runs the entire span of the wing. The combined effect of slot and flap is to decrease the stalling speed, to prevent "stalling," and to keep the ailerons perfectly effective under the slowest flight conditions. The Fieseler-Storch, a braced monoplane of German construction, is otherwise in no way remarkable, though it achieves a fair speed for its type and power. Perhaps Fräulein Reitsch's exhibition will revive interest in the utilization of such slots.—*A. K.*

JOBS

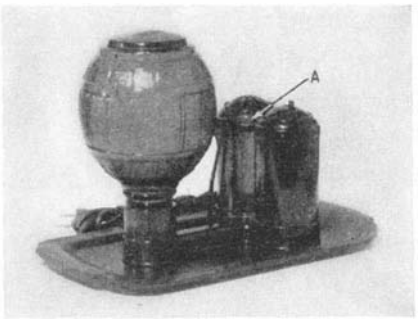
FIFTEEN of our major manufacturing industries of today have been developed since 1879, and it has been estimated that these 15 industries have created, directly and indirectly, 15,000,000 new jobs.

Competition in Transatlantic Service

So far Pan American Airways has been the sole American company contemplating a transatlantic air service, and it is interesting to learn that they are likely to have a competitor. American Export Airlines, affiliated with American Export Lines, has the backing of an organization of long experience and fine reputation in steamship operation. After two years of survey work, American Export Airlines has purchased from Consolidated Aircraft a 15 ton semi-cantilever monoplane flying boat of the PBY type, used successfully by the Navy and now converted to commercial use. The flying boat will cruise at nearly 200 miles an hour, and has a payload of 2000 pounds with a cruising radius of 4000 miles. No monopoly is as satisfactory as competition between two or three efficient organizations; hence the aviation industry will probably welcome this newcomer in the field of air transport.—*A. K.*

Breathe Easier

The Reidcraft Company has developed an ingenious device called the Airoma. It is employed for humidifying air within a room to alleviate colds and other respiratory afflictions such as laryngitis, croup, asthma, and hay fever. The Airoma consists of a glass



Fragrance diffuser

water reservoir, an electric heating chamber, and a vapor chamber. Drops of medicated inhalants, pine fragrance, and other aromatics are put on a special cotton puff which is placed over the vapor chamber. The Airoma dispels their fragrance throughout the room. The two chambers and the water receptacle unit are produced from a special type of phenolic Bakelite molded which is highly resistant to water and chemicals.

Forty-Foot Photo Map

The largest aerial photographic map in the world? Perhaps. It is a bird's-eye-view of the 100-mile-long island of Puerto Rico! A picture so large that a full minute and a half is required to circumscribe it on foot; and so precise that individual houses may be discerned upon it. Such a unique enterprise has just been completed by the Puerto Rico Reconstruction Administration.

In 1935 when the Puerto Rico Reconstruction Administration came into being as an agency for the rehabilitation of the stricken Puerto Ricans, it was deemed necessary to make an aerial map for use in planning a long-range program of reconstruction in the fields of agriculture, industry, rural rehabilitation, slum clearance, and so on.

The project got under way. A total of 95 individual flights were made and 3564 exposures taken. Precision work of the most involved and exact kind was carried on so that the photographic map would be, in every way, scientifically correct.

100 miles in 40 feet

Now, the picture is made, and the Puerto Rico Reconstruction Administration and other government agencies have at their disposal possibly one of the most interesting and valuable photographic products in the world. Costing about $69,000 to make, copies of the map are being made available to private concerns and parties for less than $300 each.

The uses of such maps are manifold. Valuable for the interpretation of agricultural, industrial, engineering and municipal problems, they also may be used for surveys of all kinds, for the location of high-tension power lines, the planning of reservoirs for water power, electrification and hydro-electric projects, harbor improvements, city planning, traffic surveying, flood control, and timber estimates.

The immeasurable value of the map for use in planning fortifications, in carrying on maneuvers, or in war time is self-apparent. Both the Army and the Navy are availing themselves of the possibilities of this map.

"Thermos Bottle" Air Conditioning

The idea of churches being air conditioned by a giant Thermos bottle was discussed recently in Boston at the meeting of the Power Engineers Association at the Engineers Club.

Walter A. Grant, District Chief Engineer for Carrier Corporation, described this method as being ideally adapted because of the short periods during which churches are used.

"It appears self-evident," stated Mr. Grant, "that an application such as air conditioning a church for only a few services a week will permit the use of a very small refrigeration plant storing up cooling effect 24 hours per day for the six week days, and releasing all of this stored cold in a veritable avalanche for the relatively few hours of actual use.

"There are a number of similar applications," he continued, "where storage is the obvious solution. Under this heading come cafeterias operating just during noon hour.

The Fieseler-Storch, a German monoplane with slots and flaps, which recently created a sensation by its ability to fly and land slowly, under perfect control

This is the method used in the Carrier employes' cafeteria at the Syracuse plant. Also funeral parlors and certain classes of auditoriums can provide summer comfort with this system. Water is gradually cooled and stored in a large insulated tank that is virtually a Thermos bottle. This chilled water is then released to the air-conditioning system where the air is cooled to the desired temperature for comfort."

High School Students Study Eugenics

EUGENICS, including a study of venereal diseases, sterilization, attitude and fitness for marriage, is being taught to pupils in the high school at Blackfoot, Idaho, and in several other towns in Idaho.

The students like the course and think it practical, S. Edmund Stoddard, of the Blackfoot High School, reports to the journal *School and Society*.

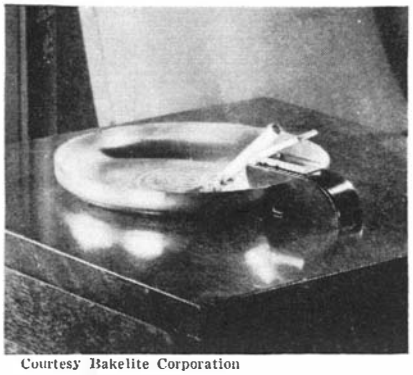
Eugenics is taught as part of a course dealing with genetics and heredity, in which popular misconceptions concerning prenatal influences and sex determination are debunked and the students are allowed to observe the mechanism of heredity in plants and fruit flies. Each is required to work out charts showing the inheritance in his own family of two traits such as eye color, teeth abnormalities, or taste differences.

Venereal diseases are included in the studies because, although they are not hereditary, they are so readily transmitted from mother to child. Objection to the course has been made on the ground that high-school seniors are too immature for such discussions, Mr. Stoddard said. His reply is that high-school students are getting married and becoming parents. "It would seem a worth-while education for these young people to realize the responsibility of marriage and the vital rôle of inheritance, and also environment, in the rearing of their children," he said. "Certainly young married people should know the facts of marriage." —*Science Service.*

Floating Home

SOME months ago we described in these pages an all-steel, all-welded house built by R. G. LeTourneau, Inc., which was built in the factory and then moved to its site on a trailer. Since that time 33 similar houses have been built and some of them have served as homes for employees of the company.

Recently home No. 1, after serving as a residence for a year and a half, was carried on a 16-wheel trailer to the river bank, lowered into the river by an 80-foot tractor-crane, and towed across the mile-wide Illinois River by a 27-foot, 60 horsepower motor launch. It was then set up on a new home site, none the worse for its voyage. Judging from the photographs, no extra work except partially boarding up the doors was necessary before the job of floating.



Courtesy Bakelite Corporation

Burning cigarettes, carelessly forgotten, will not drop from this ash tray to scar furniture, burn rugs. The heat from a lighted cigarette, as the ash grows long, will expand a spring which tilts the rest and dumps the cigarette into the tray

First Subway-Builder Honored

NEARLY 69 years ago, on February 26, 1870, the world's first subway was opened under Broadway, New York City, extending one block south from Warren to Murray Streets. For three years thereafter, the chief "sight" of the city was the "ride" under Broadway for a quarter, the proceeds of which were donated to charity.

Recently, on its "Famous Firsts" program, radio station WOR honored the pioneering Editor of Scientific American, Mr. Alfred Ely Beach, for his invention of the tunnelling shield that drove this nine-foot tube only 10 feet below the cobblestone surface of the thoroughfare; shields based on this same principle have bored all subaqueous tunnels ever since, including the famous Blackwall Tunnel under the Thames River at London, England.

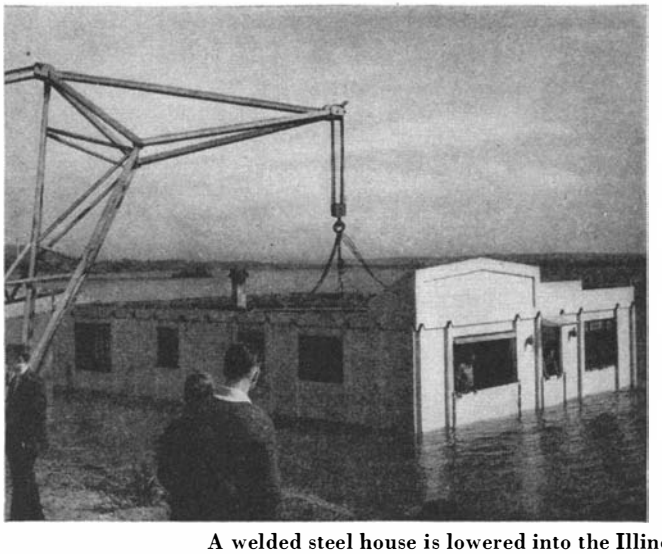
Visitors to the Edison-Ford Museum at Dearborn, Michigan, can see today the Beach Shield (which was removed from its 45-year resting place in 1912) with its hydraulic jacks or rams that, bearing against the end of the completed tunnel, pushed the cutting edge forward through the earth, directing it around a curve by exerting greater pressure on the outer edge. As the Beach Pneumatic Transit Co., under its franchise to lay pneumatic tubes to convey mail the entire length of Manhattan Island, as well as under the rivers, was not allowed to dig up the streets —"the walls of the Astor House would fall and dire calamity would follow"—Editor Beach experimented with a four-foot shield of wood. Finding that it would work and that he could direct it, he boldly drove a nine-foot tube.

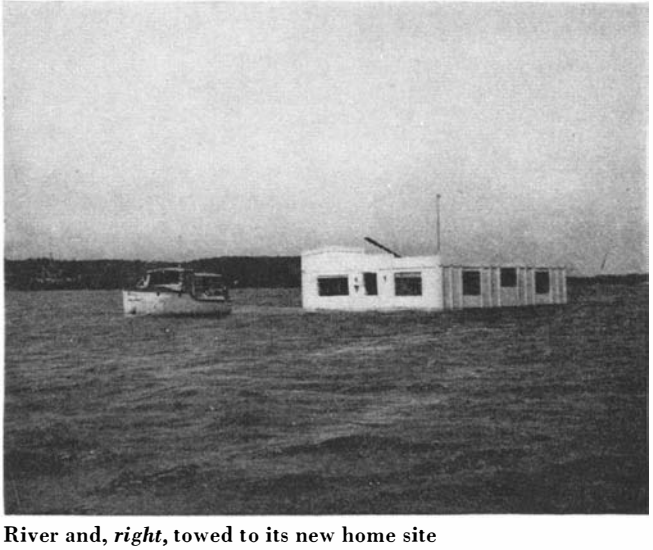
SENSITIVITY

A GALVANOMETER that will detect a current variation of a ten-trillionth of an ampere, has been built at the Smithsonian Institution. Twenty times more sensitive than any heretofore used, this instrument, together with a thermocouple, will make available to astronomers data from which can be deduced hitherto unobtainable information on the structure of luminous bodies in far distant space.

Hydrogen in Bulk

THE increasing use of hydrogen in chemical manufacture, particularly for the synthesis of ammonia and the hydrogenation of coal and oils, has put production on a huge scale. Although no less than 25 different methods have been used at one time or another in the production of hydrogen, only three are of present substantial importance. These are the complete gasification of coal, coke, lignite or other carbonaceous materials by the water-gas and producer-gas processes; the separation of hydrogen from coke-oven gas by low-temperature liquefaction plants; and the electrolysis of water. The first of





A welded steel house is lowered into the Illinois River and, *right*, towed to its new home site

these accounts for approximately 55 percent of the total hydrogen produced, the second for about 26 percent, and the third for 16 percent. In the United States, hydrogen is produced principally by the water-gas process and by electrolysis.—*D. H. K.*

SMOKE

THE visible part of the smoke emitted from one cigarette weighs .0031 of an ounce. By puffing 322 cigarettes, it is possible to make enough smoke to weigh one ounce.

Freezing Needle for Chilling Beef

WITH the advent of refrigeration and the refrigerator car, the modern packing industry might be said to have had its birth. Today the housewife anywhere in the United States and in most foreign countries can have fresh meat for her table all year 'round.

Now another invention in refrigeration, developed by two Wilson & Company employes,

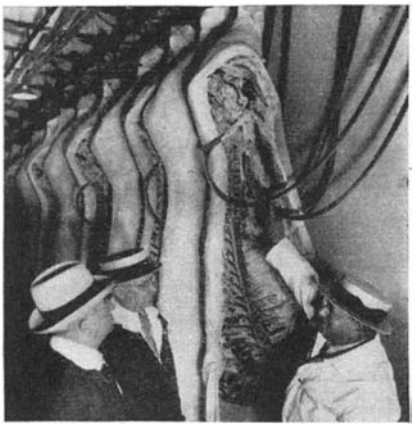
How the new freezing needle is inserted into a heavy beef carcass

makes possible an improved method of chilling heavy beef carcasses to insure finer quality beef.

For many years meat packers have been confronted with the problem of getting refrigeration into the interior of the round on heavy beef carcasses. Because of the large bulk of the round and its covering of fat, the interior of the rounds frequently soured because they did not chill sufficiently rapidly to stop bacterial action.

Laboratory tests demonstrated that bacterial action in beef can be retarded at 50 degrees to 55 degrees, Fahrenheit. Tests have further shown that where the cooler temperature was 28 degrees to 32 degrees, Fahrenheit, the temperature inside the round was still 79 degrees, Fahrenheit, after 12 hours in the cooler.

A unique invention, developed and patented by John Malone, beef division superintendent of the Wilson & Co. Chicago plant, jointly with Adam Young, beef dressing foreman in the same plant, and now being used by Wilson & Co., has effectively solved



Commercial beef-freezing set-up

the problem. The invention consists of a hollow, stainless steel needle through which flows a regulatable stream of cold brine. The needle has a length of 17½ inches from base to tip, and a solid sharp point which permits insertion into the beef hind quarter to make direct contact with the hip joint region where bacterial action is most likely to occur if the temperature is not rapidly brought down to 50 degrees, Fahrenheit, or lower within 12 hours after the animal is slaughtered.

Full and uniform circulation of the brine through the needle is assured by the inner tube assembly. Inside of the outer needle is a stainless steel tube which fits into the base and body of the needle to direct the flow of in-coming brine to the point of the needle. From the point, the brine flows back between the walls of the needle and the inner tube to an outlet in the base. The inlet and outlet connections of the needle are joined with the cooler brine lines by flexible hose lines which permit considerable freedom of motion in the insertion and withdrawal of the needle. Petcocks permit stoppage of brine flow through the needles when they are not in use.

With the use of these new needles, cooler temperatures need not be lower than 32 degrees, Fahrenheit, which means that there are savings in the cost of refrigeration, as well as protection against souring in the rounds.

