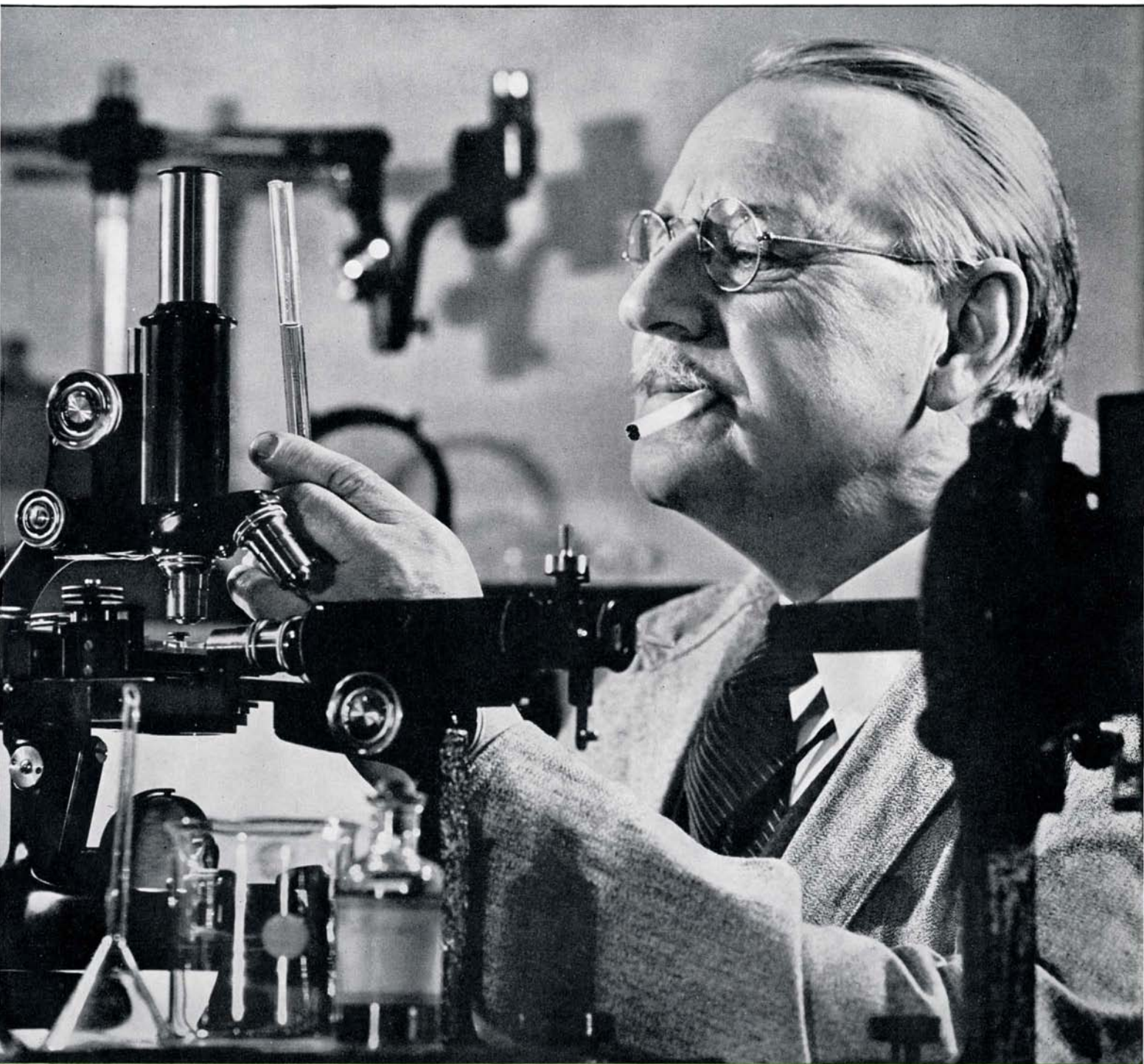
Assistant Secretary of Navy

Roosevelt: WHY THE NEW NAVAL PROGRAM IS NECESSARY

SCIENTIFIC AMERICAN

Vol. 150 No. 4 APRIL, 1934 35c a Copy



Working with the Ultra-microscope (See page 169)

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•

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SCIENTIFIC AMERICAN

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NINETIETH YEAR • ORSON D. MUNN, Editor

CONTENTS · APRIL · 1934

Cover

PARTICLES smaller than about 1/100,000 inch cannot be seen clearly (resolved) by any microscope, no matter how much it magnifies, but the presence of particles down to about 1/4,000,000 inch can be detected with any ordinary microscope by throwing on them a powerful beam of light from one side. Such equipment as is shown on the cover constitutes the ultra-microscope. (Photo by Grancel Fitz Studios, courtesy Bausch and Lomb.)

SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, April, 1934. Vol. No. 150, No. 4, 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.

ACROSS THE EDITOR'S DESK

IN the future, even more than in the past, readers of SCIENTIFIC AMERICAN are going to be kept in touch with the events of science and industry through the thoughts of men who have achieved prominence in their respective fields. The editors are aggressively following a long-standing policy of obtaining articles only from unimpeachable sources, thus assuring the reader of the authenticity of the material. Some of the articles are noted in the box at the right; others are in preparation. For example: The question of tariffs and their effect on industry is one that has far more than political implications. Two authorities on the subject have indicated their willingness to write on opposite sides of the question, one stating that he will prepare his material after we obtain the definite promise of the other. Negotiations are now underway; we can not tell you more at this writing, but we promise that the articles will be forthcoming, and that they will be well worth waiting for.

●

A MAN claims that he is the father of one of a pair of twins, but not of the other; a mother contends that she has been given the wrong baby to bring home from the hospital; a man denies being the father of an illegitimate child when accused by the mother. These actual cases offer excellent opportunities for using blood group tests in an attempt to arrive at the truth. The question "whose baby?" is one with which the courts of the world have struggled from time out of mind. Even Solomon had this problem to solve. Now science appears to be approaching a definite basis upon which such a question may be answered to the satisfaction of all concerned. Prof. Laurence H. Snyder has prepared for us a comprehensive article, to appear next month, in which the whole story of determining parentage by blood group tests is told in an interesting and informative manner.

●

THE phrase "pushing back the frontier" usually connotes progress toward national prosperity, but when applied to our method of cutting trees for newsprint paper, it has a diametrically opposite meaning. We have pushed back the newsprint-forest frontier into Canada and it is becoming more and more apparent that another source of supply must be found to meet the huge demand. Dr. Charles H. Herty has found it in young—and otherwise practically worthless—southern pine. His article concerning this development, scheduled for our May issue, not only gives the economic side of the subject in strikingly complete fashion, but also is exceptionally interesting *per se*, and especially to Dixie. Southern pines may yet bring the south "out of the woods" with an industry of gigantic proportions.

●

PARALLELING, in some respects, the article on paper-pulp from southern pine, mentioned above, is another that we expect to present next month, and which tells of experiments now being carried out with the idea in mind of increasing the rate of growth of trees indigenous to the United States. This work, being done by the Institute of Forest Genetics in California, will have a direct bearing on every phase of our daily life in which wood enters. Not only faster growing trees, but tall straight trees, disease and cold-resisting trees, and fine-grained, knotless trees are the aim of the Institute.

●

WHEN a particular phase of pure science is being discussed, it is usual for some hard-headed, practical person to ask the question: "Of what material use is all this theory and experimental work that appears to have no definite objective?" Sometimes the answer must be: "None that we know of as yet," because by the very nature of pure science research, practical and utilitarian ends do not enter the consideration. But in other cases it is possible to point out very definite results of pure science, and seismology is a case in point. In our May issue Rev. Joseph Lynch, S. J., Director of the Seismic Observatory at Fordham University, will give two definite pictures of seismology. The first is of the workings of the instruments of the science, with an explanation of how they function and what they tell, and the second is of the practical ends which are attained. The student of science and the aforementioned hard-headed utilitarian will both find much of interest and value in this discussion.

●

BECAUSE of the growing interest in photography—not on the part of the "snap-shotter" but by the serious advanced amateur—we are planning a series of articles on this subject for early publication. The rapid advance of photographic technique in the last few years has opened a vast field of operation for those whose desires are for something more to do than just "push the button." More of this later.

Editor and Publisher

NEXT MONTH

¶ Laurence H. Snyder, Professor of Zoology, Ohio State University, will write on the determination of parentage by blood tests.

¶ Sources of paper pulp constitute a vital problem to the newspaper industry. An article by Dr. Charles H. Herty will tell of a vast potential supply of pulp that has hitherto been overlooked.

¶ Rev. Joseph Lynch, S. J., contributes a highly informative article on the work of seismologists, written for the layman.

COMING

¶ Charles F. Kettering, Director of the Research Laboratories of General Motors, will write on the necessity of business managers getting the research point of view.

¶ Sterilization of the mentally unfit and criminally insane will be dealt with in two and possibly three articles, prepared by authorities.

¶ How important is foreign trade to national recovery? We are now negotiating for two articles on this question, and expect to present them soon.

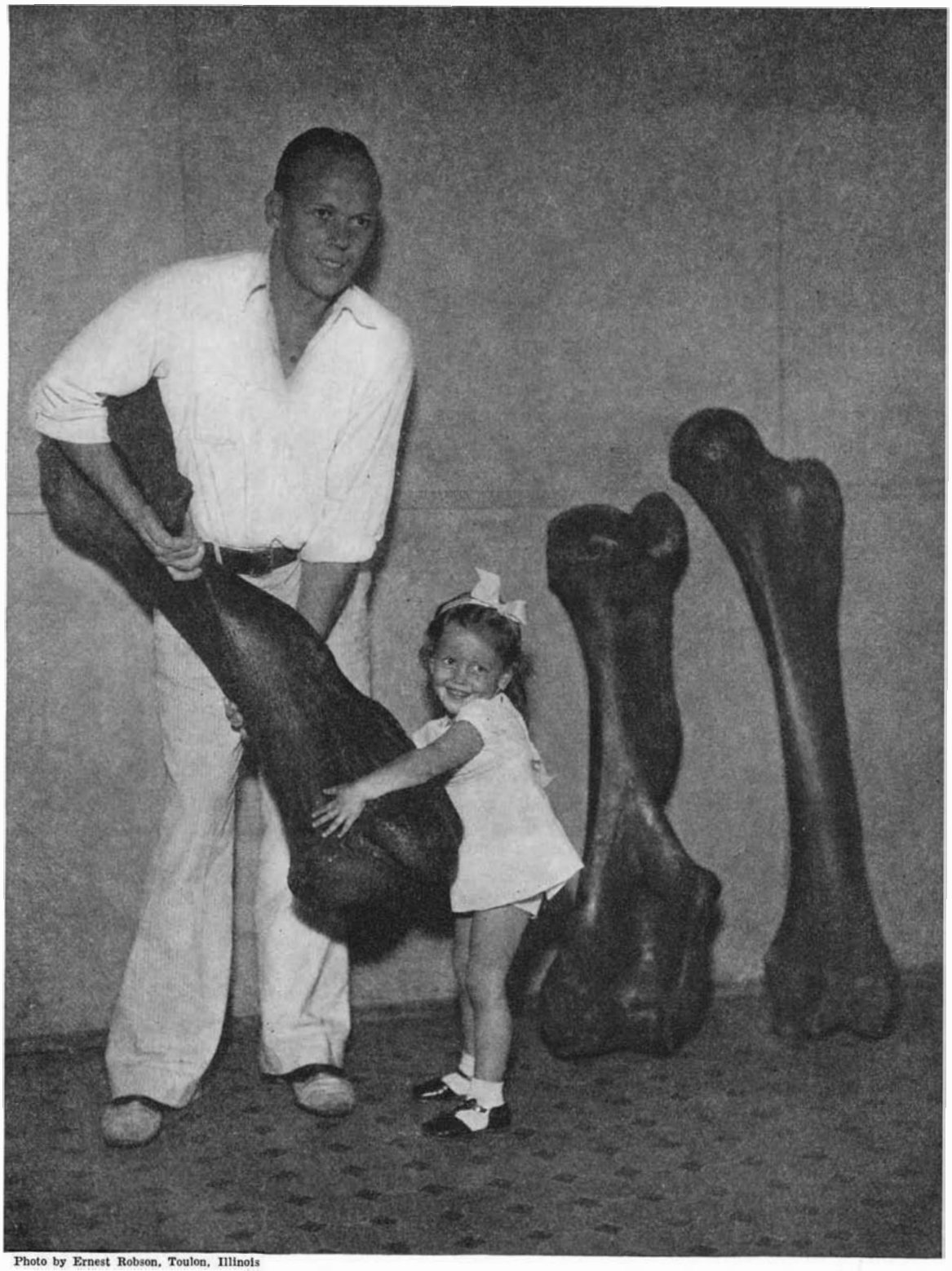
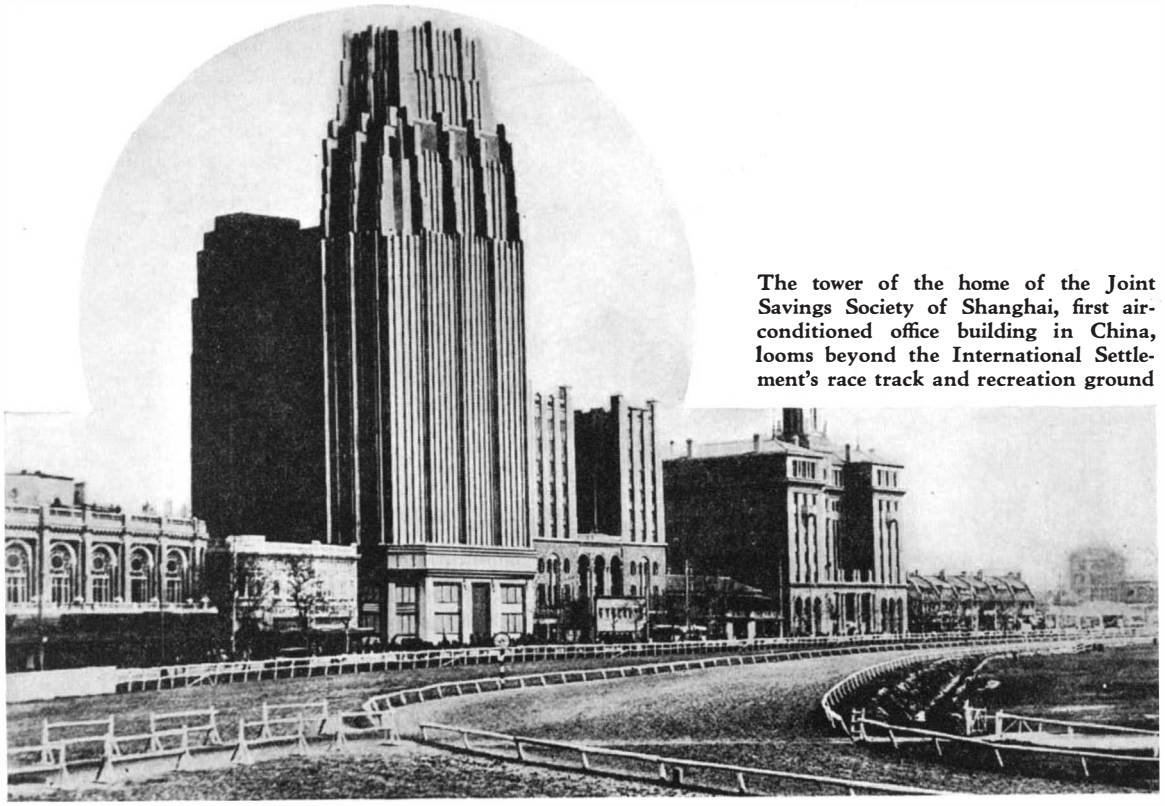