This invention is another step in insuring finer quality meat for the American consumer, and is an example of the constant refinements in meat packing being brought about through scientific research by large packers. It is this constant scientific research which assures that the meat supply of the American housewife will be the finest obtainable.

Resin Plasticizer in Lubricants

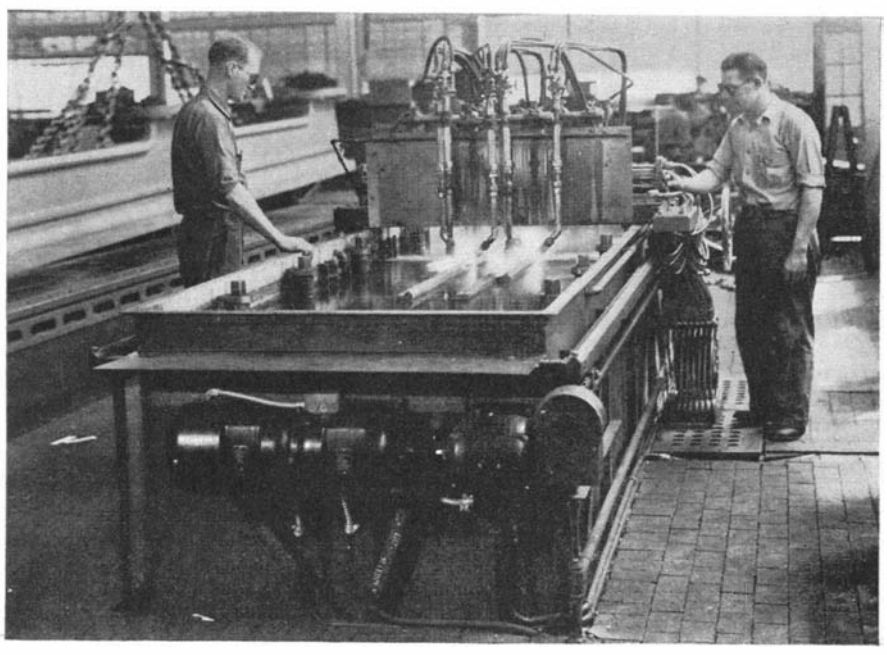
LUBRICANTS can be improved and made resistant to high temperatures by the addition of dibutyl phthalate, a material used to soften resins, and a resin as a thickener. Resistance to carbonization at high temperatures and good lubricating and viscosity characteristics are claimed for the mixture. A typical blend consists of mineral oil, 16 parts; dibutyl phthalate, 3 parts; and polyvinyl acetate, 1 part.—*D. H. K.*

LOCOMOTIVES

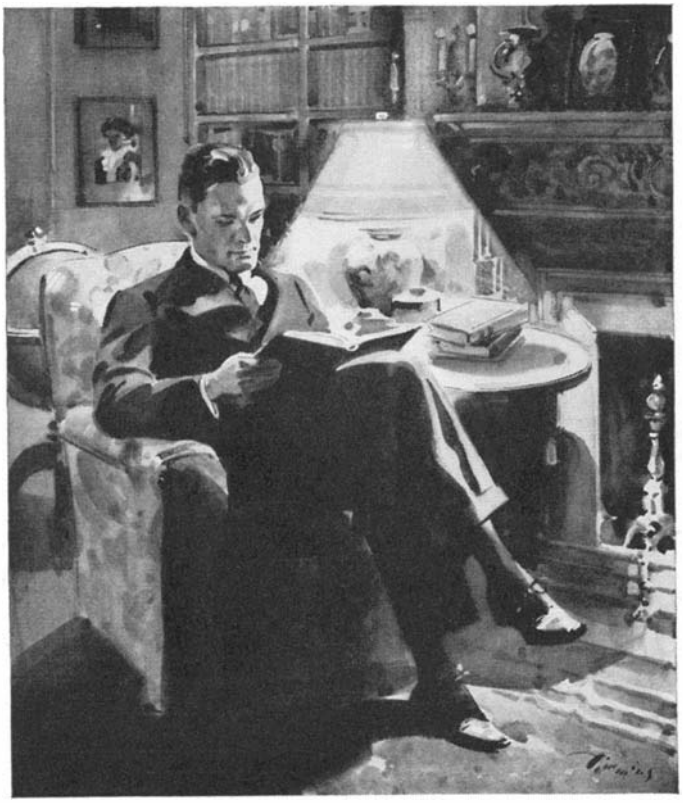
IF coupled together, all the locomotives and cars owned by the railroads of the United States would make a train approximately 20,000 miles long.

Unique Heat Treating Method

RESEARCH conducted during the last four years by the Monarch Machine Tool Company has resulted in the development of a process which permits selective heat treatment of the ways of large lathe beds without the necessity of building a furnace of sufficient size to accommodate the entire casting. By the new method, no furnace at all is required, the heating and quenching being carried out in one operation by means of a specially designed oxy-acetylene torch equipped with a series of water jets for quenching, which follow immediately behind the burner tip. In this



Heat-treating lathe-bed ways without a furnace



THESE TWO MEN GREW UP TOGETHER but today they have gone separate ways...one into a blind alley...the other to SUCCESS

HERE ARE TWO MEN. They were boyhood chums. They lived in the same block. They attended the same schools. Yet, today, one is well up the ladder of success—the other is a minor employee tied down to humdrum routine, his salary small, his future insecure.

Why is one a success and the other a failure? Because only one has learned the secret of "Fifteen Minutes a Day." Planned reading brought him pleasure, advancement and profit. It gave him the cultural background he needed to build a successful social and business career.

READING FOR PLEASURE, AND PROFIT

Dr. Charles W. Eliot (for forty years President of Harvard University) realized perhaps more clearly than any other man that *knowledge is power*. And he knew that the most useful background of knowledge could be obtained in an easy, fascinating way . . . through daily association with the world's most brilliant minds.

From Dr. Eliot's intimate acquaintance with the great books of the world, he selected the priceless treasures of literature. He gives them to you in his famous Five-Foot Shelf of Books (The Harvard Classics) . . . maps out a course of reading . . . shows how to get the most out of every spare moment by following his masterful Reader's Guide.

CONQUER NEW WORLDS, IN 15 MINUTES A DAY

Tonight, perhaps, you ride with chivalrous, whimsical Don Quixote, sharing his hilarious adventures in the land of dark-eyed senoritas. Tomorrow you may join Omar Khayyam in his glamorous verse, while orientals dance to mystic rhythms. Or you may choose to follow Socrates' wit-sharpening logic, the political economy of Adam Smith, or Joseph Lister's discoveries.

THE SCOPE OF THESE AMAZING VOLUMES

A turn of the page and you skip from century to century—from science to religion—from poetry to prose. You marvel at the mighty scope of these fifty masterful volumes—and suddenly the realization breaks over you that you have at your finger tips the sublime thought of the ages—the sum total of man's achievement since civilization began. Without leaving your arm chair, you enjoy the companionship of the world's most illustrious minds.

THIS LITTLE BOOK TELLS YOU HOW

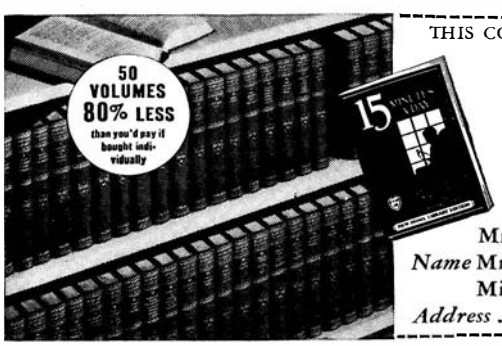
You owe it to yourself to know more about this momentous opportunity for self-advancement. Read the full description of The Harvard Classics in this fascinating little book entitled, "15 Minutes a Day."

THIS VALUABLE BOOKLET FREE!

It is yours for the asking. In it you will see how to broaden your horizon beyond the limits of your own experience—how to store your mind with the wisdom and wit of the ages—break the chains of mental inferiority that hold many men back—and step forward into the business and social position which is rightfully yours. Take the first step now by mailing this coupon before you turn another page!

DR. ELIOT'S FIVE-FOOT SHELF OF BOOKS

(THE HARVARD CLASSICS)



THIS COUPON ENTITLES YOU TO *FREE* BOOKLET

P. F. COLLIER & SON CORPORATION
250 Park Avenue, New York City

I am interested in receiving by mail, free and without obligation, your valuable booklet, "Fifteen Minutes a Day" describing the famous library, Dr. Eliot's Five-Foot Shelf of Books (The Harvard Classics) and containing Dr. Eliot's own plan of constructive reading.

998-HCR

Mr.
Name Mrs. .....
Miss
Address .....

flame-hardening process, the lathe bed is immersed in a tank of water to a point just below the ways and a motor-driven mechanism then draws the heating and quenching unit at a uniform speed over the ways. Only one pass over the bed is required. The rate of travel of the burner tips over the bed ways depends on the thickness of the bed, varying from three to six inches per minute.

Test trips corresponding to the different sections of ways are used to determine the proper burner tips, the amount of heat to be applied and the rate of travel. The depth of penetration of the hardened surface can be varied from ⅛ inch to ¼ inch and the Brinell hardness is raised from 225/240 "as-cast" up to 575/590 after this treatment.

The nickel-chromium cast iron employed in Monarch lathes, aside from its other desirable properties such as high strength, rigidity, and machinability, is admirably adapted to this unique method of heat treatment. Nickel lowers the critical range, thereby permitting hardening at a lower quenching temperature than if plain cast iron were used, and tending to "blend" the hardened surface gradually into the core, hence minimizing troubles which might result from a too sharp line of demarcation between the surface and the unhardened interior portion of the casting.—*Nickel Cast Iron News.*

Treating Dairy Wastes

BY adding a tanning agent to the waste waters from dairies, the proteins are coagulated and putrefaction is prevented. This new process is being applied in Denmark. Chrome alum and similar mineral tanning agents are used and relatively small quantities will serve the purpose. The dosage must be regulated according to the concentration and nature of the waste water. A little over an ounce of chrome alum per 100 gallons of waste water is effective.—*D. H. K.*

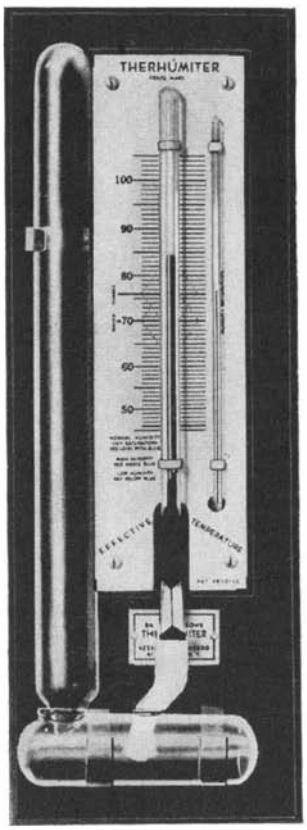
"Jitterbug" Swings Three Tons Twelve Feet in Air

"JITTERBUGS" are usually associated with "swing." That's why R. C. Howell, Cleveland engineer, decided on the name "Jitterbug" when he perfected a new type of Howell industrial truck which will swing a load up to 6000 pounds from a factory floor up to a height of nearly 12 feet, with

Mechanical "Jitterbug"

DIRECT READING EFFECTIVE TEMPERATURE "METER"

WITH the rapid expansion of air conditioning it has become increasingly necessary to determine something more than mere temperature and humidity of the air in a room. Effective temperature is more important than either, yet it is determined by a consideration of both these other factors. Effective temperature is an arbitrary index of the degree of warmth or cold felt by the human body in response to heat, humidity, and air motion.



Effective temperature read directly

Any student of physics knows that it is a simple matter to determine the percentage of humidity in any given space by taking readings of a wet bulb thermometer and a dry bulb thermometer and then, by using the two readings, finding the percentage of humidity on a large chart. This method is too indirect for all practical purposes, so the Bailey-Parsons Therhumiter has been worked out to give not only a direct reading of humidity but also the effective temperature.

The accompanying illustration shows the Therhumiter with a center column ending at the bottom in two communicating bulbs containing red spirits. The upper bulb is responsive to heat (air temperature) only, the lower bulb is responsive to relative humidity and air motion. The result is registered on the scale above as a composite value indicat-

ing effective temperature directly. Two diamond-shaped areas on the scale represent the winter and summer comfort zones with 70 degrees effective temperature the optimum for winter and 76 degrees for summer. The wick of the wet bulb is kept saturated by immersion in the lower reservoir. A uniform water level is maintained by a removable, automatic-feed reservoir standing upright at the left, with its open end inserted into the lower reservoir.

The separate, blue thermometer on the right indicates air temperatures only.

Relative humidity is quickly determined by this simple formula, engraved on the scale: Normal humidity (50 percent saturation)—Red level with Blue. High humidity—Red above Blue—50 percent plus 8 percent per degree difference. Low humidity—Red below Blue—50 percent minus 8 percent per degree difference. This formula is based on moderate air movement. In still air deduct one degree from Red before calculating relative humidity.

Electrolytic Production of Lead and Sulfur

BY electrolyzing a solution of galena (the ordinary lead-sulfide ore) in molten lead chloride, both lead and sulfur are produced simultaneously. The concentration used may be as great as 25 percent by weight of galena in the fused lead-chloride bath. Before solution, the galena is broken to relatively small sized particles, and impurities present are removed by concentration processes.—*D. H. K.*

Portable Home Electric Ironer

IN the past most women have been somewhat frightened at the numerous mechanical gadgets on a stationary type of home ironer. They have in many cases not been sufficiently interested to go through the training period necessary to get full efficiency with one of the larger ironers. Now with the Handee, developed by the Chicago Wheel and Manufacturing Company, it is claimed that even a 10-year-old girl can iron efficiently without previous experience.

But its simplicity is only one of its advantages. The Handee is portable and may be used anywhere in the house where there

Simple, portable, inexpensive

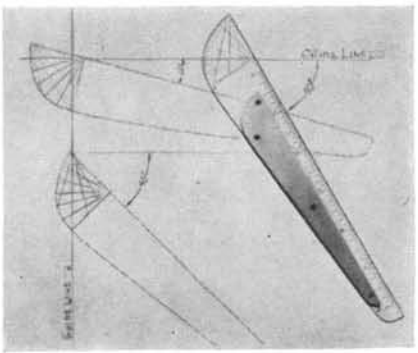
is an A.C. electric socket. A third point is its very low price—claimed by the manufacturer as being the lowest ever placed upon a quality rotary ironer.

The Handee weighs only 25 pounds. It has just two controls—a simple switch which turns on the heat and a motor control operated by the elbow so that both hands are free to handle the clothes being ironed. It will iron anything from a handkerchief to a sheet.

Pocket Drafting Instrument

A NEW pocket device known as the U-Draft pocket "drafting machine" has been put on the market by L. G. Wright, Inc. This instrument combines T-square, triangles, and drafting scales in a unique combination so that the instrument literally is a pocket-size drafting machine. It is 7½ inches long over-all and 1¼ inches wide.

The instrument consists of a graduated scale and a protractor head on which lines



Drafting instruments combined

are inscribed at 15 degree angles to the horizontal scale. The instrument is made of pyroxlin; all the scales are engine-divided. A metal stiffener, eyeleted to the pyroxlin, keeps the instrument flat.

It is possible to make with this device an accurate drawing six inches by six inches on any kind of paper. With it, angles 15 degrees apart may be drawn and all lines may be drawn accurately to length. It is supplied in four different graduations.

The tool is suitable for all types of mechanical drawings, cabinet drawings, installation diagrams, mathematical solutions, graphical calculations, floor plans, lettering, layouts, quick sketches, and dimensioning on larger drawings.

Where to Find Sunlight

"IF what you want is sunlight, live either at the North or South Pole, not at the Equator," is the advice of illumination engineers, judging from a study recently completed by Frank Benford and John F. Bock, of the General Electric Company. The poles receive 65 hours more sunlight a year than does the equator, their study reveals.

The explanation is that the earth's atmosphere refracts the sun's rays, so that the sun is visible even when it is below the horizon. At the equator this increase amounts to 40 hours a year, compared with 105 hours at the poles.

More close to home, they found that the south side of a building in New York City,

or other places in like latitude, annually receives 4½ times as much sunlight as does the north side. The north side receives 800 hours of direct sunlight each year; the south side receives 3600 hours. Effects of fog and clouds are not taken into consideration in the study, however.

FUME-LESS DRAIN-OPENER

IMPROVEMENTS resulting from extensive laboratory experimentation have been made in a widely-used chemical drain-pipe-opener for household use. According to the manufacturers, the fumes caused by the product's action are now absorbed before they emerge from the drain. Also, the action

takes place in the bottom of the trap where grease and other refuse frequently collect into a solid mass, and is not dissipated at the top of the pipe as happens with old-fashioned drain cleaners.

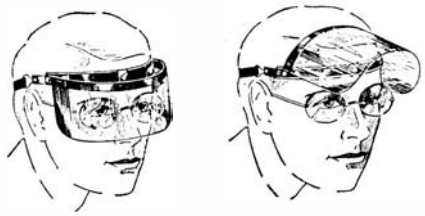
Most cases of stopped or slowed-up drains can be traced to an accumulation of greasy muck in the trap. Hair, coffee grounds, soap, garbage, lint, even scouring powders, are likely to be found in the clogging mass. This improved drain cleaner removes these substances efficiently and economically. A cup of cold water is first poured into the drain, then a little of the drain cleaner. Heat is quickly produced. At the same time, a stirring action occurs. The heat and agitation melt and loosen the hard, greasy muck, turning it into a soft mass that water easily flushes away. The amount of heat and agitation produced depend on a closely-controlled chemical formula that is the secret of the product's effectiveness.

EYE PROTECTION

SAFETY engineers, personnel directors, and production officials will be interested in a new eye protection device designed for general industrial use, having the advantages of lightness, wide range of vision, and generous ventilation.

The Jackson Type C Eyeshield consists of a flexible, transparent, non-inflammable visor obtainable in clear, smoked, light green, dark green or amber shades, adjustably hinged to a light headgear. No part of it rests on the nose or ears, making it very comfortable to wear. It does not interfere with the mechan-

ic's eye-glasses, if he wears them. Ample ventilation eliminates fogging. Hot metal rolls off this visor without marking it. This shield provides ideal protection for workmen engaged in soldering; flash, gun, and spot welding operations; for welders' helpers; for general



Eye protection that may be used either with or without eye-glasses

eye protection in industrial plants; for use in chipping operations; and in many other cases where the workman's eyes must be protected from flying particles.

A smaller eyeshield, available in the same shades, has many industrial uses and is said to be gaining popularity for sports wear and for the protection of motor car and truck drivers from sun and road glare.

Living Storage: Strange System of Honeypot Ants

THERE are ants in Central Australia which use the bodies of their fellows as a living storehouse for honey. They are among the many rare and curious specimens brought back by a well-known naturalist, Charles Barrett.

Just ordinary black ants in appearance, they yet have this unique habit of storing honey, surely among the most extraordinary of nature's many queer provisions.

How they choose the fortunate or unfortunate creature which is to spend the rest of its days inert, a mere helpless bag of sweetness, is not known. Seemingly any member of the community is eligible. Once selected, the workers bring to it their daily grains of nectar. The "honey-pots" swallow the nectar but keep it for the general use of the colony. They have two stomachs, a private and a communal one.

When a member wants nourishment it caresses the honey pot with its antennae and the living pantry passes out from its mouth a drop of the desired food.

As the body swells, the ant takes on the appearance of a shiny deep-toned cherry. Head and thorax remain unaltered, and so the insect looks ludicrously disproportioned. Aborigines call the honey ant "Yarumpa," and eat it alive as a delicacy.

Stockings Made of Castor Oil, Coal

CASTOR oil and coal appear to be the "silkworm" from which the silk stockings American women will wear tomorrow may be made. With these basic ingredients, chemists are now fashioning, in their test tubes, a viscous fluid which can be drawn into fibers that are finer and stronger than natural silk and have amazing elasticity.

While not yet ready for commercial production, chemists studying the new fibers aim at the goal of producing sheerer two-

thread stockings that will have the durability of four-thread hose.

In the posthumous patent of the brilliant du Pont chemist, Dr. Wallace Hume Carothers, just granted by the U. S. Patent Office, is revealed this strange fiber that gives promise of being silk's crucial rival in the hosiery field. The new patent's implications to a nation like Japan producing the great bulk of the world's natural silk, are not to be overlooked. When and if the chemists decide to bring the new product out of the laboratory, America, with its vast supplies of coal, will be a step nearer freedom from foreign domination of its silk requirements.

The new silk is not rayon, for its origin is not from the cellulose of growing plants like cotton or wood, but from coal and its highly important coal-tar derivatives. Coal tar has already produced thousands of organic compounds that range from perfumes which nature never knew to explosives and dyes and even to organic compounds of the human body itself, one of which is called cadaverine.

Out of sticky black tar, formed as coal is heated and its vapor caught by distillation, a long series of steps can duplicate cadaverine. It is by this completely synthetic method that Dr. Carothers prepared his material from which the silk-rivaling fibers come.

Castor oil enters into production of the new fiber because it is used to form an acid which is reacted with the cadaverine. This is sebacic acid. To make it, chemists first make a castor oil soap (just as soaps are made out of palm oil and other vegetable oils). Heating this castor oil soap with sodium hydroxide creates sebacic acid.—Copyright 1938 by *Science Service*.

NEW QUARTZ ULTRA-VIOLET LAMP

THE Hanovia Chemical and Manufacturing Company has perfected a new and more efficient lamp for producing intense ultra-violet radiations. This is a self-lighting quartz-mercury vapor arc, operating from alternating current thru a reactive transformer.

"Burner" of new ultra-violet lamp

The apparatus is small, of compact construction, inexpensive to purchase and maintain.

Measurements show an ultra-violet intensity of 6000 micro-watts of radiations of 3130 Angstrom units and shorter, at a distance of three inches. The spectrum is characteristic of the high pressure, quartz-mercury arc. The quartz "burner" is "C" shaped, the use-

ful arc being 1½ inches in length by half an inch in width. The burner can be operated in any position and is not affected by shocks or jars unless these are of sufficient intensity to fracture the quartz tube.

The "S" 100 burner, as it is termed, uses only about 100 watts of power. Tests show that after a thousand hours of service the burner still provides an average of 75 percent of initial intensity.

The new lamp also differs from the old type of mercury arc in that there are no pools of fluid mercury. Only a small amount of mercury is in the tube and this is all vaporized when the burner is in operation.

The burner envelope is made of clear fused quartz which has a far greater efficiency in transmitting ultra-violet radiations than even the best of expensive chemical glass. Quartz also does not readily exhibit the solarizing characteristics of glass. Fused quartz withstands temperatures where glass would melt. The new lamp has many commercial uses in addition to being a therapeutic source of ultra-violet radiations for home use.

Mysterious Springs—Night and First-Frost Types

IN two recent numbers this department has contained the explanations of two types of intermittent springs, the cold syphon type and the barometric type, written by the United States Weather Bureau meteorological physicist Prof. W. J. Humphreys, author of standard treatises on peculiar atmospheric and cognate phenomena. Two remaining types, night springs and first-frost springs, are explained by Prof. Humphreys as follows:

"Often in the summer time, and especially in dry weather, a weak spring in a deciduous forest runs well at night but feebly, or even not at all, between nine o'clock in the morning and sundown. This is because the ground-water at such localities, as indeed in practically all localities, has two outlets, or two ways of escape, one by seepage and vein-like drainage to springs; the other through evaporation from the myriads of leaves overhead. When evaporation is least, as it is at night, loss by seepage is at its maximum and the spring-flow greatest. When, on the other hand, evaporation is most active, that is, during the warmer daylight hours, tree leakage is largest and spring-flow least, even to complete cessation by mid-afternoon, or earlier. Such is the course and the explanation of the well known, but to few familiar, night spring. In the course of a severe drought such a spring first becomes feeble by day, then flows only at night, and finally neither by day nor at night.

"From the explanation above of night springs it is clear that anything that suddenly would shut off tree evaporation would, during a period of dry weather, as promptly strengthen, or even start afresh, many a small forest spring. Clearly, too, the thing that does just that is the first killing frost of autumn. That is why at times and places springs start up anew, and branches flow again, or stronger at least, immediately after the first heavy frost in the fall of the year; and that, too, without any precipitation to supply the goodly quantity of water where but a day before there had been little or none."

Conducted by JACOB DESCHIN

The Focal Point

MANY subjects that we run across casually when wandering in search of pictures compose themselves naturally; others offer the opportunity for good composition, but must be arranged. Two examples of such opportunities, or "settings," are illustrated here. In each case, the photographer realized that he had a good setting, but needed a focal point to move in and make the subject complete.

Figures 1 and 2 were taken from the seventh story of an apartment building one morning after the street had been washed. The subject was almost obvious, and the

Figure 1

diagonal composition of the street imperative. But it took only a little study and a disappointing shot or two to make it clear that the important thing was not to include too many persons in the picture space and this conviction finally brought the photographer to the conclusion that by far the best picture would be obtained by having but one person and that person in the focal point at the upper right-hand cross-section of the compositional "skeleton," that is, one third of the way from the top and one third from the side.

A comparative study of the two pictures makes it pretty clear which of the two is the more attractive, and the stronger both as to content and composition.

Figure 3 is a typical shot experienced by the sea-goer. Water, water, everywhere, and no relief in sight. Many such pictures are made which include a more interesting sky than that shown in Figure 3 and in some such cases the picture is wholly satisfying, but in our particular case there is, somehow,

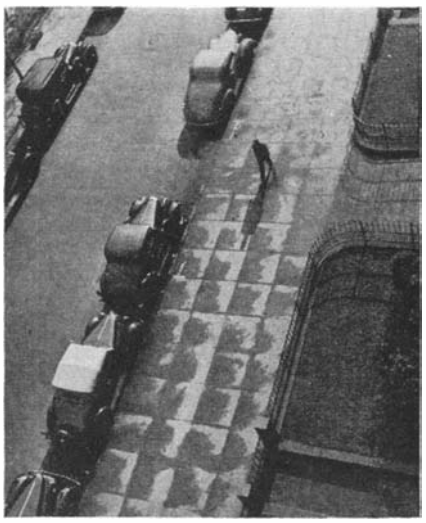


Figure 2

something lacking. We instinctively feel the need of an accent, a focal point to tie things together. Even so simple a thing as a sailboat (Figure 4) is sufficient to break into the expanse of sea and sky and bring the picture home to us.

The moral is plain. A focal point is essential, but in striving to introduce it into the picture pattern, beware of overdoing it—avoid confusion and meaninglessness. Work for simplicity, for directness. A small sailboat in the distance does not look like much in such a wide expanse as sea and sky, but see how effectively it does the trick in Figure 4. The impression of vastness and space is much more vividly portrayed in this latter picture than in Figure 3, although both pictures are the same with the single exception of the little boat.

Figure 3

Figure 4

The suggested treatments of the familiar subjects illustrated in Figures 2 and 4 may offer some clues to possible arrangements with similar "settings." The important thing to remember is that some point of emphasis must be included in order to make a picture out of a picture possibility, but that unless this point is properly arranged, through careful selection of available material, nothing is gained. To know what to leave out is just as important as to know what to leave in or to put in, and the individual judgment in such cases is very often dictated as much by instinctive feeling as by artistic perception or mere mechanical manipulation.

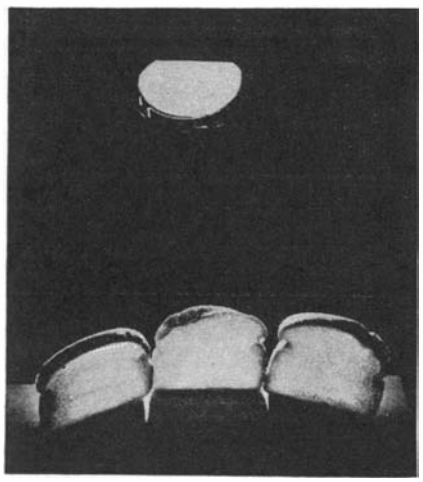
17,000,000 Camera Shooters

STATISTICS have been so rampant of late concerning the number of camera owners that it is a comfort to get the real low-down from an authoritative source, the identity of which, however, we are not at liberty to disclose.

We are informed that there are 25,000,000 cameras owned in the United States, 17,000,000 of which are in active use. This does not mean that there are 17,000,000 camera *owners*, for some own more than one camera. Camera clubs in the country total 3000. Of the cameras purchased, 40 percent are bought as gifts for friends and relatives; as to film, 80 percent is bought in drug stores, not camera stores. The leading camera type seems to be the box camera, the number of these in use being 50 percent of the total of all types. Also, 37 percent of the film consumed annually is shot in box cameras. Most pictures are made by married persons between the ages of 20 and 30; 90 percent of the exposed films are developed by commercial finishers; 50 percent of the pictures are snapped at home.

Backlighting

ONE of the illustrations shows both the illuminant—a spotlight—and the subject. Backlighting of translucent or semi-translucent subjects provides some of the most beautiful effects obtainable in photography. The most important precaution to observe is, of course, to make sure the light does not strike the camera lens directly. In the illustration, "Backlighting Method," it was possible to include both light and subject because the light source itself, the 500-watt projection bulb, was avoided by angling



"Backlighting Method"

the camera high enough for this purpose. Ordinarily, the camera is maneuvered to avoid the light altogether. Where the subject is larger than the light source, the latter can be placed directly back of the subject and the camera pointed head-on, because in that case only the light transmitted through the subject reaches the lens. A lens shade should generally be employed in this kind of work.

British Show Coming

THE complete pictorial section of the annual exhibition of the Royal Photographic Society, the last to be seen in the society's old premises in London, will be shown in New York City at the National Academy of Design. The 220 prints, nearly 60 of which represent American photographers, will be on display December 1 to 14, under the sponsorship of the Oval Table Society. The National Academy of Design will be host.

Resolving Power of Eye *vs.* Lens

BY a happy coincidence, Franklin W. Smith, of Thiells, New York, has made actual experiments, both celestial and terrestrial, on the question propounded by L.C.D. in the August Round Table; namely, whether a miniature camera could take a picture from a considerable distance and by enlarging the negative bring out a detail (such as a license number on a car) which the taker of the picture could not see with his naked eye at the time the picture was taken, assuming excellent eyesight.