Photo by Ernest Robson, Toulon, Illinois

HUMERUS, HUMERUS, FEMUR, OF MAMMOTH

FRED KELLER, Kewanee, Illinois barber, has the instincts of a scientist, for when he stubbed his toe while wading in a river he quit fishing to investigate and discovered a fine skeleton of a mammoth. Mastodon and mammoth skeletons are not so rare as some believe—hundreds have been found and it is said that there is one in every swamp, but good ones, well preserved, are not common. Many otherwise good specimens have been ruined by amateur excavation, as some crumble when exposed to the air without special treatment. It is best to cover up such finds and call in a scientist.



The tower of the home of the Joint Savings Society of Shanghai, first air-conditioned office building in China, looms beyond the International Settlement's race track and recreation ground

China Modernizes

By WILLIAM S. SHIPLEY
President, York Ice Machinery Corporation

MENTION China to the average American citizen who has never traveled abroad, and there immediately comes to his mind the picture of a far-off, half civilized country, vaguely located "somewhere East of Suez," where strange and mysterious things happen; a land of unending wars and counter-wars, of fierce hatreds and quick-flaming passions; a land of quaint, picturesque cities teeming with humanity, full of queer sights and queerer smells, where furtive, shadowy, queued figures scurry through dark, narrow alleys, with now and then the flash of a jade dagger in the dim light of swinging colored paper lanterns.

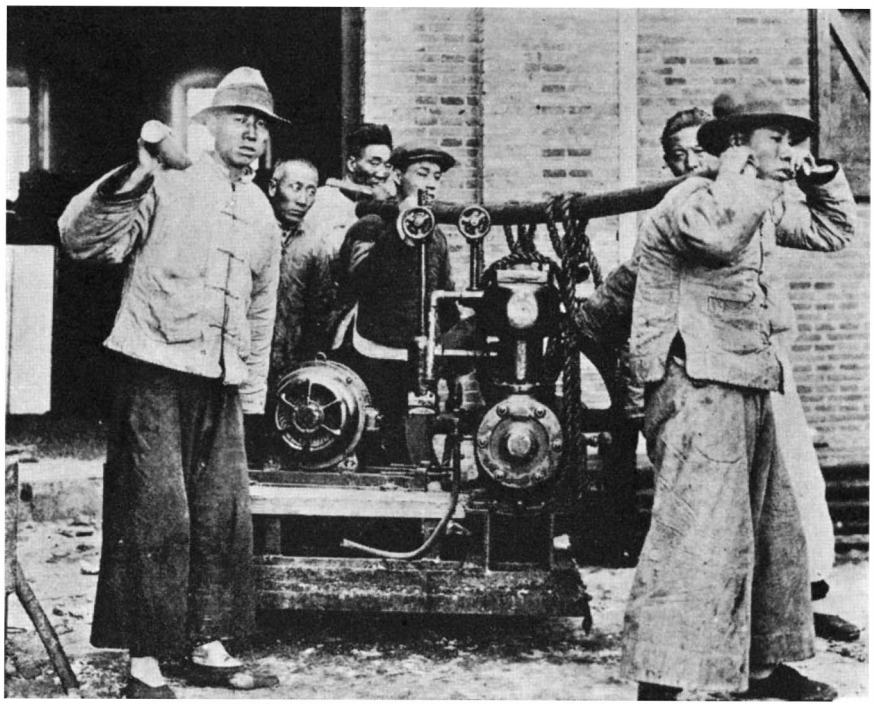
This is the China of the movies. It would indeed be difficult for one who carries in his mind's eye such a picture of China, to get into that picture the modern steel-and-concrete, 22-story structure which has recently been erected, in the International Settlement district of Shanghai, as the home of the Joint Savings Society of Shanghai. Somehow those unfamiliar with present-day China do not find it easy to associate that country with a modern skyscraper, rising to a height of 265 feet from the sidewalk to its topmost pinnacle—a building of architectural beauty and refinement of design that would be a credit to New York or Chicago or San Francisco. And still more difficult is it for most of us to fit into our conception of China that most recent product of western civilization: air conditioning.

YET in this ultra-modern banking structure was installed, by the engineering staff of the Shanghai Division of the York Ice Machinery Corporation, an air-conditioning system as complete and as up-to-date as any to be found in America. In fact, it is perhaps the most complete system of its kind yet installed outside the boundaries of the United States.

The building, designed by a Czecho-Slovakian architect who is considered a leading member of his profession in Shanghai, is more than an office building, since it is intended to serve also as an apartment hotel for both permanent and transient guests, as well as to serve the needs of the Joint Savings Society of Shanghai. The latter is a Chinese owned and operated institution for savings. Its capital stock is held by a number of large Chinese banking institutions that make use of the Joint Savings Society's facilities in lieu of savings departments in their own banks.

In this building, the vaults, located in the basement and sub-basement, are supplied with fresh, pure air, automatically kept at the right temperature and relative humidity for comfort. The main banking hall, also in the basement, is likewise air-cooled and conditioned, as are the main lobby and the dining room and lounge on the second floor. Separate units cool the air of the grille room on the 14th floor, keeping the air washed clean of impurities and properly dehumidified. Other units take care of storage rooms used in connection with the hotel kitchen and pantry service on the second floor, and supply constantly cooled and conditioned air to special refrigerating chambers located on each floor from the third to the fourteenth. The system also supplies cold drinking water for each of these floors from a central water-cooling system in the sub-basement.

Shanghai, scene of the International Settlement, where many American, French, and British firms have established headquarters or branch offices, is today the principal customs port and clearing house of China's world-wide



"Many hands make light work." Skids or rollers are seldom used in China for even the heaviest work. Plenty of coolies are always available to do any job

foreign trade. Due to the security of life and property in the International Settlement of Shanghai, and also because of the fact that each nationality represented in Shanghai is under the protection of its own national courts and laws, the city has become the headquarters of practically all foreign firms doing business in China.

THE city, as now constituted, includes the International Settlement, which takes in the original British, American, and Japanese concessions, now consolidated into one unit under a Municipal Council. Adjacent to the International Settlement lies the French concession, governed by a French Council, but on the order of a French colony, subject to the home government. Beyond this lies the Municipality of Greater Shanghai, better known as the Old City, or the Native City.

Shanghai has been aptly termed the Paris of the Orient. It is indeed a city of brilliant, flashing color and unending drama, the scenes of which change with kaleidoscopic swiftness, from the endless variety of wares to be seen in its fascinating shops, along Nanking Road—the "Champs Élysées" of Shanghai—to the unique, hand-wrought native curios so alluringly displayed to tempt the tourist as he goes ricksha-ing through "Pig Alley," the local name for the last street of the International Settlement before you come to the Old City—that ancient section of native Shanghai, whose narrow, dim alleys and quaint customs have remained unchanged since before the days of Rome.

Yet the part of Shanghai which is the International Settlement has its modern aspect. It has its clean, well-paved streets, its street cars, its motor cars. It has its great department stores too, with their modern open-air ground-floor dining rooms and roof-garden cafes. In size, variety, and quality of merchandise, these stores are fully comparable with many of the larger department stores of our American cities.

To visit Shanghai, and to live there for any length of time, is to discover that it is a city which combines the modern with the ancient in a most fascinating way, a city whose people are living their daily lives and carrying on their daily business in much the same way as we of the western world conduct our affairs, yet according to customs and traditions that have come down to them, from father to son, through countless generations. For China—the real China—is centuries old.

But there is a young China today, a new generation of young men in China, who in recent years have grown more venturesome, and who have allowed themselves to come into closer contact with other races and to come under the influence of foreign ways and customs. Today they are slowly, gradually, building a scientific and industrial system which is establishing new standards of living—standards that seem more alluring to the younger China than do the age-old traditions and customs which they have inherited from their honored ancestors.

One senses this change in their apparent eagerness to emulate and copy American ways and methods; in their earnest desire to acquire something of that material prosperity which they have seen in their contacts with foreign business men and business enterprises in China, and particularly with Americans. This is largely responsible for the steady growth in China's trade with foreign nations, and this, too, accounts for their eagerness to import American-made products, even though many such products are, to them, new, unknown, and wholly strange.

Despite this willingness to accept American ways, it was no easy task to introduce into China the American innovation of air that is mechanically washed, purified, cooled, and regulated as to temperature and humidity, before it can be breathed with safety and comfort. At first, the native Chinese looked with suspicion on all things mechanical, preferring to do things as they had been doing them for centuries, often in ways that seemed crude and primitive from the standpoint of western civilization. Even today, no native Chinese woodworker or carpenter will drive a nail into a piece of wood without first drilling a hole in the wood with his crude drill. It is the way he has always done it—why change?

The American manufacturing concern attempting to do business in China will find itself confronted with a situation that is unique, due to political and economic conditions which are peculiar to the country, and to the long ingrained habits of its people.

A coil unit for the the Joint Savings So to position by a g

The method of securing contracts, for example, is different in China from that of America. Owing to the fact that the nationals of each foreign country live in China under their own laws, and conduct their business procedure under these laws, it is impossible to assume that certain conditions are legal, which we in America are accustomed to accept without question. It is not safe to take any business situation for granted in China, or to assume that such and such is the case in dealing with the other nations; some countries have lien laws and some have none, while some nationals have consular courts and others are governed by and subject to the rulings of the Chinese courts. Thus the nationality of the purchaser, the location of the plant, the source of the money supply, and the credit of the purchaser are all factors that have an important bearing upon the making of contracts in China.