"I became interested in that problem," writes Mr. Smith, "a couple of years ago and made some experiments to determine the answer. My first experiment was in the field of astronomical photography. There is a double star, Epsilon Lyrae, which is considered a good test of eyesight, being separated only by eyes possessing quite keen vision. I photographed this with a cheap miniature camera (having an *f*/3.5 lens of 50-mm focal length) by simply directing the camera toward that region of the sky at night and opening the shutter for a few minutes and allowing the star image to trail across the film. The trail obtained is very plainly double (when negative is examined under microscope). Thus, in this case the camera surpasses the eye in resolving power, but it must be admitted that it is a particularly favorable case because of the great contrast (between the sky and the sky background).

"When the trial was made on the terrestrial object it was not possible to get a satisfactory image even when just close enough to read the number with the eye. The limiting factor appeared to be the grain of the film (although I used Panatomic film and Eastman Ultra Fine Grain developer). I therefore repeated the experiment by photographing directly on glossy Azo paper (giving an appropriate exposure of a minute or so, as I recall it). I found that I could get a readable negative from the greatest distance at which I could read the number with the naked eye, *but no farther.* I repeated the experiment still using Azo paper but using a vest pocket Kodak with *f*/7.7 anastigmat lens of 83-mm focal length. With this it was possible to get better definition in the negative than with the naked eye.

"In summary, my conclusions are: Theoretically, the resolving power of a miniature camera lens should be better than that of the naked eye—in practice this is the case only when a very special object is photographed, that is, when the conditions are set up to favor the camera lens; The grain of the film rather than the defining power of the lens appears to be the limiting factor; A slight increase in focal length makes it possible to obtain the desired result."

Bad Weather?

A SUCCESSION of showers lasting several weeks recently broke many photographic hearts, but the wise ones looked for the silver lining and found it in such subjects as the one shown here. Raindrops on the window panes is one of the

"Raindrops"

charming compensations for a rainy day and is yours for the asking if you will be sure of getting the right viewpoint. In "Raindrops" it was necessary to take up a camera position that would provide a dark background for the subject. The two lower panes are the best for this reason, the highlights on the raindrops showing up brilliantly against the buildings. Notice how this effect is lost in the upper right-hand pane.

Is the Grass Really Greener?

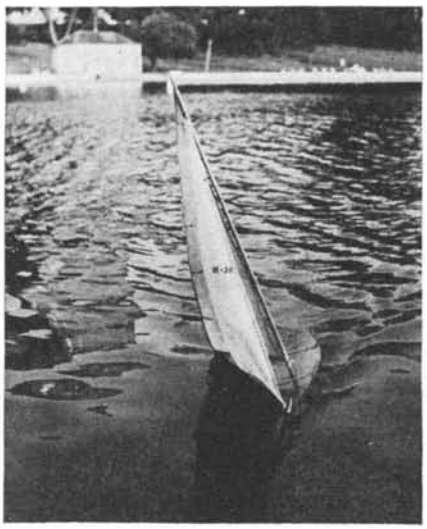
NO, says Mrs. Helene Sanders, of New York City, who, with her former teacher, Nicholas Haz, has just opened the Master School of Photography at Rockefeller Center in New York. Mrs. Sanders is one of only three women in the United States who are Fellows of the Royal Photographic Society of Great Britain.

"One need not go abroad to find wonderful material for photography," she says. "You have heard, have you not, about the artists' convention? The men from Vienna complained they had no material at home, for New York had all the skyscrapers, but the men from New York complained they were at a disadvantage because the men from Europe had all the beautiful old

buildings to photograph. The truth is, of course, that the artist will find material wherever he is—even in an ashcan, if he looks. I have lived in many parts of the world, but I have found nothing more interesting than the Catskills in the fall, when the leaves are beginning to turn, and Gloucester when the fishing smacks tie up at the old wharves. For skyscrapers and night photography, of course, no place can compare with New York."

Adventure on the Play Seas

THOUGH moving along the water entirely by grace of wind and sail, the little toy sailboats that are sent adventuring



"Homecoming"

over park lakes provide thrills for boys—and girls too—equal to anything in their play repertoire. Take your camera to the park lake some week-end afternoon and watch your chances for the graceful movement of these little giants of the play seas, for the striking resemblance some of them have in certain attitudes to the grown-up originals which these play boats attempt to imitate. "Homecoming" is an example of a shot made as the boat had almost reached shore and as it made a curving last spurt toward its destination. Close-ups of this sort will generally be found more interesting and worthwhile than shots of a group of boats.

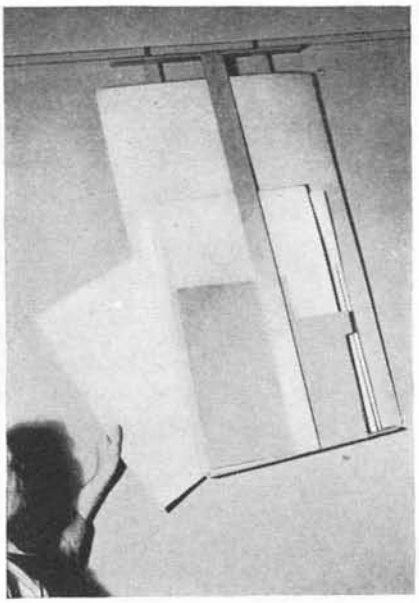
There's Many a Slip

IT was a swell subject and the lighting was just right. The vantage point was carefully chosen—the foot of the subway staircase—and through the archway above stood the skyscraper in all its sunlit glory. The photographer had the time and the subject was patient, so why not make the most of the opportunity. Try it with a yellow filter first, then with a blue filter, a green one, a red one, this exposure and that exposure. The winding key (of the automatic stop type) moved rather freely, it seemed, but then.... In the darkroom everything turned black of a sudden, and it wasn't because the light was out. The camera was empty! And all that fine shooting was just for practice. However, the photographer who confessed all this to us, took it in good spirit. He didn't get any

pictures but he had had all the fun of shooting the pictures, so that all had not been lost after all.

Storing Cardboard

ODDS and ends of cardboard for mounts and other purposes are conveniently stored in the illustrated gadget. Its construction is simplicity itself and is evident from



For storing cardboard

the illustration; two strips of wood at the back and one at the front, although more may be used if required. The device is suspended from the molding with two ordinary picture hooks. Another use for the device is the storage of large photographic blotters.

Camera and Golf

FAULTS in your golf technique show up glaringly on a photographic negative. Harry Cooper, champion golf player, soon found that out in teaching the art of golf via the camera and in a recent issue of *Zeiss Magazine* writes:

"Very frequently all the explanations in the world will not put over a particular point in teaching, but a single picture, showing the fault in the swing, will get over your point so that the pupil will try to remedy it. In this instance, seeing is certainly believing."

Table-Topping Tips

WATER effects produced by sheets of crinkled Cellophane; jockeys converted from dime store cowboy figures; prison bars made of sticks of spaghetti, painted black; effect of suspended movement obtained by laying objects on a glass-topped table and pointing the camera down at them. Asparagus tips simulate exotic growths; skinned twigs simulate blasted oaks; piece of fur strewn with sand equals grass; tapioca used for cobblestones.

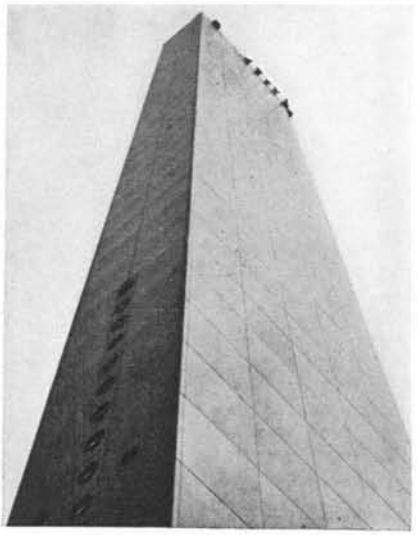
Bigger and Bigger

THE paradox of bigger pictures from smaller negatives continues to grow apace, the latest news in this vein being a Leica picture by Rudolf H. Hoffmann. The negative in question has been enlarged, in

lithographic reproduction, for service as an illustration for a roadside billboard advertisement, to seventeen thousand and a half times the area of the original negative!

Angles and Color

THIS department's recent preview around the site of the New York World's Fair presages a riot of angle shooting on the part of the droves of camera users who will invade the grounds. One of these will undoubtedly be the illumination tower reproduced here. Others will be the famous Perisphere and Trylon, which constitute the Theme Center of the exposition.



An angle on the future

Color enthusiasts are in for the time of their lives, for colors of various hues will dominate practically every feature of the Fair, both by day and by night. In fact, color pictures will be a must for the majority of shots, which in many cases will fall flat, or at least far short of the possibilities of the subjects, if "black and white" film is used.

Getting Places

"THE most wonderful feeling of all," writes Samuel E. Lesser, of New York City, "is the feeling that when I'm taking a shot I know what I am doing, know the result I'm after, know if it's possible to get that result. . . ."

Every camera user who has come a step away from the purely button-pushing, gee-I-hope-it-comes-out stage, knows what Mr. Lesser means and just how proud he must be. As a matter of fact, it seems to us that it is only when the amateur worker has reached this point that he can really begin to enjoy his hobby to the greatest extent.

WHAT'S NEW
In Photographic Equipment

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

PHOTRIX ENLARGEMENT CALCULATOR: Designed for finding required enlarging time after light from lens of enlarger has been measured with photo-electric meter.

Once emulsion speed of paper is known, calculator indicates negative density and magnification. Picture size scale up to 40 by 60 inches. Exposure time scale from 10 minutes down to 0.15 seconds. Variations in exposure time for flat or contrasty negatives indicated by lines engraved on celluloid pointer.

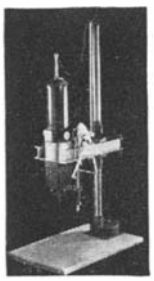
D+F Combination Developer (24-oz., $1.40; 32-oz., $1.85): Combines developer and fixing bath in single solution. Developing-fixing time 15 minutes, with occasional agitation. Enlargements 5 to 6 times linear.

Tenax 1 inch by 1 inch (with Tessar *f*/2.8, $153.; with Sonnar *f*/2, $183): Short-throw lever advances film and cocks shutter with single, instantaneous movement. Uses standard 35-mm film in Contax daylight-loading spools, cartridges, or Contax metal magazines, making 50 negatives 24 by 24 mm on single loading. Standard lens focal length 4 cm. Interchangeable with standard lens is wide angle Orthometar *f*/4.5, 2.7 cm and telephoto Sonnar *f*/4, 7.5 cm. All lenses couple with built-in rangefinder combined with large viewfinder. Lenses in bayonet mounts. Compur Rapid shutter with speeds to 1/400 second and built-in self-timer. Shutter release on top. Eveready carrying case, filters, and sunshade available. Weight, 21½ ounces. Dimensions, 2¾ by 3 by 5 inches.

Maxim Enlarging Exposure Meter ($2.95): Extinction type meter for determining exposure in enlarging. No moving parts. Sturdy construction. Movement about easel is unimpeded. Reading is direct.

Polythermic All-Temperature Negative Developer (24-oz. bottle, $1.35; 32-oz. bottle, $1.75): Features temperature flexibility and minimum grain. Maker claims for it ability to enlarge to 72 times linear with minimum of grain, great latitude and emulsion speed. Contains no paraphenylenediamine or any of its derivatives; is non-staining. One quart will develop 12 to 15 rolls of 35-mm film or equivalent.

Simmon Model D Omega Enlarger ($175 without lens): For negatives 4 by 5 and smaller. Rigid two-inch diameter steel post, 60 inches tall, long bellows and interchangeable lens board permit high-ratio enlargements: 5½ times with 5¼-inch lens (for 4 by 5 negatives), 20 times with 2-inch lens (for 35-mm negatives). Bellows maximum extension 11 inches permits pictures of reduced size; minimum draw 2 inches, allowing use of standard miniature camera lens. Dust-free negative carriers available in variety of sizes. Double condenser system, featuring special standard voltage 100-watt projection bulb, gives short exposures on slower enlarging papers. Built-in heavy-duty rheostat in cast alumin-



um housing at base of pillar controls light intensity. Dyna-Thermal ventilating system, with Bakelite lamp house, keeps negatives cool. Long 13-inch focusing lever and smooth operating mechanism provide focusing accuracy. Strong steel tape on enclosed spring reel counterbalances weight of enlarger head and duraluminum supporting beams.

KALART PRESS SPEED FLASH: A built-in mechanical synchronizer without wires and featuring automatic cushioned action; finger tip release from camera bed; combination reflector and battery case in single unit; adjustable reflector; quick-change socket; lamp ejector; three standard single-cell batteries; multiple lamp connector; remote lighting feature; two positions for reflector; weight one pound. Available for all models of Speed Graphic cameras.

KODACHROME ADAPTER FOR RECOMAR ($23.50): Consists of film chamber and ground-glass focusing panel mounted to slide on larger panel. Larger panel fits Recomar back (and backs of some other film-pack cameras) when regular ground-glass screen or film-pack adapter is removed. Picture is focused on small ground-glass panel, film chamber then slid down into position and picture snapped. Film chamber takes eight-exposure K828 Kodachrome. Adapter may be removed from camera when roll is partly exposed. Possibilities: natural size images of flowers and tiny objects, moderate close-ups, portraits, telephoto shots because of long focal length of lens when using adapter. With each adapter is included: Table of effective *f*-values of different lens apertures for various lens-to-subject distances; factors for exposure increase with greater-than-normal extensions.

AMITOL PAPER DEVELOPER (16-oz stock solution, $ .60; 24-oz. stock solution, $ .85): Maker claims will not stain print even when latter has remained in bath as long as eight minutes. For brilliant effects, dilute 1 to 1, for softer results 1 to 2. Laboratory test results in one hundred 8 by 10 prints in only 16 ounces of stock solution before exhaustion.

RAYGRAM WEIGHT-SPOON ($1): Metal hand scale for weighing chemicals. Spoon is dipped into chemical and suspended from the hand on a chain. Counter-balance built into handle is adjusted for weighing up to 10 grams.

ILFORD PLASTIKA PAPER ($1.25 dozen 8x10; $2.50 dozen 11x14): Coated with bromide emulsion of medium speed and possessing long scale, this paper is said to "match the characteristic curves of modern negative materials, reproducing accurately every gradation of the negative" and providing

roundness and modeling to the image. Especially suitable for portraiture, architecture, and landscape photography. Latitude in exposure and development. Image color black "with just a hint of warmth." Medium speed of paper allows use for either enlarging or contact printing. Available in following surfaces: Glossy single or double weight, in soft, normal, and contrasty grades; matt double weight, grained half-matt double weight, and cream semi-matt double weight in normal or contrasty grades.

OMAG RANGE FINDER ($7.50): Two large fields, one colored light yellow for easier vision, brought into coincidence by means of large knurled head at right of finder; distance then read from calibrated scale beneath hairline rule in glass window. Long focal length gives large images. Attachment fixture fitted to bottom of range finder permits slipping into standard accessory foot of most miniature cameras. Bracket for attaching finder to any camera also supplied. Outside case of finder of Bakelite with no protruding parts.

F-R DEVELOPING KITS contain all the essentials for fine-grain developing. For the ardent camera fan as well as for the newer camera user—for the stay-at-home—for the camera-toting traveller. F-R 35-MM KIT ($6.95) contains 35-mm roll-film developing tank, tank thermometer, absorbent film squeegee, 8-oz. bottle concentrated X-33, 8-oz. bottle concentrated Fixol, two spring clips. F-R ROLL-FILM KIT ($8.95), adjustable for all sizes of film up to and including 116. Contains adjustable developing tank model C, tank thermometer, absorbent film squeegee, 16-oz. bottle concentrated X-33, 16-oz. bottle concentrated Fixol, two spring clips.

FELICE HOME DARK-ROOM CABINET ($29) makes it possible to do your dark room work in any room of your home, doing it without making that room look like a shop, and when you are finished, just turning on the lights, closing two doors (safety lock) and having your work cabinet turned into a handsome piece of furniture. Cabinet is a complete photo-laboratory in itself. Handles prints up to 8 by 10 inches; equipped with two porcelain trays and a 15" diameter scientific washer and sink combined. Also has one large shelf compartment for storage of trays and squeegee plates and four large drawers equipped with label holders for paper, films, negatives and various camera accessories. A large storage compartment is also provided for chemicals and equipment.

RAYGRAM TRANSPARENCY VIEWER, WITH HOLE PUNCH ($3.25): Permits convenient selection of 35-mm strip negatives and 2 inch by 2 inch transparencies. Open gate tracks for 8-mm and 16-mm available. Can be used with any standard splicer or rewinder. Focusing eye piece adjustable to individual sight range.

CAMERA ANGLES ROUND TABLE

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

Q. **Recently, in examining the lens of my camera, I noticed small cobweb-like markings near the edges. Can you tell me the reason for this and what can be done about it?—L. E. S.**

A. These cobwebs, as you call them, are the result of the degeneration or drying up of the Canada balsam used to cement the lens elements together. These crystallizations will cause lack of sharpness in the negative and the defect must, therefore, be remedied. Take the lens to an optical company and have it re-cemented.

Q. **Is Agfa Ultra-Speed Panchromatic Film for 35-mm cameras too fast for sunlight snapshots with an Argus camera with a speed of 1/200 of a second and the smallest stop of *f*/11? What are the possibilities of taking snapshots at night with regular electric light using this film in an Argus camera?—H. Y.**

A. This film belongs in the category of the fastest films available today and is intended chiefly for use under adverse lighting conditions or where high shutter speeds are required despite fair illumination. Of course, it may and is being used for all-'round purposes, both indoors and out under various conditions of light. However, outdoors in full sunlight, it would be very easy to overexpose and this might be caused under some circumstances even at *f*/11 and 1/200 of a second. Depending on the nearness of the light to the subject as well as the light intensity, the *f*/4.5 lens on your camera would often permit moderate snapshot exposure by artificial light indoors.

Q. **(a) Using the same projection paper, and same aperture on the enlarger lens, should an enlargement of 8 diameters require 4 times the exposure of an enlargement of 4 diameters? Does the correct exposure time vary directly as the square of the magnification in diameters?**

(b) Using an enlarger lens with apertures of *f*/4.5, 5.6, 8, and 11, does each aperture require twice as much printing time as the next larger size? Is there much difference in the sharpness of focus with different aperture sizes when used for enlarging?—W. B.

A. (a) Theoretically it should, but it does not so work out in practice. The required increase in exposure is more nearly about 3 times, although the actual exposure time should be determined by test in the usual way; that is, test strip or enlarging exposure meter.

(b) The doubling of the printing exposure time for each smaller aperture is a good rough-and-ready method of finding differences in exposure at the various stops, but where best results are desired, an exposure test, as in the above case, will be needed. Inasmuch as the negative is a plane object focused on a parallel plane below (the printing paper on easel or baseboard), it is reasonable to expect that a sharp negative image can be focused sharply on the easel at the full aperture of the lens. However, a slight increase in sharpness may be noted at the smaller stops.

Q. **When using a synchronizing flash attachment on a single-lens reflex camera, I have wondered if one is dazzled by the flash when looking down into the ground glass of the camera.—Dr. R. O. R.**

A. If the flash bulb is backed up by a reflector, as it should be in order to gain the full advantage of the illumination produced, light will go forward and will not affect the photographer. As for the ground glass causing dazzle, this is not possible for two reasons. First, the mirror must go up against the ground glass before the image can reach the film, at which time the flash simultaneously operates to provide the necessary illumination; second, even if you were using a twin-lens reflex camera and viewed the image during the exposure, the briefness of the flash and the fact that what the photographer sees is the reflection of the flash from the subject rather than the flash itself, would make dazzle impossible.

Q. **Assuming that a person could time enlargements as accurately in the range of from ½ second to 1 second as he can in the range of 20 seconds to 40 seconds, would a perfectly timed print at ½ second have the same quality of a perfectly timed print at 20 seconds, the only difference being the intensity of the light; using the same film, same enlarging paper, and so on? Would it be prac-**

tical to use the shutter at, say 1/25 of a second in enlarging pictures onto a very fast enlarging paper and with strong projection light?—K. L. R.

A. Correct printing exposure time is purely a matter of the length of time—under given conditions of strength of light, distance of negative from paper on easel, density of negative, lens diaphragm opening, and contrast of paper being used; that is, the "speed" of the paper—required to produce a print of satisfactory quality. If this result is achieved at 1/25 of a second, as you suggest, or at the end of 40 seconds, we do not believe there should be any difference, all other factors being equal. Employing a shutter, which, of course, is not usually associated with enlarging lenses, "snapshot enlargements" might be fairly practical. Don't forget to turn out the enlarging light after each such exposure.

***Q.* I have been experiencing trouble in getting a background black enough to avoid reflection. What is the blackest black material available?—D. M.**

A. Black velvet is generally held by professionals to afford the blackest black background obtainable.

***Q.* I have a box camera taking No. 120 film and want to use it to make stereoscopic photos of still objects. This I plan to do by setting the camera in two slightly different positions, horizontally, and exposing two films. What I want to know is the distance to move the camera for the second exposure. I have an old stereoscopic viewer. I suppose the finished photos should be placed on a card the same distance apart as the camera was moved for the second photo. Is this correct?—G. B. A.**

A. The subject of stereophotography was discussed in general terms in the leading article of last month's Camera Angles. The method you propose for making stereos has been used with success by owners of box cameras as well as other types. Assuming that the lenses of your viewer are placed at the standard separation of 2¾ inches, the camera is moved the same distance between exposures. One method employed with box cameras is to construct a wooden tray of such dimensions as to permit this separation when the camera is shifted for the second exposure. This method will also guarantee that the shifting will be done on an absolute parallel in relation to the subject being photographed. The finished pictures, cropped, if necessary, will be transposed and separated by 2¾ inches, center to center.

***Q.* I have read that a cider vinegar solution should not be used as an acetic acid short-stop. Why not? I have been using it for several batches of prints and cannot see that it has done them any harm. I am going to try my hand at developing some 35-mm film soon. Would you advise using a more chemically pure short-stop for the film?—L. C.**

A. We hope you will pardon our candor, but we cannot quite see the point of going to the trouble of experimenting with liquids foreign to photographic practice when the real thing costs so little and has proved scientifically effective. The fact that your prints do not appear to have suffered from the cider vinegar short-stop bath is probably due to the brief period in which they were immersed in this bath prior to being treated to the regular acid fixing solution. The advice you have read against cider vinegar was prompted by the fact that this solution is much too dilute for the purpose and would tend to stain prints immersed in it. As for using such a solution in a short-stop bath while processing 35-mm film we must, once more in candor, throw up our hands in alarm. The processing of 35-mm film requires the greatest care and the use of chemically pure ingredients for acceptable results. Why take chances?

***Q.* Can you tell me if it is difficult to use the x x x camera (single lens reflex type) with the diaphragm stopped down to *f*/11?—A. J. K.**

A. When you speak of the usefulness of the x x x camera at *f*/11, we presume you are referring to the visibility of the ground-glass image at that stop. This depends, of course, on the general light conditions illuminating the subject at the time of taking the photograph. In bright sunlight outdoors and under certain favorable conditions of artificial lighting indoors, it is quite possible easily to focus on the ground glass at this opening.

***Q.* What is meant by film latitude?—D. K.**

A. This is the degree of error permissible in exposure without seriously affecting the chances of printable negatives. Modern films are said to have great latitude because they may be very much under-exposed or very much over-exposed and yet produce upon development sufficient density in shadow detail to make possible prints of satisfactory quality.

***Q.* When I take a picture I wind the shutter up for the next one. If I do not take a picture for a month or two would it do any harm to have the shutter wound up for so long without using it or would it be better after taking a picture not to turn for the next exposure until just before using?—H. V. K.**

A. The best procedure is to leave the shutter unwound when completing a picture-taking session. Otherwise, the shutter is working "over-time" and to no purpose. However, where you are making a series of exposures at relatively short intervals and particularly in the case of action photography where you must be ready to shoot at a moment's notice, it would be more convenient to wind the shutter after each exposure so as to be ready to shoot again quickly.

***Q.* Is there any remedy for water-spot marks on dried negatives?—L. J. K.**

A. The best remedy is, of course, the precautionary one of wiping the negatives clear of excess water before setting up to dry and then allowing the negatives to dry gradually in a warm atmosphere but without undue subjection to heat. However, water marks on dry negatives happen in the best of families and when they do, one remedy that has been used successfully calls for bleaching and redevelopment. The bleaching is done in a solution consisting of one gram of potassium dichromate, 100 cc. of water, and 2 cc. hydrochloric acid. After bleaching in this solution, re-develop the negatives in an elon-hydroquinone developer.

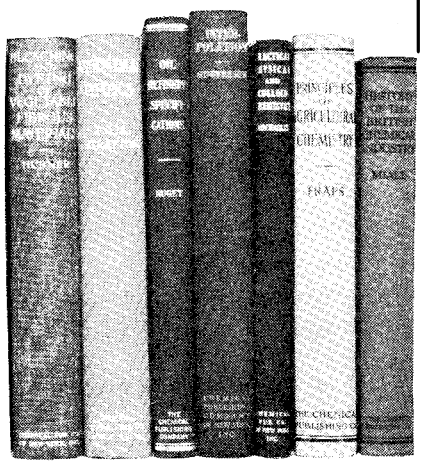
Christmas Bargains—

TECHNICAL BOOKS

for

Chemists, Engineers, Physicists, Metallurgists, Students.

Savings Up To 75%



BUILD YOUR TECHNICAL LIBRARY
GIVE BOOKS TO TECHNICAL FRIENDS

TITLE	*Publisher's Original Price*	OUR SPECIAL PRICE
Areas & Volumes, *Ferguson & Lizst*	$1.60	**$ .75**
Astronomical Physics, *Stratton*	4.00	**1.50**
Agricultural Chemistry, *Fraps*	5.00	**2.00**
Astronomy Today, *Moreux*	3.15	**1.00**
Atomic Theory, *Graetz*	3.50	**1.75**
Blacksmithing & Forging, *I. C. S.*	6.50	**1.25**
Beet Sugar Making, *Nikaido*	3.50	**1.75**
Bituminous Substances, *Spielman*	6.00	**2.00**
Brickwork, Terra Cotta, Concrete, *I. C. S.*	6.50	**1.25**
Beryllium, *Parsons*	4.00	**2.00**
Benzene Derivatives, Synthesis of, *Bate*	6.00	**3.00**
Carbonization, Low Temperature, *Gentry*	7.50	**1.50**
Chemistry of the Saccharides, *Pringsheim*	3.00	**1.50**
Chemist's Pocket Manual, *Meade*	5.00	**2.00**
Chromium, by Aid of Electric Current, *Leblanc*	1.50	**.75**
Cleaning and Dyeing of Rayon, *Foster*	3.00	**1.50**
College Geology, Vol. I, *Chamberlain*	3.00	**1.50**
Colloid Chemistry, Practical, *Ostwald*	2.25	**1.50**
Commercial Law, Principles of, *I. C. S.*	6.50	**1.25**
Concrete Design, *I. C. S.*	6.50	**1.25**
Crystals and Fine Structure of Matter, *Rinne*	3.75	**1.00**
Cyanimid, *Pranke*	1.50	**.75**
Chemistry in the Home, *Firth*	2.00	**1.25**
Chemical Analysis of X-Ray, *Von Hevesy*	3.00	**1.50**
Chemistry of Chemotherapy, *Dyson*	13.00	**4.00**
Cyaniding Copper, Zinc, *I. C. S.*	6.50	**1.25**
Colloidal Chemistry, New Conceptions, *Freundlich*	2.00	**1.00**
Coal Tar Dyes (Digest of Patents), *Doyle*	20.00	**8.00**
Chemical Engineering, *Hart*	4.00	**2.00**
Colloid Chemistry, *Hatschek*	3.50	**1.75**
Conductivity of Liquids, *Tower*	2.00	**1.00**
Diesel Operating Guide (1936), *Rosbloom*	5.00	**2.50**
Einstein's Gravitation, *Freundlich*	2.50	**.75**
Enzymes, *Waksman*	5.50	**2.50**
Elementary Chemistry, *Sutcliffe*	1.40	**.75**
Electrolytic Labs, *Nissenson*	1.50	**.75**
Electric Furnace, *Moissan*	3.50	**1.25**
Elements of Economic Geology, *Gregory*	3.25	**1.60**
Electric Measuring Instruments, *Bolton*	4.00	**1.75**
Electrolysis of Water, *Engelhardt*	1.50	**.75**
Electrical Engineering Testing, *Parr*	3.00	**1.50**
Freezing Point, Boiling Point, *Jones*	1.25	**.75**
Food Intoxicants, *I. C. S.*	2.50	**1.50**
First Year Practical Chem, *Briggs*	1.00	**.50**
Glues & Glue Handling, *Teesdale*	3.00	**1.50**
Heat Theorem, The New, *Nernst*	3.50	**1.00**
Human Body, *Martin*	4.00	**1.50**
Hygiene, Practical, *Bergey*	1.50	**.75**
Industrial Furnace Technique, *Hermansen*	10.00	**3.00**
Interpolation, *Steffensen*	8.00	**2.00**
Inorganic Qualitative Chemical Analysis, *Day*	2.75	**1.00**
Iron & Steel Work Chemists, *Heess*	1.25	**.60**
Inorganic Chemistry, *Howe*	2.00	**1.00**
Kiln Drying, Practical, *Kettle*	$3.00	**$1.50**
Lead-Electro-Metallurgy, *I. C. S.*	6.50	**1.25**
Leather Manufacture, *Wilson*	7.50	**2.50**
Line Charts for Engineers, *Rose*	3.00	**1.00**
Lubricants, American, *Lockhart*	4.00	**2.00**
Magnetism & Atomic Structure, *Stoner*	4.00	**2.00**
Metallic Objects, Electrolytically, *Pfanhauser*	1.50	**.75**
Metallurgy, *Wysor*	6.00	**3.00**
Metric System for Engineers, *Clapham*	5.00	**1.50**
Milk, The Perfect Food, *Godbole*	2.50	**1.25**
Modern Biology, *Cunningham*	3.00	**1.00**
Modern Magnetics, *Auerbach*	5.00	**2.00**
Metallography, Structural, *Pulsifer*	5.00	**2.00**
Machine Shop Practice, *Brooke*	2.00	**1.25**
Natural Terpenes, *Baker & Anderson*	2.50	**1.25**
Nitroglycerine & Nitroglycerine Explosives, *Naoum*	7.50	**2.50**
Non Metallic Mineral Products, *Bayley*	4.00	**2.00**
Optical Activity & High Temp. Meas., *Jaeger*	2.50	**1.00**
Oil Refinery Specifications, *Nugey*	3.50	**1.50**
Optics, Principles of Physical, *Mach*	5.00	**1.50**
Parachor & Valency, *Sugden*	4.00	**2.00**
Physical Chemical Evolution, *Guye*	2.50	**1.00**
Physical Chemistry, Exp., *Van Klooster*	3.50	**1.00**
Physical & Colloid Chemistry, *Michaelis*	2.00	**1.00**
Planning for Good Acoustics, *Bagenal & Wood*	6.75	**2.00**
Plumbing Design, *Nugey*	6.00	**2.50**
Pulverized Colloidal Fuels, *Dunn*	10.00	**3.00**
Physico-Chemical Metamorphosis, *Cohen*	2.00	**1.00**
Practical Physical Chem., *Fajans*	5.00	**2.50**
Quantitative Analysis, *Bassett*	4.00	**2.00**
Qualitative Analysis, *Mason*	1.00	**.50**
Qualitative Chem. Analysis, *Hinds*	2.50	**1.25**
Reinforced Concrete in Europe, *Colby*	3.50	**1.00**
Rayon Dyeing & Finishing, *Hathorne*	3.00	**1.50**
Sales Technique, *I. C. S.*	6.50	**1.50**
Science, Leading & Misleading, *Lynch*	2.50	**1.50**
Soil Solution, *Cameron*	2.00	**.75**
Sparking of Steel, *Pitios-Gat*	2.00	**.85**
Sulphur in Iron & Steel, *Pulsifer*	2.50	**1.00**
Synthetic Rubber, *Schotz*	6.00	**3.00**
Sanitary Entomology, *Pierce*	10.00	**3.00**
Sheet Metal Work & Piping, *I. C. S.*	6.50	**1.25**
Salesmanship, Fundamentals of, *I. C. S.*	6.50	**1.25**
Soil Bacteriology, *Burgess*	1.25	**.60**
Soil Fertility, *Halligan*	4.00	**1.50**
Tanning Materials, *Harvey*	6.00	**1.50**
Theory of Brownian Movement, *Einstein*	1.75	**.75**
Theory of Relativity, *Freundlich*	2.00	**.75**
Thermionic Phenomena, *Bloch*	2.50	**1.25**
Waterworks Practice, Modern, *Taylor*	5.00	**2.50**
Wood, Lumber & Timber, *Hayward*	10.00	**3.00**
Wave Mechanics of the Electrons, *Thompson*	2.50	**1.25**