In view of these complications, and considering the fact that no lien law exists in China, every supplier of ma-

chinery must employ his own methods of guaranteeing payments. When a contract is secured from a Chinese buyer, it is customary to secure an advance payment of at least 25 percent of the contract price as "bargain money," and another 25 percent or more at time of delivery, in the case of such items as machinery and equipment. As no manufacturer in China can secure a lien on machinery supplied or installed, it is necessary to secure some form of guarantee for the final payments before making delivery of the material. Without going into the intricacies of the Chinese banking system, suffice it to say that the Chinese have a system of guaranteeing payments which gives to the American business man the fullest protection.

AFTER a contract is once made and the "bargain money" paid, it may safely be said that the American concern doing business in China will be able to operate with fewer bad debts than the average firm doing business in America. This may be due to the custom of securing bank guarantees, or shop guarantees, as they are called; or it may be due to the fact that the Chinese business man, as a rule, thinks very highly of his business reputation. In other words, he dreads to "lose face." He will resort to almost any means of securing a reduction from his original price, but he will never flatly refuse to pay a bill which he has contracted, since by repudiating entirely a just debt, he would "lose face" with his business associates. This is one custom in China which reacts favorably for the American business man in his dealings with the Chinese buyers of his products.

ditioning plant in ding being moved trong-backed coolies

When York first entered into active selling in China, in 1920, the idea of refrigeration for general purposes, much less for industrial or domestic purposes, had not yet penetrated into that country. During the World War, the demand for frozen eggs gave rise to the establishment of a cold storage industry to some extent in China, and from this beginning it was more or less of an uphill fight all the way to the point where the Chinese would finally become truly "air-condition minded," as are the people of America today. But that the people of China are rapidly coming to accept the modern American viewpoint as to the value of mechanical refrigeration is indicated by the fact that more than 250 York machines, with a total refrigerating capacity in excess of 3500 tons, have been installed in China during the past decade. Some of these machines have been located in remote interior cities where few foreigners other than missionaries are permitted to visit.

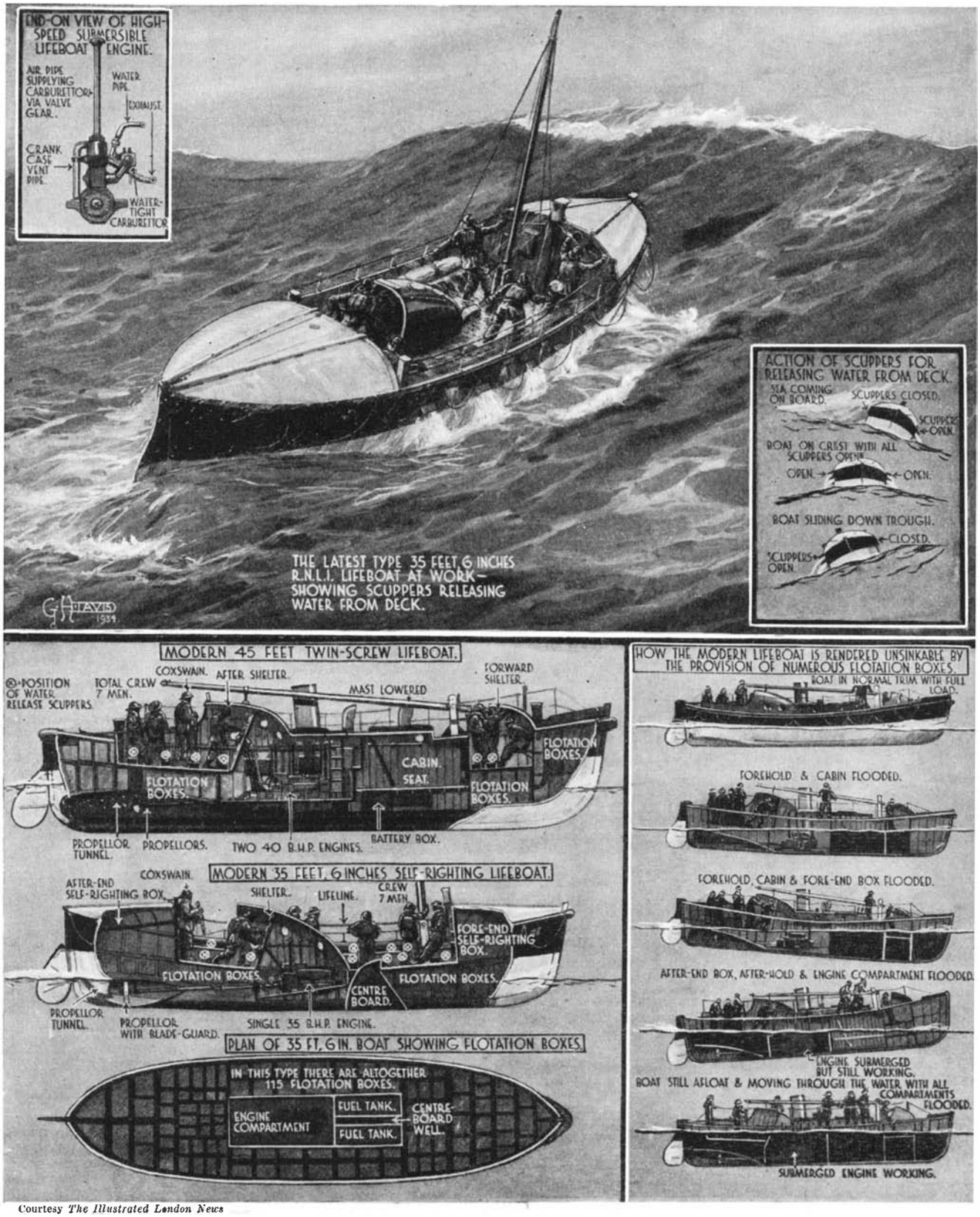
China is a place where labor is amazingly cheap, but at the same time very inefficient, except in cases where the same routine work can be done over and over again, day in and day out. The mentality of the Chinese workman is peculiar, however, in that once having been shown, and having thoroughly grasped, a principle or a method of working, he will never forget it. Today, the York organization in China has reached a stage where it has developed and trained a staff of Chinese fitters who can install complete plants of the type placed in the Joint Savings Bank Building of Shanghai. And though they still show a preference for their own tools, as against the high-grade special tools provided for them, the fact remains that they accomplish results.

Construction work in the Shanghai plant is performed in practically the same manner as it is done in America, except for the fact that every piece of machinery, even to the heaviest compressor weighing several tons, is lifted by hand and carried to its proper position, rather than moved on skids or rollers. The old adage that many hands make light work was never more aptly illustrated than here, because it is always possible to obtain as many Chinese coolies as may be required to lift anything that is desirable to move, regardless of its weight or bulk.

The Chinese native, as a rule, is not only willing but eager to follow the lead and adapt himself to the manners and methods of his American cousin, not only in his dress and manner and ways of doing things, but in his engineering, fabricating, designing, and producing of machines that contribute to his physical comfort and well being. It took him a long time, comparatively speaking, to assimilate and adapt to his own uses the principles of modern air conditioning. But now that science has pointed out that the motion of air, temperature, and relative humidity are subject to automatic mechanical control and regulation, and are factors which are intimately related to one another in contributing to his physical comfort, we may reasonably expect that air conditioning will find increasing fields of practical application in China.

IF America has taken up the air conditioning of its office buildings, China will take it up; if it is the custom to cool and condition the air of our American theaters, our homes, churches, public buildings, even of our crack American railway trains, we may soon expect to find theaters, and likewise homes and railway trains in China providing the comforts and advantages of conditioned air. If a new American method of making artificial ice, or of using refrigeration in the preservation of foods, is developed in America, we may look for its counterpart in China. For the interests of modern China and the Chinese center today in America, as the nation which points the way, a nation whose leadership China is only too willing to follow if it may lead them to a broader, richer civilization, with its attendant benefits.

These Chinese laborers, drilling holes preparatory to driving nails, prefer to use their own crude drills to which they are accustomed, rather than modern tools



Courtesy *The Illustrated London News*

British Motor-Lifeboats Are Highly Successful

THE old-fashioned oar-propelled lifeboat is rapidly being replaced along the coast of England by modern motor-driven boats equipped with numerous flotation chambers and rugged power plants. Two types of these boats, placed in service by the Royal National Lifeboat Institution, are shown in the illustrations above. In the fleet now in use, there are boats that can free themselves of water by means of scuppers as soon as it comes on board; keep afloat with every water-tight compartment damaged; right themselves in a few seconds if capsized; and continue running even with the engine room flooded. In the upper left-hand corner of the illustration is shown how the air intake pipe for the carbureter is mounted so that it remains well above the water line, even when the boat herself is water-logged. These boats are expensive to build, costing from 15,000 to 45,000 dollars each, but they saved 398 lives in 1933.

OUR POINT OF VIEW

Naval Aviation

ADMIRAL W. H. STANDLEY, Chief of Naval Operations, recently expressed the determination of the Navy "to fight bitterly against any such move as is now contemplated for an independent, united air force. . . ." He said further that the efficiency of the Navy would be destroyed utterly if her air force is taken away from her.

We heartily concur. Moreover, we wish to emphasize the Admiral's statement that the Navy *still* is the country's first line of defense.

For the sake of argument, let us assume that the country would be willing to place the responsibility for coast defense upon an independent air arm and coastal defenses. Enemy ships might operate just beyond range of either, blockading us most effectually. At the same time an enemy air armada might be made ready, with the fleet as its base, that could smash port facilities and transportation lines, thus crippling our food supply systems and causing wholesale starvation—to say nothing of populations wiped out by bombs and gas. Our fleet without its own perfectly coordinated air force—Navy-trained for operation with the Navy—when sent out to meet the enemy, would be so handicapped as to be easily destroyed or put to flight. The enemy's air and water craft, acting in concert as a well-rounded unit, would be more efficient than an unbalanced fleet. And a fleet depending on the operations of an air force over which it has no direct control—an independent air arm—would certainly be unbalanced.

It has been vehemently argued that airplanes have rendered surface war vessels obsolete. Perhaps there may have been some grain of truth in this assertion right after the World War when aviation had just learned much by actual experience and navies were still ignorant of the possibilities of air fighting. Now, things are different. Besides carrying planes, ships have been given highly efficient anti-aircraft guns and have been protected against air bombs. On good authority we know that not even the stacks of some of our latest ships are vulnerable to bombs.

The fleet is still the country's first line of defense, to protect its interests a mile or a thousand miles from shore; and the Navy must have its own air force. Now that we are to have a Navy adequate, as to ships and tonnage, to our national defense needs, it must not be again weakened by this proposed lopping off of its carefully nurtured, lusty, fighting "eye of the fleet" which "knows a ship when it sees one."

The Motorist Pays . . . and Pays

AMERICAN motorists paid over a quarter of a billion dollars to the federal government during 1933 in the form of various motor taxes. To the individual states they paid more than half a billion in sales and fuel taxes, registration and driver's license fees, and other levies. Altogether, the motorist is revealed, by figures compiled by the American Petroleum Institute Committee, as a billion-dollar tax payer.

When the first gasoline tax was imposed in 1919, the total amounted to only a little over a million dollars, and the funds so obtained were used for the direct benefit of the motorist—to finance road construction. There could be no legitimate objection to this use of the money; in fact, such taxation for the purpose was the only logical way to provide for the demands for better roads. But then the federal government recognized the motorist as a fertile—and docile—source of revenue, and it dipped deeply into his pocket without even a pretense that the proceeds of taxes would be used for roads. The ease with which individual states were collecting gasoline taxes opened a huge field for budget balancing, and the motorist paid!

It seems that those legislators who have been responsible for the steadily increasing taxation placed on the motorist are still living in the early days of the automobile, when a car was the plaything of the idle rich and as such was a distinct luxury. The time rapidly arrived, however, when the automobile became an absolute necessity to a large proportion of the people of the country, and this condition prevails now more than ever.

To cap the climax of the whole taxation grab, the additional burden was placed at a time when the motorist could ill afford to increase his expenses. The result was a decided decrease in motor travel and consequently in the purchase of the taxed items. The direct effect on the motor-car industry and those other businesses which depend on the motorist for their livelihood is perfectly plain.

It is high time that one of two things be done: Either reduce the total amount of taxes that each motorist must pay to the various collecting agencies, or make arrangements for the money to be diverted to channels where the motorist will get some direct benefit from his contributions. Either of these two steps would have a marked effect on industry as a whole and are therefore greatly to be desired. To throttle business in such a far-flung field as is represented by the motor car should never be the aim of taxation.

And Every One of Them Will Die

UNTRUTH crushed to earth will rise again. Recently Dr. Herbert E. Winlock, Director of the Metropolitan Museum of Art in New York called local reporters together and before them killed, deader than Tut-ankh-Amen himself, the old story about the death curse pronounced by that deceased Egyptian on all who might disturb his tomb. He pointed out that the man who discovered Tut-ankh-Amen's tomb is still alive; that four out of the five who were present when the tomb was opened still live; that 16 of the 22 who were present when the inner chamber was opened survive; that 20 of another 22 who were present when the sarcophagus was opened have not yet felt the royal wrath; and that not one of the ten who actually profaned the sacred monarch's mummy has met his fate. These are the facts.