(To above prices add 20c for postage for the first book, 10c for each additional book. For foreign countries add 35c for the first book and 35c for each additional book.)

QUANTITIES LIMITED—ACT QUICKLY

There will be no reprints of these. When the last copy is sold, there will be no more!

For sale by

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

INTELLECTUAL UNREST

IN A CONTENTED HOME

Our average social contacts, psychologists say, are paralyzing our intellects. Small talk and platitudes surround us; lively, constructive discussions are rare. Friends close their minds to suggestion and opinion, and we in turn withdraw into our shells, yearning for the sort of bristling intellectual stimulant we all knew in school.

TOO CONTENTED?

The driving forces of our personalities react to keep our contented lives from being *deadeningly* contented. We turn, in the quiet comfort of an armchair at home, to rediscover the constructive joys of magazine reading. Magazines of superior quality such as SCIENTIFIC AMERICAN widen our homes into a world scene, broad and informed.

NOT YOU!

Too much content is not stifling *you*, or you would not be reading this magazine, and longing to satisfy that inner thirst for knowledge and mental excitement. We want you to continue the stimulating and thought-provoking reading of SCIENTIFIC AMERICAN but we suggest that you supplement it with equally worthwhile periodicals. To help you do this, we have arranged special combination prices, whereby you can get a subscription to this magazine along with others of similar high standards—at excellent cash savings.

You may also order any of the following magazines at the special prices given providing two or more magazines are ordered at the same time. Magazines marked thus (*) do not have any combination rates, but may be ordered at the full prices shown.

American Boy	$1.50
American Girl	1.40
American Hairdresser	3.00
American Home	1.00
*American Magazine	2.50
American Mercury	3.00
Asia	3.75
Atlantic Monthly	3.75
Better Homes & Gardens	.85
*Boys' Life	1.00
Child Life	2.25
Children's Activities	2.75
Christian Herald	1.75
*Collier's Weekly	2.00
*Coronet	4.00
*Cosmopolitan	2.50
Country Life	5.00
Current History	2.75
*Esquire	5.00
Etude	1.75
Field & Stream	1.50
Forbes	5.00
Foreign Affairs	4.75
*Fortune	10.00
Forum	3.75
*Good Housekeeping	2.50
*Harper's Bazaar	5.00
Harper's Magazine	3.75
*House & Garden	3.00
*House Beautiful	3.00
Hygeia	2.50
*Ken	5.50
*Ladies' Home Journal	1.00
Liberty	2.00
*Life	4.50
Look	2.00
Magazine Digest	2.50
McCall's	1.00
Nation	4.75
National Geographic	3.50
Nature	2.75
New Republic	4.50
*Newsweek	4.00
*New Yorker	5.00
North American Review	4.00
Outdoor Life	1.35
Parents' Magazine	1.75
Photoplay	2.50
Physical Culture	2.50
*Pictorial Review	1.00
Popular Mechanics	2.25
Popular Science	1.35
Reader's Digest	3.00
Redbook	2.25
St. Nicholas	2.85
*Saturday Evening Post	2.00
Scientific American	3.75
Scribner's	2.50
Spur	4.00
*Time	5.00
True Story	1.50
*Vogue	5.00
*Woman's Home Companion	1.00
Yale Review	2.75

SCIENTIFIC AMERICAN	Special Price	You Save
with American Mercury	$6.75	$ .25
with Current History	5.00	2.00
with Forum	7.50	.50
with Foreign Affairs	8.50	.50
with Harper's Magazine	7.50	.50
with Magazine Digest	6.25	.75
with Saturday Review of Literature	6.75	.75

Your unexpired subscriptions can be extended to take advantage of these rates. The magazines may be sent to different addresses if you choose, and FREE announcement cards will be sent to recipients announcing any gift subscriptions.

MAIL THE COUPON PROMPTLY

(U. S. prices given—rates to foreign addresses on request.)

The Mayfair Agency, a division of Harper & Brothers, Publishers
51 East Thirty-Third Street, New York City

Please send these magazines for one year .....

.....

.....

☐ I am enclosing check. ☐ Send me your bill.

Name .....

Address .....

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

GLASS in several aspects pertinent to its use in telescoptics is the subject of this month's discussion, in the course of which we shall sweep up comments from several scientific journals not ordinarily seen by most readers.

ALL is not optical glass that glisters, but on the other hand not all that is not optical glass is contemptible. In a paper published in the *Journal of the Optical Society of America*, Vol. 28, No. 1, Dr. W. B. Rayton, of the scientific staff (lens designer) of the Bausch and Lomb Optical Co., makes some pertinent observations about this question:

"A Committee of this society spent many hours of discussion and carried out an extended correspondence in an effort to formulate a definition of optical glass without conspicuous success. Presumably such a definition should permit one to determine by inspection whether a sample piece of glass is optical glass or not. A definition in that sense is impossible. Certain specimens might be broken out of electric insulators that might, if judged only on a quality basis, be classed as the finest optical glass while other specimens of glass, very difficult to produce at all because of the extraordinary optical properties prescribed, would be immediately classed as ordinary glass of poor grade.

"In the consumer's mind, bubbles in glass are very offensive although from the optical standpoint they are the most harmless thing in the world. Bubbles are due to the volatilization of some of the materials in the batch in the melting process and because of greater viscosity they are held by some glasses much more tenaciously than by others. The manufacturer would like to take advantage of the more desirable optical properties of these glasses many times when he is compelled to use a less desirable glass because it is free of bubbles. Because of the refusal of the consuming public to accept bubbles in glass, he pays more for optical instruments than would otherwise be necessary and sometimes has to accept inferior performance.

"The best glass today absorbs not more than four to six tenths of a percent per centimeter except in the dense barium crowns and the densest flint glasses.

"Regarding the development of a sort of metallic luster generally known as tarnish: H. Dennis Taylor discovered to his surprise years ago that tarnished surfaces had a greater light transmission and a lower Fresnel reflection than clean, freshly-polished surfaces. Except for the appearance, then, which creates uneasiness in the mind of the owner or sales resistance in the prospective purchaser, this effect is not serious."

IN the same number (an optical glass number) of the journal named, George W. Morey, of the Geophysical Laboratory, Carnegie Institution of Washington, an optical glass expert, makes this statement: "Ordinary window glass today is of better quality than some pre-war optical glass, chiefly because of the reduction in iron content of the sand."

Incidentally, in the same article he mentions an interesting list: "Besides the eight disks supplementary to the 200-inch, all of which are of 'ribbed' structure, and one of which, the 120″ flat, is larger than any disk previously made, there have been made in Corning seven solid type disks for reflecting telescopes. These are: a 24″ for Cornell University; a 30″ and a 36″ for the Foundation for Astrophysical Research; a 60″ for Harvard University; a 76″ for the University of Toronto; an 81″ for McDonald Observatory, Texas; and a 98″ for the University of Michigan."

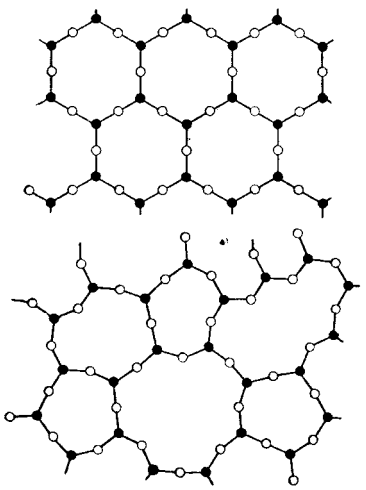


Figure 1: **Crystal versus glass form**

CONTINUING our gleanings on glass from recent technical papers, we take the following from an article on the X-ray determination of the structure of liquids and glass, by Dr. B. E. Warren, a Massachusetts Institute of Technology physicist who specializes in the X-ray study of the arrangement of the atoms and molecules of matter, published in the *Journal of Applied Physics*, Vol. 8, No. 10:

"Glass is usually called an under cooled liquid, the name suggesting that, although it has many of the mechanical properties of a true solid, it differs from the crystalline form of matter by not having passed through a sharp or definite transition in solidifying from the melt. From the X-ray studies we shall conclude that glass and liquids are similar in that both are amorphous forms of matter. In one respect, however, their structures differ; in a glass each atom has permanent neighbors at a fairly definite distance, while in a liquid the neighbors about any atom are continually changing."

HOW the atoms are arranged in matter has been fairly well worked out within recent years by X-ray analysis. This is not to be confused with ordinary X raying but consists of using X rays as "feelers" for the atoms. X rays are light having about 1/10,000 the wavelength of the light which our eyes perceive. Thus they get down into the realm of actual atom size. If light of this short wavelength is shot into matter, a part of it will be reflected from or diffracted by individual atoms and the emerging rays can be photographed. (The rays which pass on through in the commonplace X-ray manner are ignored.) If the atoms are arranged in a pattern, as in crystals, the photograph taken proves also to exhibit a systematic pattern. By means of this research tool physicists during the past few years have been able to ascertain at least as much concerning the atomic arrangement within matter as a blindfolded man could determine about the arrangement of objects in a box by feeling around within it—almost as much as if it were directly visible. In fact, the extent to which this technique has been developed and the complication of existing atomic arrangements revealed by it are remarkable. For most practical purposes, then, we can now "see" the atoms in matter as satisfactorily as we can see the rows and cross rows of trees in an orchard (though we cannot see individual atoms). And it has turned out that most common things are crystalline: wood, for example—even rubber!

But glass is an exception—it is amorphous. Before the X-ray technique was devised we were partly sure that glass was amorphous but could not prove it so directly as now. And in the *Technology Review* (Vol. 39, No. 6), edited at the Massachusetts Institute of Technology, Philip M. Morse shows what glass is like. Largely, he also points out, it has been the same Professor Warren, quoted some distance above, who has done research on the X-ray patterns and atomic arrangement of amorphous materials including glass. In these the regularity and symmetry of atoms existing in crystals are absent. However, the atoms remain about uniform distance apart, and Figure 1, reproduced from the review named, gives an idea of the difference in atomic arrangement of the same substance (B_2O_3 is the example chosen), first in its crystalline form (above) and then when turned into borate glass (below). "A glass," Prof. Morse says, "is a clumsy caricature of a crystal of the same material, distorted and with parts left out here and there."

COGNATE with all this is the fact, recently discovered by the same X-ray diffraction method, that even liquids, including water, have some orderliness of atomic arrangement. Debye, the German chemist, states as a result of his researches that liquids are much more closely related to solids than they are to gases.

JUST what happens when glass is polished? This is discussed in "ATM," pages 326-331, but since that note was written considerably more experiment has been performed and the subject has waxed in interest among physicists—particularly because we now have the X-ray method described above.

Let us first summarize the several com-

peting theories of the nature of polishing.

First, the theory of Newton and the younger Herschel: Polishing is nothing more than grinding or submicroscopically scratching down the protuberances with smaller and smaller abrasives until, as Newton put it, the visible "scratches and frettings of the surface become too small to be visible." Thus there is no essential difference between grinding and polishing. A theory of Elihu Thomson's, described in "ATM," page 328, is a relative of this one: the rouge particles embed themselves in the pitch, their cutting edges coming automatically to a common level, and make submicroscopic scratches. (Perhaps this explanation makes more appeal to the common sense than any other, but more recent evidence indicates that Theory 3, below, is closer to actual fact.)

Second, Rayleigh's theory that the operation is a molecular one. No pits are formed, as in grinding with hard surface against hard, by the breaking out of fragments, but the material is worn away, at first on the eminences, almost molecularly. The microscope shows that, as soon as the polished local areas can be observed at all, they appear absolutely structureless. In its subsequent action the polishing tool extends the boundaries of these parts but does not enhance their quality (paraphrased from Rayleigh, *Trans. Opt. Soc.*, Oct., 1917).

Third, the "butter" theory of Beilby, whose experiments threw an entirely fresh light on the nature of polish. He demonstrated smearing or flowing of the surface layer. Polishing at right angles to scratches caused a flowing that filled up and hid the scratches. Etched with hydrofluoric acid, the polished surface again revealed these scratches.

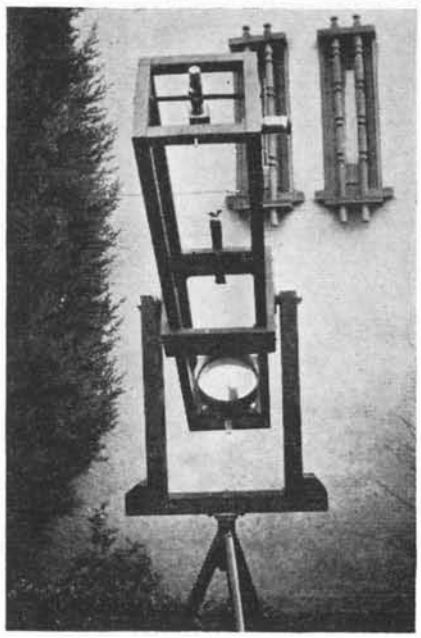
"The rouge particles hardly penetrate below the surface," Beilby states, "but, coming into almost molecular contact with the sheet of molecules on the surface, drag it off like a skin. The fresh molecular layer left by the removal of the skin retains its mobility for an instant, and, before solidification, is smoothed over by the action of surface tension, thus producing the liquid-like surface which is the necessary condition of a perfect polish."

Commenting on this, Selby says: "In many respects glass is a liquid of extremely high viscosity—not a solid. Energy expended in polishing is manifested by heat which is sufficient to lower the viscosity of the glass near the surface to such a degree that this hyperthin film—'beta layer'—can be made to flow." While heat is not a factor in the theories of Beilby or of French, it is in those of Macaulay of the Royal Technical College at Glasgow, also of Bowden and Hughes of Cambridge University. The latter two made experiments using two different metals as a thermo-couple and showed that in their sliding contact the surface temperature may be very high; in glass it would be still higher. (Letter from A. W. Everest: "I am beginning to lean toward plastic flow in polishing. I read an excellent paper pointing out the high temperatures generated in polishing—high enough in a thin layer of glass at the surface actually to melt it. If this is true, then of course plastic flow occurs. However, I still feel that most of the glass is *removed*.")

H. H. Selby, author of the chapter on flat making, in "ATMA" and a chemist, next describes his own experiments:

"Glass and light have one thing in common—dual personality. Only by assuming

THE BEGINNER'S CORNER



BETTER than to attempt to work out a perfect design for the beginner's first telescope is the alternative method of building something quite plain and simple, using it for a few weeks and then, in the light of that experience, working out something more permanent for the same optical parts. The tyro may rest assured that the two telescopes will differ considerably. Ideas that work well on paper will give way to ideas that work well in practice.

The simple mounting shown at the left above was made of wood, an easy material to work, by L. R. Pinson, 1746 S. Mansfield St., Los Angeles, Calif. The mirror is 6½" in diameter and, with the eyepiece seen protruding at the right, the telescope magnifies 60 diameters.

The mounting of the other telescope shown

is an improvisation from an old lawnmower, some blocks of wood and standard pipe fittings. Not so simple as the other, it still is simple. The main axis is placed parallel with the axis of the earth, making of the telescope an equatorial type, as explained in the handbook of the hobby, "Amateur Telescope Making." A handscrew on the jackshaft at bottom permits a star to be slowly followed as the earth turns. The internal gear of the mower wheel was made use of for this purpose. The maker is the Rev. Harold F. Palmer, of the Immaculate Conception Church, Goliad, Texas. Father Palmer writes:

"About four months ago I accidentally picked up a copy of Scientific American and read your department, 'Telescoptics'. It was a revelation to me. Always interested in astronomy, I long ago gave up hope of ever having a telescope of my own. I bought a 6" kit of materials and after some three weeks (about 50 hours actual labor), I constructed this telescope. But the picture shows only the outside. Inside are to be seen the rings of Saturn, and many others among the beautiful sights in the sky.

"I cannot say that I experienced any special difficulty in grinding and polishing the mirror. It gives what to me seems excellent definition. But I shall not rest satisfied until I have constructed a 12", with accurate slow motion and setting circles."

TELESCOPTICS

(Continued from preceding page)

that light is both corpuscular and undulatory can some optical phenomena be explained. So, in a way, must glass be considered to be in some respects solid, in others, liquid.

"For years, the several theories of polish have had their advocates, who have been engaged among themselves in acrimonious polemics and contradictory experiment. A year or so ago, the Lowers and the writer did all but take to poniard and rapier over the matter. The Lowers discounted the beta film (butter) theory of Beilby and of French and the abrasion theory of Rayleigh, but held to the planing, or imbedded particle, idea. The writer clung piteously to a combination of planing and surface flow as best describing the polishing of glass. As practical evidence, the Lowers offered the observation that the polishing liquor became less red and more white as polishing proceeded, claiming that the color change was due to removal of glass from the surface and suspension in the liquor.

"In an attempt to test this assumption, an *f*/1 sphere was polished face up for 14 hours with a pitch lap and all the rouge liquor was saved for chemical analysis. If the Lowers were right, the solids suspended in the liquor should be quite high in silica (SiO_2), since the glass used was a mixture of the oxides of sodium, calcium and silicon. If, however, the writer's contention that the color change was due to emulsification of pitch constituents was correct, very little SiO_2 would be found.

"884 ml. (approximately 1 qt.) of liquor was evaporated to constant weight at 105° C. Thus, the water, turpentine, and other volatiles were removed. The residue weighed 47.408 gm. This was ignited to constant weight at 850° C. to remove the gums, resinates, etc., of pitch. This second residue was 44.971 gm.—a loss of 2.437 gm. A 5-gm. aliquot was then treated with hydrochloric acid, as in the usual SiO_2 determinations, and the treatments continued until the washings were free from iron. (The washings removed were examined nephelometrically and found free from colloidal SiO_2.) The residue of silica, ignited, weighed but 0.0174 gm. over and above the SiO_2 found in pure pitch (.0011 gm.), acid (.0003 gm.), rouge (.0066 gm.) and water (.0000 gm.), run as controls.

"The above results indicated that the rouge liquor was not whitened by glass, for an equivalent amount of SiO_2, as glass dissolved in alkali and precipitated by acid, had no effect, nor did ten times that amount, as silica gel, silex, diatomite or tripoli. However, this experiment helped very little in elucidating the question of the theory of polish, since it merely indicated, nay, proved, that some glass was *removed*—it did not show that no flow occurred.

"Another experiment was undertaken, therefore, to shed some light on the flow question, for the writer has reason to consider glass as a supersaturated solution of normally crystalline silicates which cannot crystallize due to the very high viscosity of the solu-

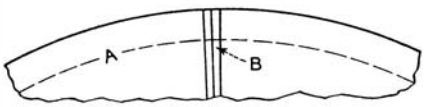


Figure 2: Selby's experiment

tion. (On a scale in which water=1, some glasses, even melting, would run to a viscosity of 10,000,000.)

"A 15 cm. flat, 23 mm. thick, was very finely marked with radial grooves 4 cm. long, using a tungsten carbide pencil (Figure 2). The grooves were made in a lathe chuck, in triplicate, by drawing the spring-loaded pencil outward between guides, using kerosene as a lubricant. After many trials, smooth grooves were cut, the depth of which could be measured along the circle *A*, using the fine adjustment of the microscope, which could be read to 0.001 mm. Also, the thickness of the disk could be measured at *B*, using a micrometer calipers graduated to 0.01 mm. and readable to 0.001 mm.

"It was assumed that surface flow would be proved if a series of grooves of a given depth could be obliterated before the disk thickness had been decreased by a similar amount. Such proved to be the case.

"A typical pair of cases follows: (Each measurement was repeated ten times, 24 hours after last polishing period, at a constant temperature $\pm 1^{\circ}$C. and the average value reported.)

A. Hard pitch, 5% rouge suspension, 2 meters per min. Pressure, 0.3 Kg./sq.cm. Each wet dried.

3 grooves, av. depth 0.023 mm. obliterated in 22 wets. Thickness change 0.008 mm.

B. Hard pitch, 15% rouge, 2 M./min., 0.02 Kg/sq.cm., no wets dried.

0.011 mm. grooves obliterated in 60 wets. Thickness change 0.007 mm.

"The above trials, among many others, were repeated three times, with results of the same order of magnitude.

"The writer draws the following conclusions:

1. Surface flow does occur during pitch-polishing.
2. Glass is, at the same time, planed away.
3. Under the usual conditions of figuring (low pressure and thick rouge mixture) planing predominates, almost to the exclusion of flow.
4. Under rough and rapid polishing conditions, surface flow is marked and performs the major part of the polishing."

ON reading much of the literature about polish one conclusion becomes evident: an oversimplified answer will never do.

CURRENT BULLETIN BRIEFS

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

PICTURE WRITING OF TEXAS INDIANS, by A. T. Jackson, field archeologist, is a collection of pictographs, with discussion. *University Publications, The University of Texas, Austin, Texas.—Gratis.*

THE ITINERANT PHOTOGRAPHER, by George H. Chappell, is a 32-page pocket-size book that outlines briefly but concisely the business of making money with a camera, while at the same time enjoying the fruits of travel. Business methods, equipment, various phases of activity—all are covered in straight-forward manner. Order direct from *George H. Chappell, Schoenig and Company, Inc., 8 East 42nd Street, New York City.—Regularly 50 cents. Special to Scientific American readers, 25 cents.*

SOIL MECHANICS APPLIED TO HIGHWAY ENGINEERING IN OHIO summarizes the history and procedure of this work, from the efforts of pioneers down to present practice. Purposes, importance, and methods of investigation and treatment are discussed. Essentially this bulletin is a manual for highway engineers and those who are particularly interested in better highways. Bulletin 99. *Engineering Experiment Station, Ohio State University, Columbus, Ohio.—50 cents.*

BOULDER DAM POWER is a pictorial presentation of facts and figures regarding Boulder Dam and its equipment, with particular emphasis on the electrical generators and power distribution apparatus. *General Cable Corporation, 420 Lexington Avenue, New York City.—Gratis, as long as limited supply lasts.*

SYNCHRO-SUNLIGHT PHOTOGRAPHY WITH KALART is a small folder which describes some of the advantages which the amateur photographer can obtain by the use of photoflash bulbs for outdoor photography. *The Kalart Company, 915 Broadway, New York City.—Gratis.*

RADIO WORLD-TIME INDICATOR GADGET is a circular "slide-rule" type of device which shows at a quick glance the exact time for any radio program or news event in any part of the world. Readings are given for standard, daylight-saving, or Greenwich mean time. The device also indicates the number of hours difference between any two given cities. Printed in colors, 5 by 7 inches in size. *Radio & Technical Publishing Co., 45 Astor Place, Dept. 35, New York City.—50 cents. Illustrated circular free upon request.*

AMERICAN HARDWOODS AND THEIR USES is a 76-page pamphlet designed to present interesting facts and practical knowledge regarding American woods. Describes means of identification and the principal uses, properties, and grades of woods; reviews the hardwood industry as well as domestic and export trade. Trade Promotion Series No. 178, U. S. Department of Commerce. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

HOW TO USE FILTERS, by Karl A. Barleben, Jr., F.R.P.S., is a comprehensive discussion of current filter knowledge and a reliable guide for both the novice and the advanced photographic worker. Contains practical information on all types of filters, some of them not generally familiar, and includes such helpful subjects as the care of filters, the use of the lens shade, filter factors and other useful filter data. Filter types discussed include gelatin, cemented, solid glass, monotone, U. F., yellow, green, red, and special-effect filters. *H & K Publications, Stamford, Conn.—75 cents.*

THE 75TH ANNIVERSARY NUMBER OF "THE ARMY AND NAVY JOURNAL" is an outstanding anniversary issue of 130 pages. It contains about 75 articles on every phase of Army, Navy, and Air Corps work, construction, status, and history. *Army and Navy Journal, 1701 Connecticut Avenue, N. W., Washington, D. C.—$2.00.*

MT-SCOPE describes equipment for geophysical prospecting, designed to locate buried treasure and metals at varying depths below the surface of the ground. Prices are given. *R. Burton Rose, 1133 Cristina Avenue, San Jose, California.—Gratis.*

FAMOUS TREES, by Charles E. Randall and D. Priscilla Edgerton, contains descriptions of many of the oldest and largest trees in the United States as well as in other parts of the world. It also deals with the historical connection between trees and a number of noted persons. Miscellaneous Publication 295 of the U. S. Department of Agriculture. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

PROPANE, BUTANE, AND RELATED FUELS, by E. R. Weaver, describes the composition, manufacture, properties, and methods of distribution of these fuels which are finding wide markets today. A tabulation lists the trade names of a large number of "bottled" gases, together with their manufacturers and their fuel types. Circular C 420, U. S. Department of Commerce. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

SOYBEANS, THE WONDER FOOD, by N. A. Ferri, M.D., is a 62-page pocket-size booklet which gives a complete résumé of the numerous uses to which soybeans can be put, with particular attention to their rôle in food. A group of special recipes using soybean products includes waffles, bread, muffins, icing, omelettes, soups, and so on. *Bruce Humphries, Inc., 306 Stuart Street, Boston, Massachusetts.—25 cents.*

REAL FIGURES is a single folded sheet which offers definite proof that well-managed farms in relatively poor price years can return an income that is comparable with that of any investment of equal safety. *Farmers National Company, 388-396 Brandeis Theatre Building, Omaha, Nebraska.—Gratis.*

LEGAL HIGH-LIGHTS

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

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

Detective Stories

DETECTIVE stories were involved in the defense of a recent suit for trade-mark infringement. The plaintiff in the suit was engaged in the business of selling men's clothing at retail under the trade mark "Finchley" and it was established that the plaintiff had used the trade mark for many years. The defendant had recently commenced to use the trade mark "Fay Finchley" on women's clothing and the plaintiff charged that defendant's actions constituted trade-mark infringement. The Court concluded that the use by the defendant of the trade mark "Fay Finchley" on women's wearing apparel constituted infringement of the plaintiff's trade mark "Finchley."

In the course of the proceedings it was argued in behalf of the defendant that the defendant selected the name "Fay Finchley" because he had "read in numerous detective story magazines of Finchley Common, located outside of London, the favorite haunt of the notorious bandit, Dick Turpin."

In its opinion the Court referred to this argument, stating:

"Whether the activities of the latter (Dick Turpin) suggested the appropriation of which the plaintiff complains, is not the subject of discussion in the defendant's brief."

Procrastination

COPYRIGHT law is purely statutory and one seeking the protection of the law must comply strictly with the statute. To obtain a copyright on a published book the book must first be duly published with proper notice of copyright affixed thereto. The statute provides that thereafter two copies must "be promptly deposited in the copyright office or in the mail addressed to the register of copyrights." The statute further provides that until this provision is complied with no action or proceeding shall be maintained for infringement of the copyright.

In a recent case the publisher of a monthly magazine had affixed notice of copyright to one of the issues of the magazine but had failed to deposit the copies with the register of copyrights until after a lapse of 14 months. In the interval between the publication of the magazine and the deposit of the copies a book publisher published a book containing material substantially identical with an article appearing in the magazine. After the magazine publisher had deposited the copies with the register of copyrights he brought suit for copyright infringement against the book publisher.

The publisher of the book contended that the magazine publisher had failed promptly to deposit copies of the magazine with the register of copyrights as required by law and that he was barred from bringing suit. The Court pointed out that the purpose of the requirement of deposit was to enable publishers to determine whether they were infringing any existing copyrights. Since the book was published prior to the deposit of copies and since the delay in depositing the magazine copies was really substantial the Court held that the magazine publisher had failed to comply with the statute and was deprived of his remedy.

Converted Converter

THE uninitiated may have difficulty in distinguishing between a manufacturer and a converter of textile fabrics. Apparently, however, there is an important distinction in the textile industry. A converter is a person who purchases textile fabrics from a manufacturer and then sends them to another concern for finishing, bleaching, dyeing, or printing.