And who are dead?

Lord Carnarvon, who was always frail.

Sir William Garstin, who died in 1926 of old age.

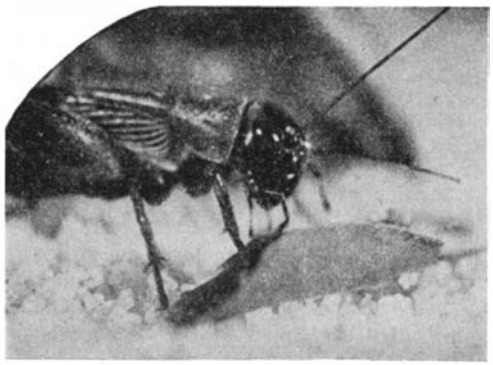
Sir Charles Crist, died in 1932, aged 68.

Mervyn Herbert, Lord Carnarvon's brother, who died at 48, and Richard Bethell who died at the same age (perhaps this particular curse works best at 48).

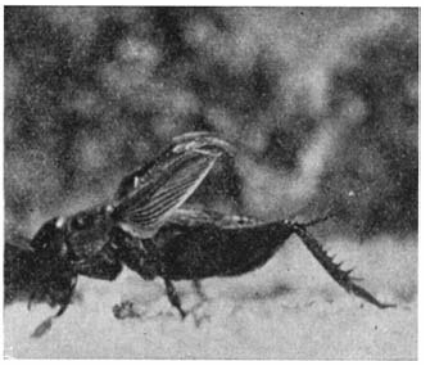
Arthur H. Mace, who died in 1928 of tuberculosis.

Well, out of the number present, largely persons past middle age, or the same number chosen at random on earth, about the same proportion would be dead, would they not? People do die occasionally, even without being cursed.

The fundamental fact in the psychology involved in such cases is, of course, not so much that people really do believe in such things, as that they want to believe in them. It is more interesting.

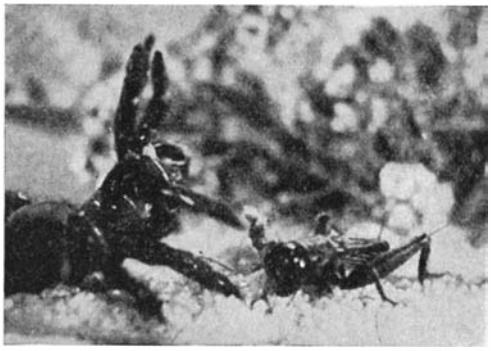


A cricket calmly devouring the tender parts of a leaf, while the movie camera makes a permanent record of the feast

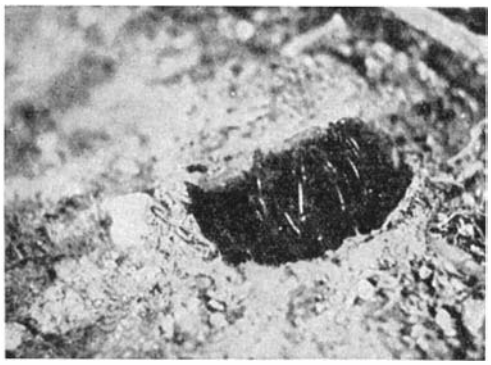


A cricket stridulating or "singing" by rubbing his wings together

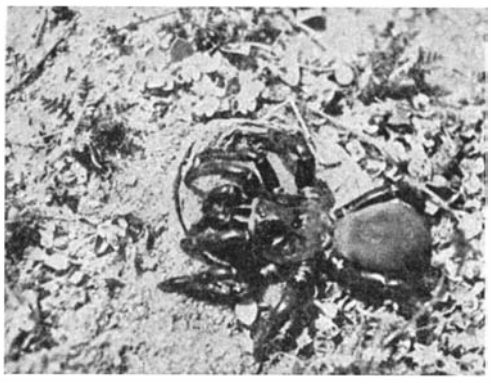
A wolf spider, sitting above his hole, waiting for insects to pass his way



A trapdoor spider about to capture a cricket. Note how the camera has caught the spider in position to make the leap



A trapdoor spider at work on the hinged lid of his home, busily kneading dirt into the web frame which he previously spun



In the center of the picture may be seen the circular outline of the door covering the spider's burrow. The spider is about to raise the lid he so laboriously built

INSECT WARRIORS

By STACY WOODARD

IN the darkness outside our tent on the Arizona desert, near Tucson, the sound of two tiny bodies threshing around on the sand distracted us from our rest. I rushed outside, but at first I saw nothing; then, on closer inspection, I perceived the dim outlines of two insects in a death embrace—a deadly centipede and a Jerusalem or sand cricket.

"Get the lights," I shouted to my helper.

As he hurriedly set up the incandescent lamps, I brought out the camera and pointed its macroscopic lens toward the death battle being waged on the great outdoor stage of the southwest. Quickly I pulled the two warriors apart, separating them about a foot. Immediately the centipede rushed at the cricket and again went about his business of killing his antagonist.

Now the sand cricket, in his small way, is no unworthy foe. His powerful mandibles, had he been able to fasten them in the centipede, would have crushed the enemy. So what did the centipede do, as one of the photographs on these pages shows, but roll on his back, stiffen his body and hold the cricket out of crushing distance. At his convenience, he administered the death-bite to the cricket.

Of course I did not permit the kill to be completed immediately. We had actors on our stage, insects living the intense drama of nature, and I wanted a full half hour of photography; I might never have another opportunity to film this rare scene under natural conditions. So from time to time I pulled them apart, and after each separation the centipede rushed again to the attack, providing, before the final extinguishing of the lights, one of the finest scenes I have ever photographed.

In recording the constant struggle among insects, of killer vanquishing killer, of the eternal struggle for life, I have not always carried my camera into the open. Frequently it has been necessary to set the stage, to reproduce the desert in miniature within a Hollywood movie studio. Some insects shy away from lights, others are frightened by sounds. We not only set the stage, but we also accustomed these tiny warriors to strange sounds and provided for them familiar surroundings in order that they might conduct their amours, seize their natural prey, and fight their battles under our direction amid physical conditions to which they had been long accustomed.

WITH macroscopic lenses, I have paraded hunting wasps, deadly scorpions, the praying mantis, solpugids, warrior ants, desert orbs, trapdoor spiders, wolf spiders, and crickets before my camera, on both indoor and outdoor stages. I have followed at close range deadly battles, waged with an intensity of which few humans are capable, and have staged battles on a stage no larger than a foot square.

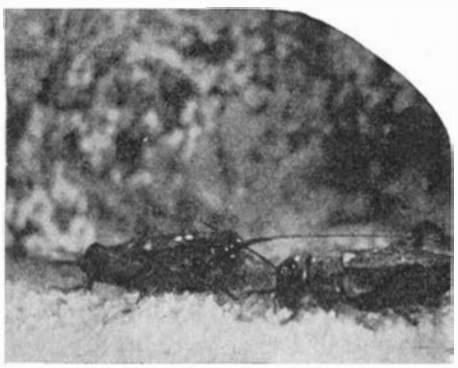
One of the most remarkable sequences showed the hunting wasp stalking a cricket, finally stinging him to death. I had tried to get this subject on the desert, but found it impossible to control either the lighting or the warriors properly.

Back to Hollywood I went, to the silence of a sound-proof room. There I built a tiny stage, camouflaging it so that it would look to the little actors exactly like their desert home, complete to the brush and sand. I built a series of runways, all of which terminated in

Photographs courtesy Educational

The author on location in the desert, with camera set up for recording insect battles

A wasp poised over a cricket, after administering the death sting



Two male crickets staging a battle royal over a female; death to one of the combatants will be the result

BATTLE FOR THE MOVIES

a glass-enclosed case. The 12-inch lens peered directly through a glass wall at the battle ground.

After placing a cricket in the case I turned a hunting wasp loose at the back of a runway. She took her own sweet time in crawling forward, but at last reached the case. The cricket being the wasp's natural enemy, the hunter wasted no time, once she came within view, in leaping on the cricket; and there, directly before the camera, she carried out nature's brutal process.

CONSIDER the scorpion—most merciless of fighters. When scorpion meets scorpion, a death battle follows. I took several scorpions from the desert back to Hollywood, and again reproduced their natural conditions. Since the scorpion is a nocturnal insect, I kept the stage dark until two of them actually reached the enclosure. Then we switched on the lights and in the brilliant arena the fight started.

There was no hesitation. Scorpions advance unafraid, each trying mightily to press its barbed tail home between links in the other's armor. This accomplished, he backs off and awaits the death. Then he consumes his foe. Sometimes both accomplish the fatal thrust, and a double death follows in a few minutes.

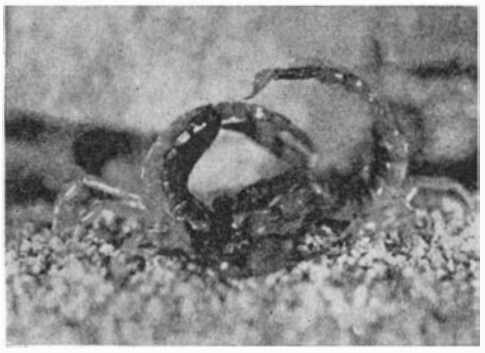
Oddly, trapdoor spiders are timid, while crickets will walk into death without flinching. The spiders proved so timid that I found it impractical to film them on the desert and again transported an army of these fellows, holes and all, to Hollywood. The first two nights after setting up the apparatus, we waited vainly for them to appear. Spiders are supposed to be unable to hear, but they must have seen the lights and "felt" the motors, for as soon as the cameras were started they would retreat. I solved this problem by keeping a motor running constantly, and after a time the spiders became accustomed to this strange and almost inaudible noise.

Crickets fight each other naturally. In order to get our pictures, I placed several within the enclosure, the floor of which was pock-marked with holes into which they could retreat. As the "inkies" glared on the scene, the males emerged from the hole to "stridulate" or rub their wings together. In this way they sing their songs of love to the females. Often the males would fight over a female, continuing the struggle until one passed from this world.

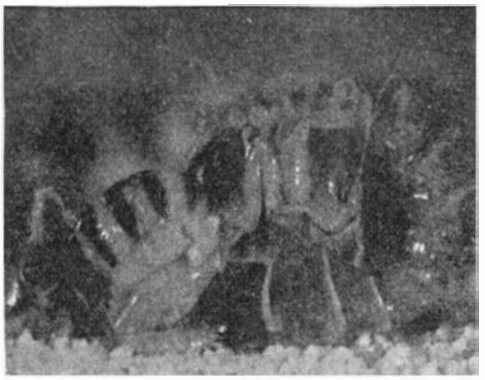
There is no set way of recording these dramas of the world under foot. New processes were evolved as we progressed. Every situation was different. Broadly, it was necessary to know which insects are natural enemies. Then we needed only to bring them together under conditions to which they are accustomed. I did not really direct these combats. Their lives within themselves are dramatic, terrific—for insect eats insect and gives no quarter.

As the sun beat down on the Arizona desert one day, I was recording a tribe of agricultural ants as they went with seeds to their storage bins at the nest. One turned aside. I followed him with my camera. He climbed a flowered plant and crawled out on a leaf where he found a drop of water, tiny yet larger than his body.

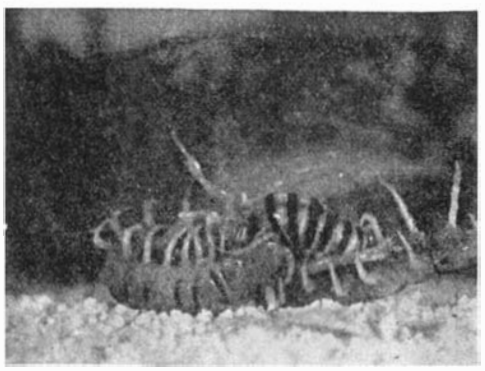
These sparkling dew drops serve as drinking fountains for insects. They are the "water holes" of the insect world. I observed him quietly as the camera's motor whirred. He was drinking from the surface. Carefully his mouth parts moved over the dew drop so as not to break the tiny bubble—but in his excitement and thirst he pushed the dewdrop off the leaf. Off it slid, leaving the little worker completely bewildered.



Scorpions locked in mortal combat, fencing for an opening in each other's armor through which the stinger can be thrust



A centipede and a sand cricket fighting; the centipede is holding the cricket at "arm's length" to avoid the powerful mandibles that could cause instant death



The end of the centipede-cricket fight; the centipede has just succeeded in closing his jaws in the final dramatic act

TRIBULATIONS OF THE TROPICAL

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
Retiring President, the American Association for the Advancement of Science

THE question, "What country is most distinguished in science?" admits of no simple answer. One or another will be found at the head of the list, according to the particular science under consideration and the criteria of distinction which are employed. But the inquiry, "What country is most distinguished in science in proportion to its population?" admits of less debate. Whether measured by the number of men of great eminence, such as Nobel laureates, or the volume and quantity of research publications, no nation, in proportion to the number of its people, surpasses Holland.

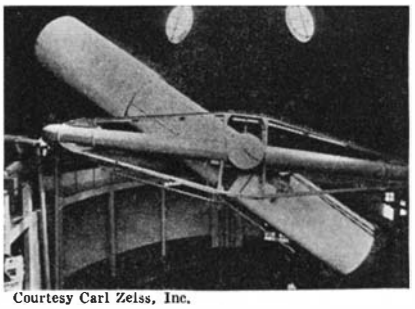
The cause of this eminence may well invite the careful study of students of race, education, and government; we are concerned rather with its results in the field of astronomy. Everyone knows the names of the lamented Kapteyn and the still active DeSitter, and the "Bulletin of the Astronomical Institutes of the Netherlands" is one of the most important journals in its science.

THE greater part of this fine Dutch work has been wholly or partly theoretical, for obvious reasons. Neither in latitude nor in climate are the Netherlands well fitted for great telescopes or observing stations of the first rank. Admirable work has been done with modest instruments at Leyden, Utrecht, and elsewhere, but the national situation lends itself especially to the discussion of observations obtained elsewhere, or to more abstruse investigations. The worldwide freemasonry of astronomers has time after time resulted in effective international co-operation, as when Kapteyn in his laboratory at Groningen, planned and supervised the measurement and calculation of the positions of the nearly half million southern stars of the Cape Photographic Durchmusterung. (Some of the actual work, by the way, was done by selected convicts from a nearby prison, who welcomed this change of occupation!)

But Holland has a great colonial empire in the East Indies, in the quarter of the world where observatories are fewest. There is—or was until recently—hardly a single large observatory within the tropics, though excellent solar work was done at Kodaikanal in southern India. The establishment of a notable institution in Java is therefore a matter of no small importance.

The foundation of the Netherlands India Astronomical Society in 1920 was intimately connected with the generous gift of more than 100,000 dollars from a wealthy Dutch resident, Mr. Bosscha, toward the establishment of an observatory. Though many of us have heard little of it, the Bosscha Observatory has just celebrated its tenth anniversary and the report of its Director De Voûte tells a tale of much interest.

Like all modern observatories this is "set on a hill"—more precisely on a mountainside—near the village of Lembang and some ten miles from the flourishing city of Bandoeng where full technical and machine shop facilities are available. It lies on a local ridge 4000 feet above the sea, with a quiescent volcano rising 2000 feet higher six miles or so away.



Courtesy Carl Zeiss, Inc.

The double refractor of the Bosscha Observatory at Lembang, in Java

The latitude is 6° 49′ south, so that the photographs of the telescopes have a curious look to those of us who are accustomed to work in the cooler part of the temperate zone. The polar axis, which as we usually see it is tipped up steeply toward the north, here lies almost horizontal and extends between two piers, the southern a little the higher. To point at the pole—which is so important in northern or southern latitudes—is no longer of any use since it lies in the mist of the horizon. The observer's interest lies rather in the equatorial zone and the region south of it. The northern sky, though equally accessible, is taken care of by other observatories.

Weather conditions seem strange enough to the northern reader. The average temperature varies very little throughout the year—the daily maximum ranging from 73 to 77 degrees Fahrenheit from month to month and the minimum from 58 to 61 degrees. The humidity, even in the daytime, averages from 60 to 75 percent. Just before dawn when the cooler air can hold less water it is always more than 90 percent.

The rainfall is heavy—88 inches a year, two-thirds of it in the rainy season from October to May. This seems very bad for astronomers, but only one third of the rain falls in the evening and at night, and hardly any after midnight when the chance of clear sky is as good in the rainy season as in the dry.

An observer's life under these conditions must be somewhat strenuous, and the care of his instruments too is far more arduous than here. Dew "falls" as soon as the metal of the telescope cools at night and in far greater amounts than in less humid regions, and De Voûte says that "all instruments become dripping wet when exposed to the dew process during the night observations. To protect the lenses from fogging it was necessary to use long dew caps about five times the aperture of the objectives; if they still get wet they are dried by means of an electric hair dryer"(!)

THIS is not all of the tale. Great care is necessary "in avoiding the formation on glass surfaces of fungi which, after some time, cause spots which cannot be removed. These fungi live in moist and dank air". They "secrete an alkaline matter, naturally only in minute quantities, so that only after a long time is its influence on the glass surfaces noticeable. Therefore a regular disinfecting cleaning after some months is the best safeguard. It is the glass surface of lenses and prisms built within the instruments which cause the greatest trouble, where every cleaning demands a readjustment." To cap the climax, "on account of the neighborhood of the volcano, the air generally contains hydrogen sulfide (H_2S)—most of the time so much that it becomes disagreeable—and this excludes the use of reflectors." Silver mirrors would tarnish hopelessly in a few days. The new aluminum coatings should behave better if the complicated apparatus for producing them could be set up in Java.

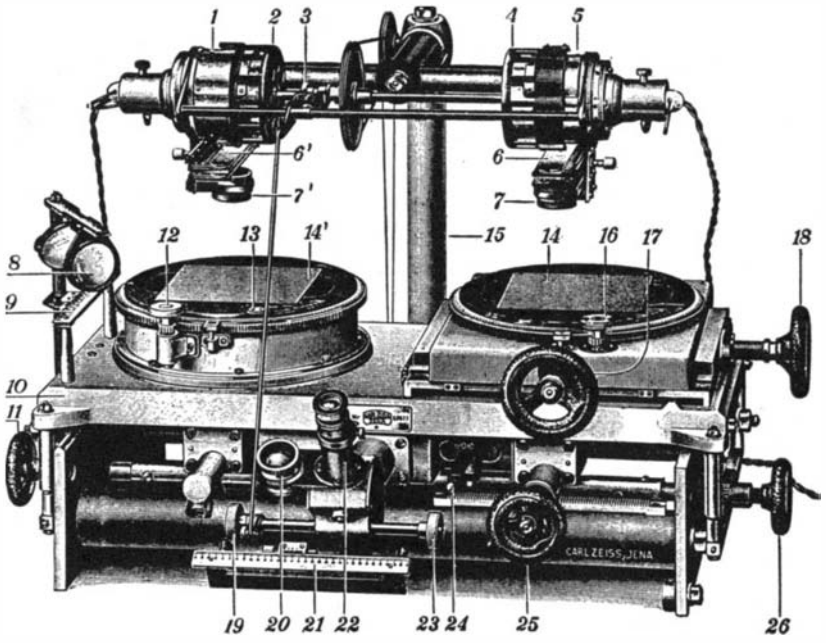
Finally, the Director remarks casually, "Earthquakes are in this part of Java rather weak, their origin being situated at a great distance in the Indian Ocean. Volcanic eruptions are not precluded, but the position of the Observatory is rather safe because it is

ASTRONOMER

situated on the most stable side of the volcano, the south."

An astronomer's work at such a station evidently contains a heroic element. There are compensations, though. The small temperature range and the usual absence of strong winds make the air steady and the seeing very good, so that close and difficult double stars have been measured in great numbers.

The principal instrument at the Observatory is a double telescope with visual and photographic objectives of 24 inches aperture mounted side by side. The important double star measures already mentioned were made with the one, and photographs for stellar parallax are being obtained with the other. Only one sort of work can be done at once, but this is no great handicap, for parallax observations must be made just after twilight or before dawn, leaving the rest of the night free for double stars. The cloudy evenings of the rainy season interfere seriously with work on stars in certain parts of the sky, but there remains an abundance to do.



In his article the author refers to "faint objects of large proper motion discovered with the blink microscope." Before this apparatus was discovered the method of search was most laborious. The astronomer took two photographs of the same star field several months apart, and one by one compared each star image with its corresponding image on the second plate. Today the same two plates are put on a blink comparator or flicker microscope and the image of the shifted star at once pops out from among its myriad companions. How is this done? In the (Zeiss) instrument shown above, the first plate (14′) is placed on the round table at left, the other plate (14) on similar table at right. Both are illuminated from above. The images of the two plates are picked up by diagonal mirrors within the base and passed to a half-silvered diagonal prism below the microscope (22). The two plates are now in rough coincidence, visible in the same eyepiece, and the use of wheels 17 and 18, with rotating screw 16, completes their perfect coincidence so that now but one star field is visible. Next the illumination is changed so that it illuminates the plates alternately. Hand screw 23 (or 19) does this (note vertical rod connecting shaft to control of illumination cut-offs above). Especially if the same alternation is done more rapidly by motor (note belt and pulley), the single displaced star image lost among all the rest will shift back and forth, blinking or flickering prominently

DE VOÛTE has just published the first reports of this work, which is very thorough—20 to 40 plates being taken and measured for each star—and the results appear to be excellent. The most interesting star on which he reports is Proxima Centauri, the faint star discovered by the late Dr. Innes, which shares the rapid proper motion of Alpha Centauri though more than 10 degrees away. His measures give a parallax of $0''.746 \pm 0.006$—substantially the same as that of Alpha Centauri—and fully confirms its relation to the latter. It will take a good deal more observation to determine with certainty whether this faint object is really a little nearer than Alpha Centauri (as indicated by Dr. Alden's measurements made at the Yale Station in South Africa) or slightly farther, as the later measures suggest, so we must wait to learn whether it is actually the nearest of the stars after all.

Most of his other stars are faint objects of large proper motion, discovered by various observers with the blink microscope. They are "good fishing," for among his first dozen he has caught two with parallaxes of $0''.20$ and $0''.21$—adding two more to the short list of stars nearer than five parsecs (16 light-years). Their photographic magnitudes are 11.1 and 12.9, so that one is 1/200 and the other only 1/3500 as bright photographically as the sun. This puts them definitely in the growing class of faint dwarf stars, though they are brilliant compared with Proxima which, measured photographically, is but 1/60,000 of the sun's brightness.

With these cares and duties, and with several smaller instruments to look after, one might expect the time of the small staff to be taken up fully by making and reducing observations. Yet the tradition of theoretical work is not neglected. Dr. Wallenquist, a Swedish astronomer and member of the staff, contributes an excellent "Miscellaneous Paper" on the distribution of stars in clusters. Photographs of a cluster show that the stars are much more thickly concentrated at the center than in the outer regions, but in the middle of the cluster as it appears to us we see not only the central stars but others belonging to the outer layers which lie in front or behind. By an ingenious and simple method our author has allowed for this and finds that the actual space-density of the stars near the center is from 70 to 400 times that near the edges. The brighter stars on the whole are less widely scattered than the fainter ones. This is no accident, but has a physical cause first worked out by von Zeipel. In a fairly close cluster individual stars must at times pass near enough to have their paths diverted by their mutual attraction before they escape from its influence. In the long run such encounters will on the average speed up the stars of small mass and slow down the massive ones. The former, having higher speeds, will get farther from the center of the cluster before the attraction of the whole mass brings them back. From the difference of their average distances the ratio of their masses can be found. Wallenquist has done this for stars of different brightness, and finds differences in mass which are in agreement with the law discovered years ago by Eddington.

Altogether, the work of this little isolated group of courageous and devoted astronomers does the highest credit to them and to the community in Java which supports them. Their brother astronomers in less picturesque climes join in hearty good wishes for the continued success of the Bosscha Observatory.—*Princeton University Observatory*, February 5, 1934.

WORKING and THINKING and EATING

THERE is not much energy concentrated in half a peanut, in a gram of cane sugar, in 1½ grams of white bread, or in 4 grams[1] of the edible part of a banana, yet, little as there is, there is enough in each of these portions to supply the surplusage of energy that an hour of intense mental effort requires.

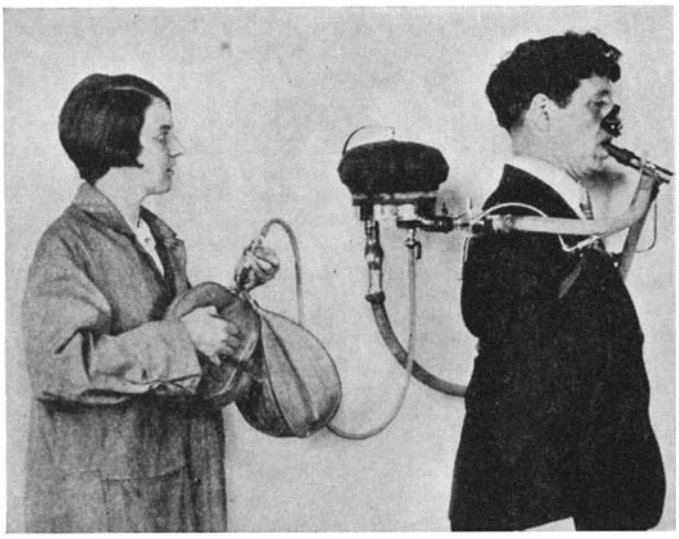
Indeed, so small is this demand that a housemaid engaged in sweeping and dusting the study of a college professor would expend as much extra caloric energy in three minutes as the professor would expend in excess of his basic needs during an hour of intensive work at his books.