In a recent case a Federal Court affirmed the right of the Federal Trade Commission to order a converter to cease and desist from even indirectly indicating that he was a manufacturer. In the case in question a converter had been engaged in business for many years under a name which included the words "Mill Manufacturing Company." The Federal Trade Commission contended that the words "Mill" and "Manufacturing" indicated that the converter maintained a mill and was engaged in manufacturing fabrics. The Commission found that the purchasing public preferred to purchase fabrics directly from a manufacturer or mill as distinguished from a converter and that accordingly the converter was misleading the public and obtaining an unfair competitive advantage. To correct this the Commission issued an order requiring the converter to cease and desist from using the words "Mill" and "Manufacturing" in its name.

On appeal to a Federal Circuit Court of Appeals, the Court reviewed the findings of the Commission and held that the Commission was authorized to guard the public against dangers arising from misleading names. In the particular case, however, the Court pointed out that very little business was done with the purchasing public and that most of the merchandise was sold to retailers or to garment manufacturers who were well aware of the nature of the converter's business. The Court then stated that the converter's name had been used in good faith for many years and was of excellent repute. Under the circumstances the order of the Commission was considered too drastic and it was modified so as to permit the use of the words "Mill" and "Manufacturing" but so as to require the converter to place after its name the statement: "Converters, Not Manufacturers, of Textiles."

Author by Proxy

THE interpretation of the word "author" was involved in a recent suit for copyright infringement involving a music publishing company who had hired a musician to arrange certain musical compositions. The compositions thus arranged were copyrighted by the publisher. Thereafter the musician died and, upon the expiration of the copyrights, his son renewed them. The copyright law authorizes the renewal of a copyright by the author if he is living, or, if he is dead, by his widow or children.

In the case in question the renewal of the copyright was held to be invalid. The Court pointed out that the music publishing company hired the musician to arrange the compositions in question and that the word "author" as used in the copyright statute included a person who hired another to create a musical production. Since the renewal of a copyright must be taken out by the author, if living, and since the author was the publishing company the Court held that only the publishing company could renew the copyrights.

This case indicates a sharp difference between the copyright and patent laws. Under our patent laws an inventor is a person who conceives of and completes an invention. A person who hires another to make an invention is not an inventor. As seen above, under our copyright laws a person who hires another to create or compose a literary, musical, or artistic production is an author and may copyright the production.

Contempt Disclaimed

WHERE a claim of a patent has been declared invalid by a court of competent jurisdiction it is necessary for the patentee to file in the Patent Office a disclaimer of the invalid claim within a reasonable time after the adjudication. This principle of patent law was recently invoked to protect a defendant from being adjudged in contempt of court. Suit had been brought by a patentee against an infringer. The Court had found one of the claims to be valid and infringed while the remaining claims were declared invalid. Pursuant to its findings the court issued an injunction restraining the defendant from infringing the valid claim.

Approximately 20 months thereafter the patentee charged that the defendant violated the injunction and instituted proceedings to have the defendant adjudged in contempt of court. The defendant pointed out that the court had previously held all of the claims with the exception of one to be invalid and that even though 20 months had elapsed between the adjudication and the institution of the contempt proceedings the patentee had not filed a disclaimer of the invalid claims. It was argued by the defendant that the plaintiff had not filed a disclaimer of the invalid claims within a reasonable time and accordingly could not enforce its patent rights. The Court sustained the defendant's contention stating:

"Considering all the factors involved, I am of the opinion that plaintiff has allowed an unreasonable time to elapse without taking advantage of the disclaimer act * * * and the patent has therefore become void."

INDEX TO VOLUME 159, JULY-DECEMBER, 1938

SCIENTIFIC AMERICAN ADVERTISERS

December · 1938

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

Western Advertising Representatives

EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.

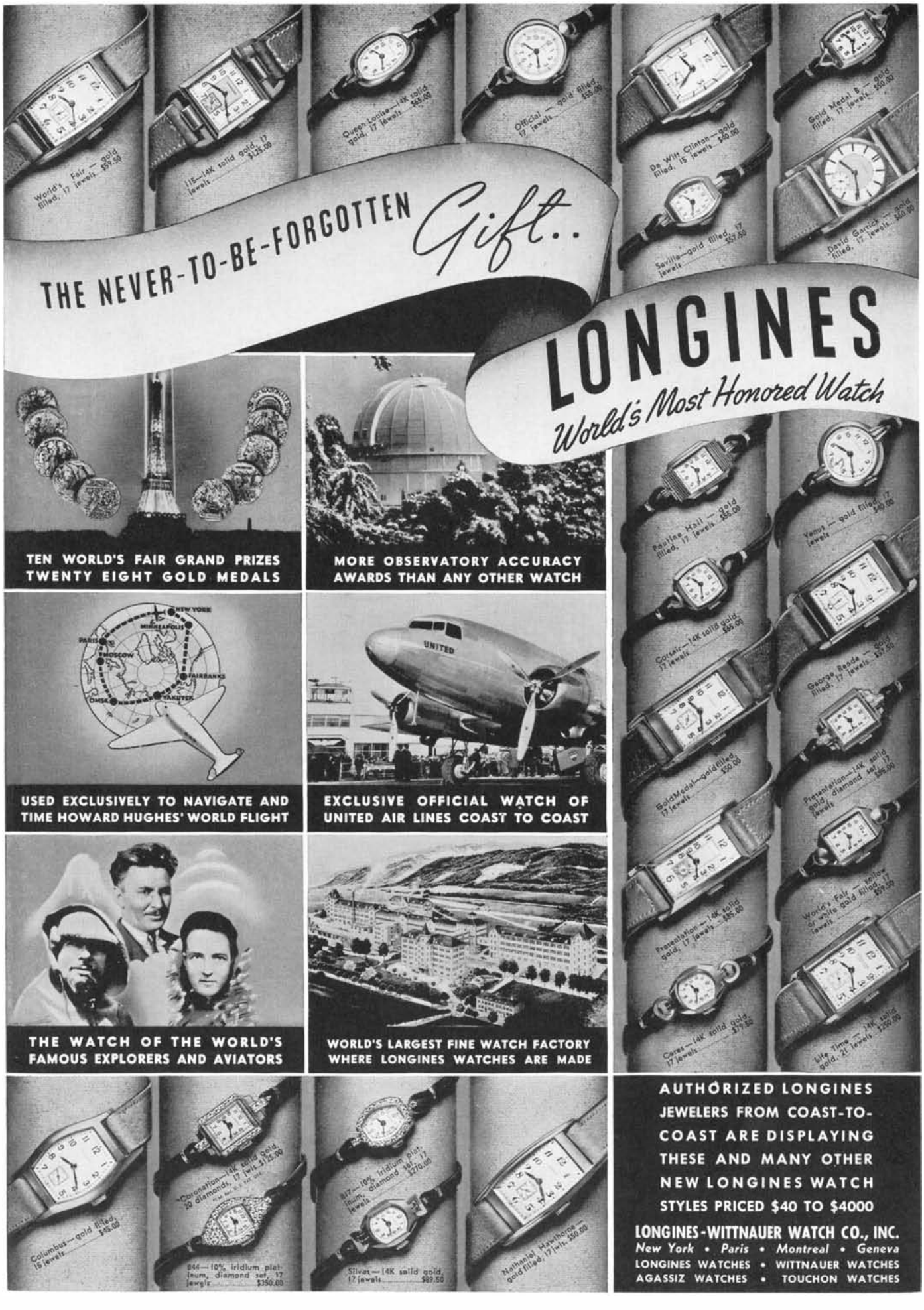
BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco and Seattle

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

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

Vol. 159, No. 6, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid.

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


THE NEVER-TO-BE-FORGOTTEN Gift..
LONGINES
World's Most Honored Watch
TEN WORLD'S FAIR GRAND PRIZES
TWENTY EIGHT GOLD MEDALS
MORE OBSERVATORY ACCURACY
AWARDS THAN ANY OTHER WATCH
USED EXCLUSIVELY TO NAVIGATE AND
TIME HOWARD HUGHES' WORLD FLIGHT
EXCLUSIVE OFFICIAL WATCH OF
UNITED AIR LINES COAST TO COAST
THE WATCH OF THE WORLD'S
FAMOUS EXPLORERS AND AVIATORS
WORLD'S LARGEST FINE WATCH FACTORY
WHERE LONGINES WATCHES ARE MADE
AUTHORIZED LONGINES
JEWELERS FROM COAST-TO-
COAST ARE DISPLAYING
THESE AND MANY OTHER
NEW LONGINES WATCH
STYLES PRICED $40 TO $4000
LONGINES-WITTNAUER WATCH CO., INC.
New York • Paris • Montreal • Geneva
LONGINES WATCHES • WITTNAUER WATCHES
AGASSIZ WATCHES • TOUCHON WATCHES

The Most Comprehensive
Most Authoritative
Reference Work of
Practical Science

VAN NOSTRAND'S

SCIENTIFIC ENCYCLOPEDIA

Covers completely All the Sciences

12 great books in one, thoroughly treating Chemistry, Physics, Mathematics, Engineering, Astronomy, Medicine, Numerology, Aeronautics, Navigation, Geology, Zoology, Botany. Brand new, just completed. Every subject fully covered from fundamentals to latest advanced discoveries—Principles, Methods, Formulas—with charts, diagrams, and halftones.

Written by Experts

Twenty-one authorities of many Universities such as Columbia, Rose Polytechnic, Princeton, Lehigh, Amherst have given unquestioned authority to the entire book.

The Instant Question-Answerer for Laboratory and Shop Workers, Mechanics, Home Scientists, Students

Answers tens of thousands of questions such as: The value of radial, rotary-gas engines—How the Diesel Engine operates—How air conditioning functions—What is the coming television system—How storage batteries work—How to find your position at sea—How to do dead reckoning—How your nervous system works—How to recognize every star, planet, constellation—How optical instruments are constructed—How to work arithmetic, algebra, geometry problems—How bridges are constructed—How an airplane beacon system works—How petroleum is cracked to make gasoline—How rayon is made—How to survey a piece of land—and thousands more.

1500 Pages—10,000 Articles—1200 Illustrations
Bound in handsome and durable Fabricoid

Examine It Free

Send No Money—Mail Coupon

D. Van Nostrand Co., Inc.,
250 Fourth Ave., New York, N. Y.

Send me the SCIENTIFIC ENCYCLOPEDIA for examination. Within 10 days I may return it and owe nothing. If I keep it I will send $2.00 as first payment and $2.00 monthly for four months—$10.00 in all. (5% discount for cash with order. Same return privilege.)
(S.A. 12-38)

Name .....

Address .....

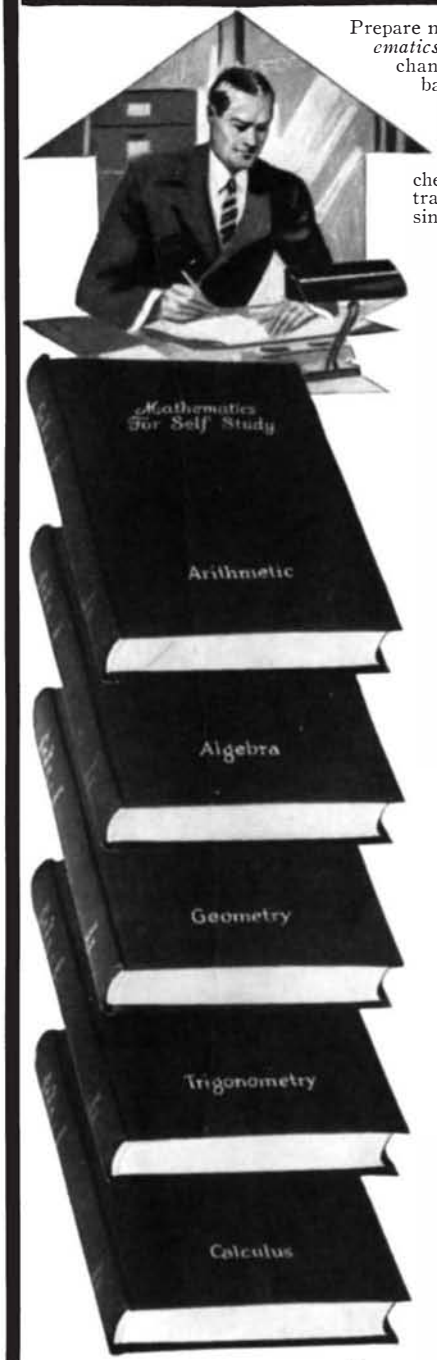
City & State .....

Reference .....

Address .....

THIS COMPLETE, SIMPLE, PRACTICAL COURSE FOR SELF-INSTRUCTION WILL QUICKLY GIVE YOU

A Complete Mastery of MATHEMATICS



Prepare now to advance yourself to an important job by *Mathematics Training. Mathematics* is the foundation of all mechanical and scientific work, and of all business or industry based on science. Without this essential knowledge even the most capable man is left behind while others forge ahead to better jobs, bigger contracts, more money. You need mathematics to solve technical problems, and to improve, speed up and check on your work and the work of others. Such basic training is quickly recognized and gladly paid for. It singles you out from the crowd and gives you an advantage whether it is a matter of a job, a promotion, or a contract for work.

Now you can learn mathematics by an easy, inexpensive and time-saving method. A very simple and extremely interesting course in book form has been prepared for you by an expert who has devoted a lifetime to teaching practical men the fundamentals of this important subject.

Mathematics For Self Study

By J. E. Thompson, B.S. in E.E., A.M.,
Dept. of Mathematics, Pratt Institute, Brooklyn

These books start right from the beginning with a review of arithmetic that gives you all special short-cuts and trick problems that save countless hours of your time and make you more valuable to yourself and your job. Then they go right into higher mathematics and show you how simple it is when an expert explains it for you. Don't let appearances fool you, mathematics is *easy*. You can get these books on approval and see for yourself how much enjoyment you can have while getting this valuable training and solving interesting practical problems that puzzle your friends and fellow-workers. In no time at all you will be tackling with ease the most difficult question on this subject.

A Complete Course and Reference Library in 5 Volumes

ARITHMETIC—Starting with a quick review of principles, it presents all the special calculation methods used in business and industry which every practical man should know.
ALGEBRA—Starting with simple practical problems, this book shows you, step by step, how to apply algebraic methods to the most complex problems.
GEOMETRY—States clearly all needed facts about plane figures, circles, polygons, etc.
TRIGONOMETRY—This volume makes easy the principles of angles and triangles, shows you how to use tables that explain their functions.
CALCULUS—You will enjoy mastering calculus in this interesting new way and you will find it will enable you to solve problems that can be solved in no other way.

1598 Pages—Illustrated

Send No Money

Examine These Books For 10 Days Free

The coupon below brings you the five books for 10 days' free trial. After 10 days return the books to us without obligation or send us the small down payment of $2.95, balance in three monthly payments (5% discount for cash).

Mail This Coupon

An Expert Gives You These Simplified Methods

Mr. Thompson, the author of these books, is not an ordinary teacher of mathematics. He has had many years' experience in giving students the kind of mathematical training they need in practical work. He presents each practical method and problem in the clearest and simplest way. He gets right down to the kind of information that you need in your daily work.

D. Van Nostrand Co., Inc.
250 Fourth Ave., New York.

Send me MATHEMATICS FOR SELF STUDY in 5 volumes. Within 10 days I will either return the books or send you $2.95 as first payment and $2.00 per month for 3 months—total, $8.95. (5% discount for cash.)
(S.A. 12-38)

Name .....

Address .....

City and State .....

Business Connection .....

Reference .....

Address .....