These surprising statements were made by Dr. Francis G. Benedict, the Director of the Nutrition Laboratory of Carnegie Institution of Washington, in summing up the results of an experimental investigation of mental effort as it affects the metabolism of the body, an investigation which he and Mrs. Benedict have recently reported.[2] In effect, the study denies that there is any basis in fact for the popular belief that brain-workers, more than others, require food that, like fish, is rich in phosphorus.

REPORT of this study, recently published by Carnegie Institution of Washington, brings the great work that physiologists are doing in their field of investigation once again to general attention. To grasp the importance of the conclusions they have reached, some information is called for regarding the physiological processes of the body and the methods employed in their study.

Scientists tell us that our bodies are marvelously constructed machines, working with extraordinary facility and efficiency. Viewed as machines, they are of the nature of the engines of industry in which combustion of fuel releases energy which can be put to useful work. The energy required to walk, to run, to swim, to play tennis, to perform the countless activities daily demanded of us, is obtained through combustion of the food that is eaten. Food-stuff is, therefore, the fuel of the body and, as such, the energy-producing power of all the common items in our dietary can and has been determined.

Just as methods have been developed for measuring the amount of energy obtainable from various articles of food, persistent attempts have been made to devise ways of determining how much energy is expended when the body is called upon to perform tasks requiring special effort. It is in these reciprocally related fields of investigation that Dr. Benedict and the staff of the Nutrition Laboratory have been working for many years.



Apparatus used in measuring the energy expended by a subject while walking. The carbon dioxide in the exhaled air is absorbed by chemicals in the rubber-covered can on his back. The operator behind the subject holds two football bladders containing an accurately measured volume of oxygen which is fed into the closed circuit as needed to keep him supplied

Very early in course of his studies, Dr. Benedict found that even when the body is nominally at rest, with its "fires banked," so to speak, energy is being consumed.

The heart, for example, never pauses in its task of maintaining a head of pressure in the blood conduits of our bodies. The respiratory mechanism is constantly supplying us with the oxygen we need and removing the useless and harmful products of combustion. The thermostatic devices by which the temperature of the body is regulated and held constant are always functioning. The white corpuscles of the blood, "scavenger cells" so-called, are forever wandering about, amoebic-fashion, searching for infected tissues and clearing them of bacteria. Then, whether we are asleep or awake, glands are secreting their products, visceral muscles are rhythmically contracting, the nervous system, the master tissue which controls all the functions of the body, is being kept "in tone." In short, the body is a *living* machine which is obliged to expend a measure of energy simply in keeping alive.

The condition of the body in such state, Dr. Benedict has likened to that of a great factory that is awaiting the signal to begin the business of the day. The building is at a comfortable temperature, steam is up in the boilers, engines are purring, shafts and wheels and pulleys are idly turning, the operators are at their stations, all is in readiness to swing into action the moment the control switch is set. In such case, energy is being consumed, not much of it, but the necessary modicum to enable the factory to begin performing its appointed work, promptly and with full efficiency, when the starting hour arrives.

AS with the factory so with the body: maintenance of it in form fit for meeting either emergencies or the orderly routine of the day calls for a definite though relatively small expenditure of energy. The measure of this resting energy consumption is the measure of one's *basal metabolism*. This measure provides a baseline, so to speak, from which to determine the overplus of energy required in the performance of particular tasks calling for either physical or mental effort.

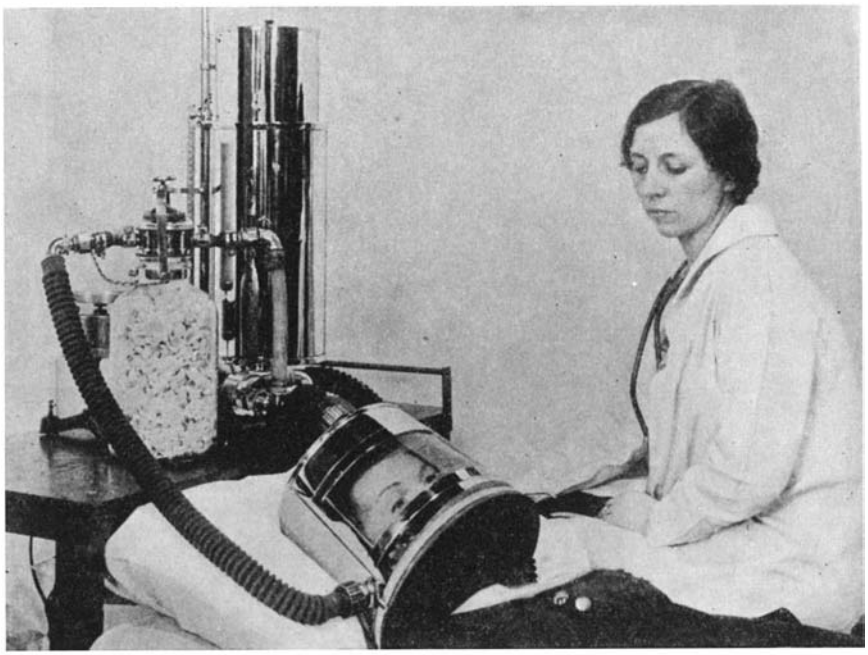
Countless studies of warm and cold blooded animals, and of man himself, conducted by Dr. Benedict and his staff, and by other workers in the field of experimental physiology, have led the investigators, slowly, step by step, to recognition that combustion of food by the metabolic processes of the body produces heat; that the heat so produced represents the energy available for work; and that, in the performance

[1] One gram is approximately 1/30 ounce.—*Ed.*
[2] *Mental Effort*, Francis G. Benedict and Cornelia Golay Benedict, being No. 446 of Carnegie Institution publications.

of a given task, the measure of the heat output in excess of that required by the basal metabolism of the body is the measure of the energy expended in such activity.

First steps in the attempt to determine the basal metabolism of the body, the factors affecting it, the heat-energy required in support of it, led Dr. Benedict to the construction of an air-tight and heat-tight chamber so arranged and equipped that a person could live in it under controlled conditions without discomfort for days at a time.

Ingenious devices and methods enabled the observer to record the amount of heat-energy produced by the person inside—when asleep, when resting quietly, after fasting, after eating a hearty meal, when engaged in muscular work of various intensities, when performing difficult mathematical calculations.



Measuring the energy consumed in merely keeping alive. The subject lies in a comfortable position, his head enclosed in an air-tight helmet provided with a window for vision. Although the apparatus differs somewhat from that employed in measuring the energy requirements of strenuous work, the principle upon which it operates is the same. The measure of the heat-energy required when the subject is awake, lying prone, quietly resting before breakfast when the digestive processes are at lowest ebb, is the measure of his basal metabolism

AFTER many observations, it was found that body metabolism is sensitively responsive to conditions and influences. A hearty meal, for example, will increase the heat output as much as 40 percent, and the increase, gradually lessening, may last from 10 to 12 hours. In prolonged fasting, on the other hand, heat production falls off rapidly for a time and then becomes relatively constant at a lower level. Exercise in any form meets a quick response in heat production and so do fluctuations in the state of one's health.

Consideration of all the factors affecting metabolism led to the conclusion that the heat-energy required by the vital processes alone, that is, the measure of the basal metabolism of the body, could best be determined when the subject is awake, lying prone, quietly resting, before breakfast when the digestive processes are at lowest ebb. Taken at such a time and under such conditions, Dr. Benedict is convinced that every healthy person will show a basal metabolism that is remarkably constant for that person. Having determined what the basal metabolism of a given subject is, it is a comparatively easy matter to measure the change made when he is assigned a task requiring special effort, either physical or mental.

Although the essential features of the method of measuring the energy demands of special tasks were developed through employment of the respiration chamber, already mentioned, in consequence of information gained through its use, the chamber was soon superseded by much simpler and less expensive apparatus.

That is to say, it was found that the consumption of oxygen, the production of carbon-dioxide, and the liberation of heat-energy, phenomena which always occur when fuel is burned or food is consumed, are all so closely correlated and occur in such constant ratios that, given one of these factors, the others can be found by simple calculation. In practice, then, all that the investigator needs to obtain is the exhaled air of the subject undergoing test; analysis and measurement of this exhaled air will give the amount of oxygen consumed, the only factor needed to determine the energy expended. Simple and convenient apparatus for collecting the expired breath, suitable for various types of experimentation, have been developed.

Through application of this method of measuring the metabolism of the body many interesting and important facts have been learned.

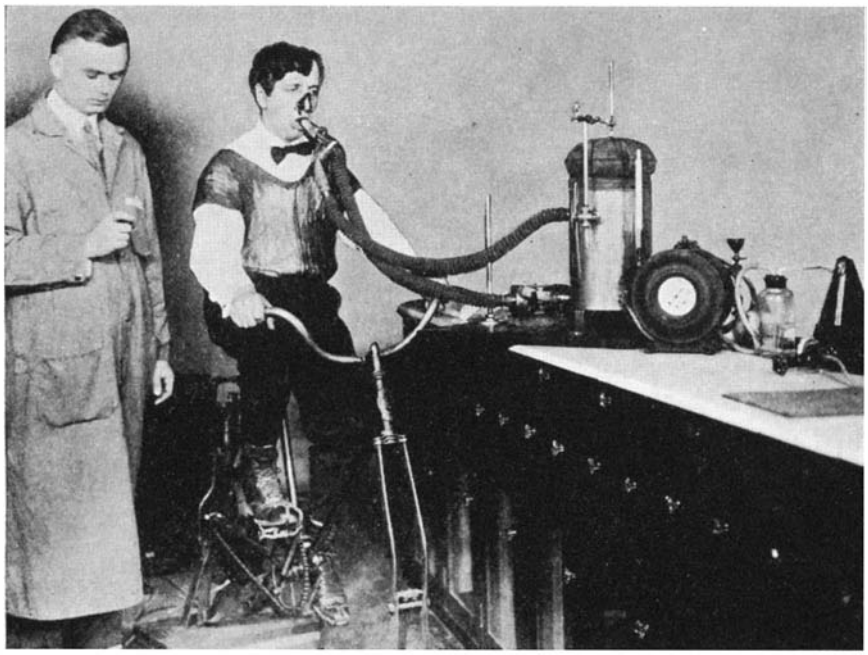
It has been found, for example, that although the basal metabolism of individuals differs, the heat-energy production of the average man in a group of 100, when lying quietly in bed before breakfast, is about one calorie per minute—just about the amount produced in the same length of time by a 75-watt electric light, or a burning paraffin candle of ordinary size. This represents the overhead cost, the cost prior to production, as Dr. Benedict puts it.

He adds: "Two lumps of sugar would run a man resting quietly for about an hour; a pat of butter, for one and one-half hours; and a doughnut would furnish the calories he would need for about three hours. Now, when he begins to move about the costs mount. Just sitting up increases the cost 5 percent, standing up 10 percent, a brisk walk will increase it by 200 percent, and a man working up to the limit of human endurance will increase it 1000 percent or more."

Putting the matter another way, many studies made by Dr. Benedict and his co-workers in this field show that, in general, a person engaged in a sedentary occupation requires 2500 calories per day to cover basal needs and the energy expenditure because of work. Farmers, on the average, consume about 3500 calories a day. Maine lumbermen have been tested whose energy expenditure reached 7000 calories; while Dr. Benedict reports a study made of a professional long distance bicycle racer who developed a metabolism of the rate of 10,000 calories per day.

SUCH energy provisions, it should be said, represent the need of the average member of the respective groups; they must be modified to suit individual requirements. Thus, for example, experiments show that a heavy man expends more heat-energy in support of basal metabolism than a thin man of the same height; that a tall man expends more than a short man of the same weight; that a man of 25 years of age expends more than a man of 70; and, as to sex, even though weight, height, and age are taken into account, a man's basal metabolism will run about 10 percent higher than that of a woman.

If the food intake, in a specific case, is greater in energy-yield than the individual expends in maintaining his basal metabolism and his normal activities, the excess is stored up in his



Respiration apparatus developed by Dr. Francis G. Benedict for measuring the oxygen consumed in strenuous work. The nostrils are closed by a clip and the subject breathes through a rubber mouthpiece. The exhaled air passes through a chemical that absorbs the carbon dioxide. Oxygen from another receptacle is fed into the air stream as needed, to supply the loss through combustion, the amount used in a given time being registered on a gas meter. The oxygen consumption being known, the energy expended in pedaling can be calculated

tissues in the form of fat and he takes on weight. On the other hand, if the food eaten yields fewer calories than the body requires, reserve stores are drawn upon, weight decreases, and energy production diminishes.

Dr. Benedict says that in the great proportion of cases the only reason people grow fat is that each day they eat a little more than they require. To quote from his discussion of this matter: "If you eat the equivalent each day of an ounce of butter *more* than you need what happens? You don't lose it; you don't burn it; it is digested, assimilated, and, note this, it is deposited as fat.

"ONE extra ounce of fat means a pound in about two weeks or 25 pounds a year. All this from but one ounce, say three pats of butter *extra* each day. Please note that I emphasize *extra;* that means three pats of butter *above* your daily needs. This goes on gradually, I might say insidiously, until the weight increases, the girth increases, the creases increase, and there you are.

"The best way of all to lose fat is not to get fat. If you are fat then it is nearly hopeless to attempt to 'work it off.' There is only one way to lose it intelligently, and that is to limit your intake slightly and burn it up slowly. Fats are, so to speak, twice as concentrated as starches and sugars; hence it is helpful if one avoids all visible fats in the food.

"Cutting out visible fats is usually not a great hardship, but of itself it is of no value if one over-eats other equally fat-producing materials. It is useless to cut out any particular article of the diet, such as bread or potatoes or butter, and then fill up on ice cream. Diets of salads and greens are sound in principle but may be easily overdone and produce digestive disturbances. The use of patent preparations to produce slimness is nonsense.

"There is no royal road to slimness. Diet reduction, at times demanding a Spartanlike abstinence from especially loved foods, is the only really logical procedure. It all boils down to a careful, intelligent curtailment of food or fuel intake. It might be termed 'scientific stoking.'"

Since the caloric value of all the commoner food-stuffs has been determined and since information is now available regarding the fuel requirements of persons working in the principal occupations, suitable meals can be provided for individuals which will enable them to do their work well and yet maintain their vigor and sense of physical well-being.

In making such provision, however, it is now clear, due to the recent study of mental effort made by Dr. and Mrs. Benedict, that no special dietary preparation needs to be made for the brain-worker.

In planning this investigation it was decided to study particularly the effects of mental effort upon heart rate, the mechanics of respiration, the carbon-dioxide exhaled, the oxygen absorbed, and the "respiratory quotient," the latter of which gives information as to whether the body is consuming proteins, chiefly, or carbohydrates. Extraneous activity, if any, was to be recorded and the heat production was to be calculated from the measured oxygen consumption.

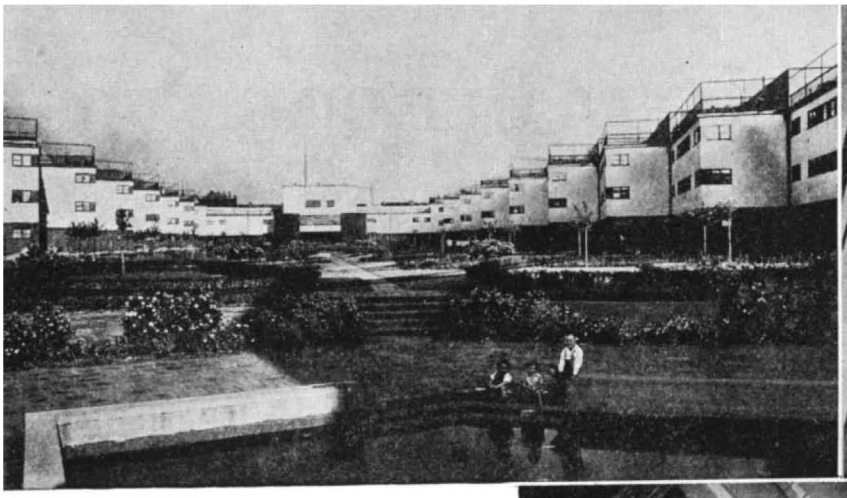
Six men and one woman were selected to serve as subjects. Of the men, five were university trained and two had the rank of college professor. The woman had been a professional accountant. All were in good health and records of their basal metabolism showed that they were physiologically normal in every respect.

The subjects were tested several times when in each of three mental states: awake but in "mental vacuity," that is, thinking of nothing; in a state of "mental attention," but without tension; and during sustained, intense mental effort, as in multiplying two-digit numbers, the entire process being carried out mentally and continued without interruption for an hour.

IN summarizing the conclusions reached, Dr. and Mrs. Benedict say, in part: "From a consideration of the various factors measured in our investigation it is concluded that sustained, intense mental effort causes an increase in heart rate; an insignificant, hardly measurable increase in respiration rate; a marked alteration in the character of the respiration; a considerable increase in the apparent total ventilation of the lungs; a small increase in the carbon-dioxide exhalation; a smaller increase (on the average, 4 percent) in the oxygen consumption and heat production; and a slight increase in the apparent respiratory quotient.

"The small increases in oxygen consumption and heat production are in large part to be accounted for by the increased muscular activity accompanying the increased ventilation of the lungs and the increased heart rate. Hence, making a most conservatively small allowance for the effect of increased circulatory and respiratory activities in this small metabolic increase, we conclude that mental effort *per se* is without significant influence upon the energy metabolism.

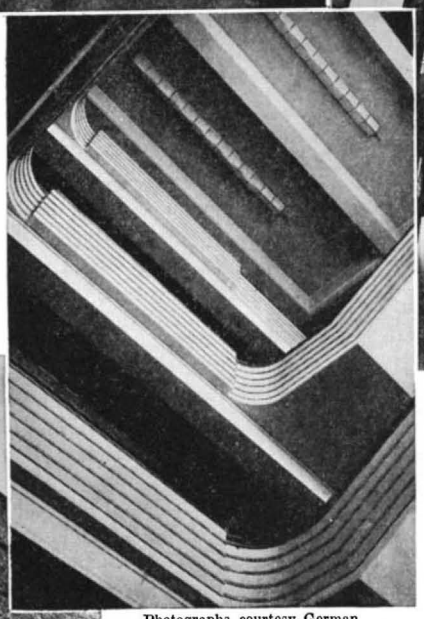
"In view of the sense of extreme, almost over-powering fatigue in both mind and body following sustained intellectual activity, it is surprising that brain-work has such an insignificant effect upon the general level of vital activity. This pronounced sense of mental and physical fatigue following mental effort, noted by so many brain-workers, can hardly be explained by the slightly increased physical activity of the heart and respiratory muscles. Our study gives us little, if any, direct evidence for a satisfactory explanation of this feeling of extreme fatigue."



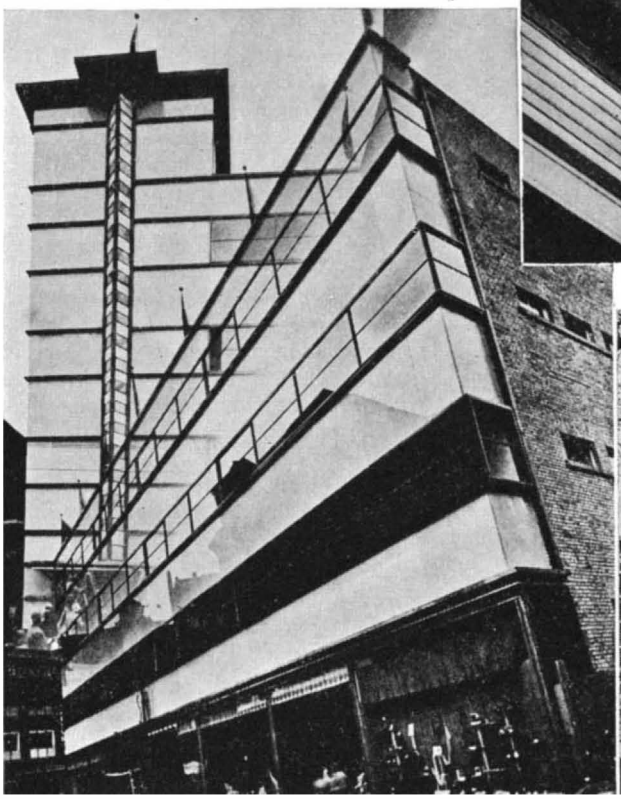
A group of residential buildings on the outskirts of Frankfurt-on-Main, in which the indented arrangement makes it possible for sunlight to enter every room. Although the buildings are uniform in character, touches of individuality are provided by garden and grass plots

Above: A staircase tower entirely constructed of reinforced concrete and glass, so that the spiral stairway receives a maximum of light

Right: Looking up through the well of a modernistic staircase: Town Hall of Rüstringen

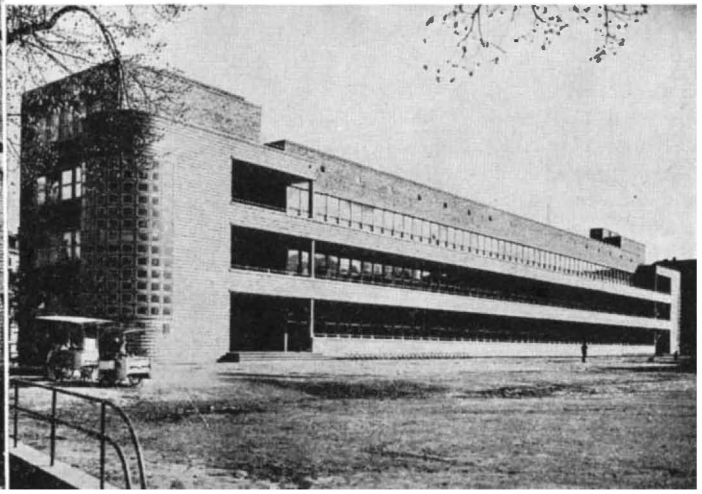


Below: Distortion by the camera lends odd angles to the walls of this modern retail store in which continuous windows supply ample light



Photographs courtesy German Tourist Information Office

Below: The Labor Exchange in Kiel, in which long undivided offices extend the entire length of the building, an arrangement which is admirably suited to the purpose for which the structure was designed



Modern Architecture in Germany

THE history of a thousand years of architecture may be read in the walls of buildings throughout Germany; but, on the other hand, a modern trend toward designs demanded by special purposes will be found side by side with the old. This newer architecture, examples of which are shown in the above group, is rapidly growing in favor, not only because of the individualistic expression which may be obtained by means of it, but also because of its adaptability to purposes of business and industry. Great stress is being placed by architects on the fact that the purpose of new buildings and their internal arrangement should be honestly and clearly indicated by their façades. Although this objective fitness is the keynote of construction, the personal expression of artistry is not precluded, and great factories and halls that have been erected not only symbolize their purpose but also appeal to the eye and stimulate the sense of appreciation.

WHY THE NEW NAVAL BUILDING PROGRAM

By HENRY L. ROOSEVELT
Assistant Secretary of the Navy

THE fundamental naval policy of the United States, which has been affirmed for many years, is: "To maintain the Navy in sufficient strength to support the national policies and commerce, and to guard the continental and overseas possessions of the United States."

The obligation laid upon the Navy by the enunciation of this policy is a grave one, far reaching in scope, and presenting many difficulties. The Canal Zone, the insular possessions, and Alaska combine to present a problem very different from one involving only coast defense.

The United States is a signatory to international treaties which establish the naval strength of the several great powers, not only as to total naval tonnage, but as to the numbers, size, and armament of the several categories of ships.

This definitely fixes the size of our Navy and precludes the old discussion of what is an adequate Navy. There can be no question of naval races for supremacy. The ratio is established and each country that is a party to the naval treaties has but one obligation and that is to keep naval building programs within treaty limits.

My position on the question of national defense is quite clear. I am for a Navy second to none: A Navy built to the limit of our treaty commitments; and a definite national policy of continued building that authorizes the President to construct such vessels as may be necessary to replace obsolete vessels in order to maintain the Navy at treaty strength, and thereby to evolve a logical, orderly plan for the maintenance of the Navy that will also promote efficiency and keep expenditures at a minimum.

For our national security it is not sufficient to have the will to enforce a principle which is firmly held and avowed. There must be a clear expression of national purpose accompanied by evident and sufficient means to carry it into effect, provided the policy is maintained with a courteous consideration of the rights and susceptibilities of other nations. This will afford the surest safeguard against war. On the other hand, no condition is more hazardous than the existence of the dormant popular feeling which may be fanned to fever heat by a moment of great passion and behind which lies no organized power for action.

IT is necessary for the protection and security of our national ideals, commerce, and continued pursuit of peaceful occupations, for this nation to have international police protection in the form of a protective navy. In my opinion a navy is the very cheapest national insurance that can be procured but it must be adequate to give full protection. A famous Admiral has very aptly remarked, "A second best Navy is like a second best poker hand—worthless when called."

It is, therefore, most essential that this country build its Navy up to full treaty strength and maintain it in a most efficient manner. This is believed to be the very surest preventive measure to avert trouble as long as we pursue a policy of non-aggression and so long as we remain a peaceful nation. Only a few days ago the President reiterated our resolve never to seek another yard of territory by conquest, and we have renounced war as an instrument of national policy. What nation on earth will be enticed to attack a nation with a Navy second to none, ready for any emergency, and backed by our national resources?

ON the other hand, an unprotected nation with our far-flung commerce, distant possessions, and wealth may easily attract an avaricious and greedy enemy to attack and make war on any slight pretext. Then consider the cost in human life and wealth to rise and resist the invader.

In our own enlightened land if it is considered necessary to maintain an effective police force it would seem to me that the international situation reveals nothing of so encouraging a nature as sufficiently to justify our not having a Navy.

Our danger is that we sometimes fail to have a comprehensive idea of our needs until it is too late. In that case the expense in both lives and property is tremendous and many times greater than the insurance cost would have been had foresight and vision been exercised.

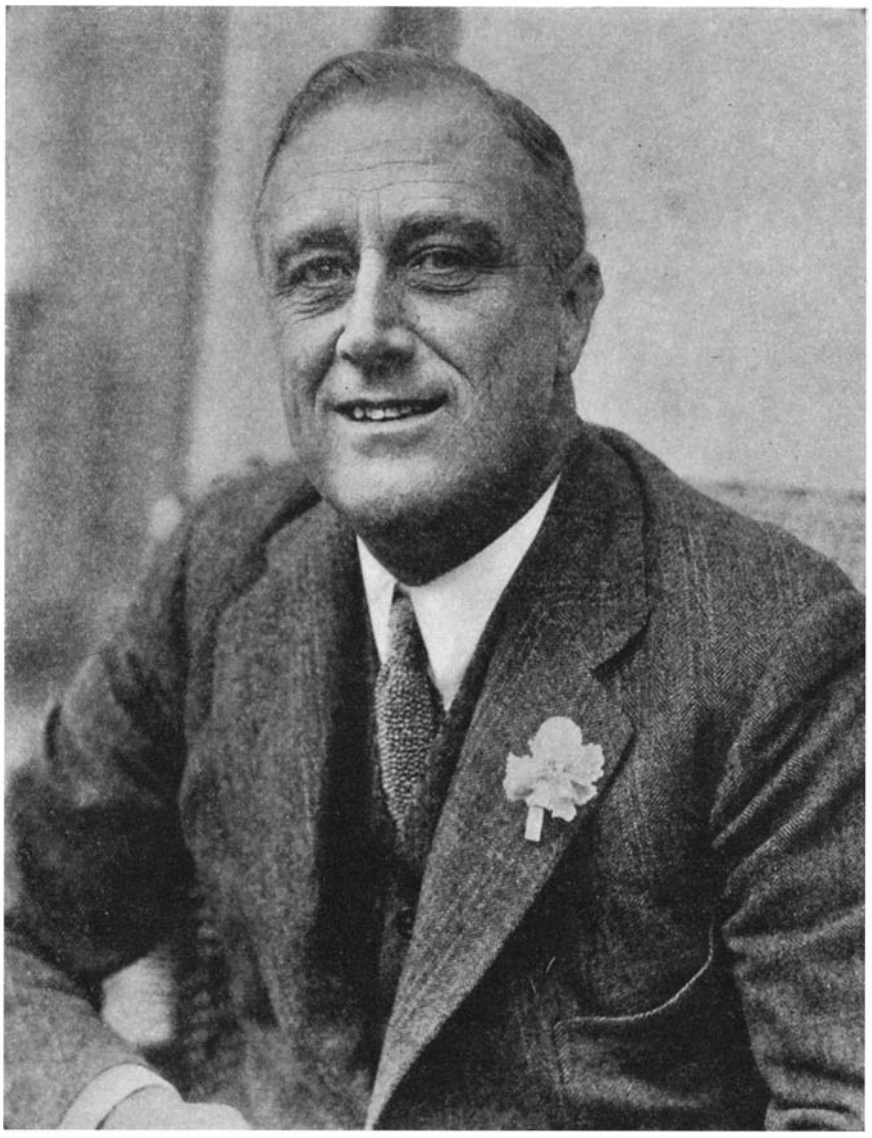
The mission of our Navy is to keep open our lines of communication and to protect our country from attack by an enemy. Our trade extends to every quarter of the globe. It is the very life blood of our industrial and agricultural prosperity. It is necessary that the sea lanes be kept open when other nations are at war. Our neutral rights must be respected by belligerents. The ocean roads to our own possessions in the West Indies, our immense coast lines on both the Atlantic and the Pacific, the Canal Zone, as well as our trade routes to all the markets of the world, these are as much integral parts of our transportation system as the great railroads that span our continent. Over these lines that traverse every ocean and enter every port, are carried the exports and imports which turn the wheels of our factories and supply the necessities for our national well-being.

In the protection of our own coasts there is a general misconception as to the strategy involved. With fast light forces

Is Necessary

and aircraft engaged in modern warfare it becomes necessary to advance the first line of defense far seaward. This is to cut off raiders and commerce destroyers and to prevent aircraft carriers from coming in close enough to launch air attacks on our coasts, and though our policy is purely defensive, since we have vast interests beyond the seas, it follows that the Navy can not be limited purely to coast defense. And it must be added as a military axiom that war, however defensive in moral character, must be waged aggressively if it is to be brought to a successful conclusion.

From the standpoint of those who are responsible for the readiness of the Navy to meet the demands of national defense it is extremely necessary that the future composition of the fleet be known as far in advance as possible so that personnel training and strategic and tactical plans for probable contingencies may be made on some definite basis.



President Franklin D. Roosevelt was Assistant Secretary of the Navy during the World War when the unpreparedness of our Navy made it necessary to inaugurate an inefficiently speedy naval building program. He has shown himself sympathetic to the needs of the Navy since his inauguration as President

PRESIDENT ROOSEVELT in the early part of his administration wisely decided to add to our sea strength and authorized the expenditure of 238,000,000 dollars from the Public Works Program for the construction of naval vessels. This work was started promptly and has done much to revive the American shipbuilding industry, as the new construction was allocated to both government and private yards on both coasts.

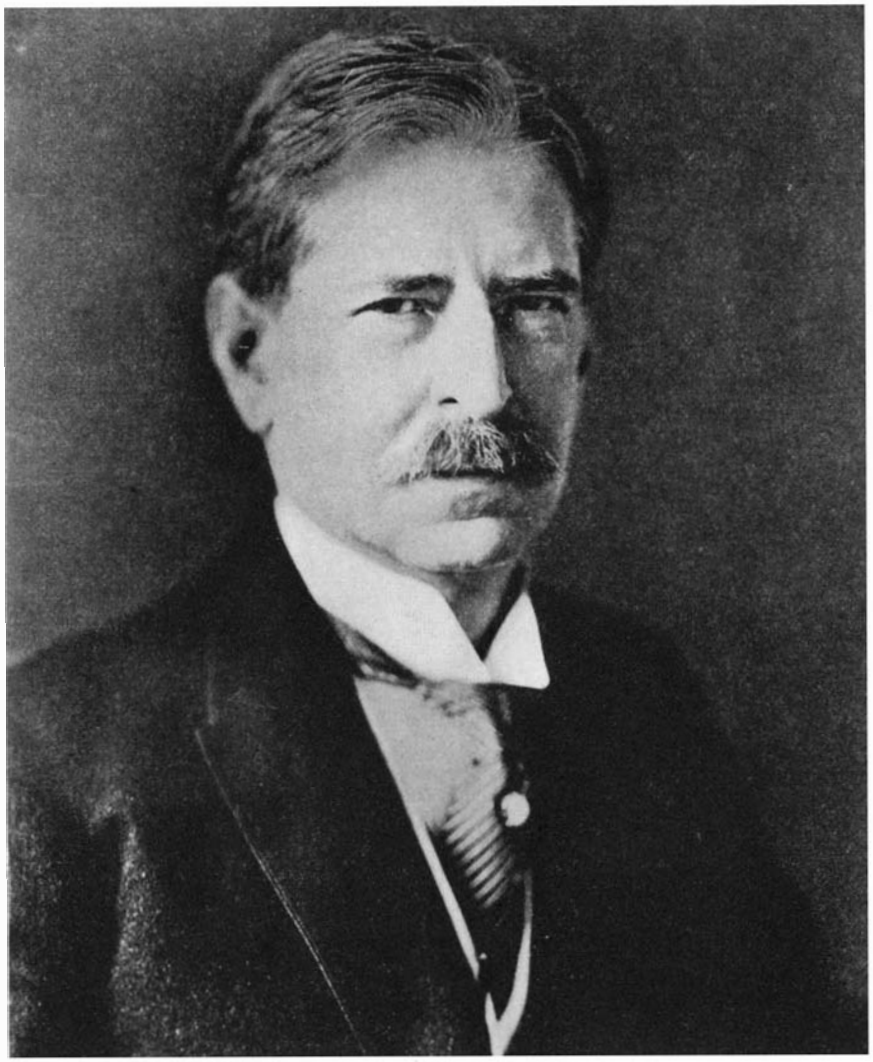
The new building program is a step in the right direction and we are at last upon the road to the realization of a Navy built to treaty strength.

The primary purpose of building men-of-war is to provide means for protecting our interests and for supporting our policies. In addition to this, however, the effect of shipbuilding as a stimulus to industry can not be overemphasized. In the first place employment is provided for many thousands of skilled artisans whose special training and abilities are essential to our continuance as a sea-faring nation. In the second place, the building of a ship is a truly national undertaking, in which every state of the Union contributes a share. Steel, lumber, paint, machinery, electrical equipment, metal fittings, furniture, and so on, come from widely separated sources and in great quantities. The assembly and transportation of these materials provide occupation for additional thousands with the accompanying circulation of wealth which recently has been so badly out of adjustment. Then, when she is completed, each ship will require fuel, food, ammunition, and other supplies of many kinds. Almost all of these come from domestic sources even when the fleet is cruising in foreign waters.

By having an orderly program of replacement, our ship yards will carry a constant load and give steady employment. Our ships will be cheaper and vastly better. They will be better designed and better built. More opportunity will be given for general improvement in machinery and equipment. There will be a steady improvement in the building of each vessel and ships will become over-age in normal numbers and not by large groups at the same time.

A fleet is like the fire department of a large city. It must be organized and equipped to meet any conflagration on instant notice. It must be of the necessary strength to cope with the existing emergency. It can never afford to come out second best in any major encounter. A good fight in the sporting world may be acclaimed; but with the destiny of a nation at stake the only type of a navy to have is one in which we have assurance that it will be successful in repelling any hostile attack on our shores, or, in case of war between other nations, will compel respect for our neutrality and the non-interruption of our seaborne commerce which is so vital to our prosperity and national wealth.

The fleet is our first and most important line of defense. The fleet must be ready every day for a national emergency and for that fleet to be deficient in either strength or training is to court disaster. The expenditures already made will not only be lost but irreparable damage may follow. Replacements in a navy take time; two to three years are required to build a ship and the same length of time is necessary to develop a trained crew to fight her effi-



I believe one of the strongest guarantees for peace and justice is an adequate United States Navy - a treaty Navy second to none.

Claude A. Swanson
SECRETARY OF THE NAVY.

ciently. It is apparent, therefore, that when an emergency does come we must rely upon our effective units ready at the moment to provide the insurance against catastrophe.

The naval treaties of the past 14 years have tended to cut down the size and number of ships allocated to the several great powers but they have put a premium on naval efficiency. With a limited number of ships, superiority can be attained only by excellence of performance. As a consequence, more than ever the training, morale, and intelligence of the naval personnel must be stressed and safeguarded.

IN our enthusiasm for material let us not overlook the necessity for an adequate and contented naval personnel to man and fight those ships efficiently should the occasion demand. The training of men requires time and experience. Men-of-war with undermanned crews on board are inefficient for a campaign. It is dangerous to allow the personnel of the active fleet to fall below proper complement, and reduction in personnel allows no reserve to call on for the rapid expansion necessary in time of an emergency. To do so is to flirt with fate and is poor economy.

In building a navy care must be exercised that the balance is maintained between the types of vessels. The fleet not only must have capital ships, heavy and light cruisers, plane carriers, destroyers, submarines, mine planters and mine sweepers, but must have an adequate naval air force, equipped and trained for the special type of air work required by the Navy. It must be remembered that naval aviation has problems that present great difficulties and complexities. The strides made by the Naval Air Force are most encouraging

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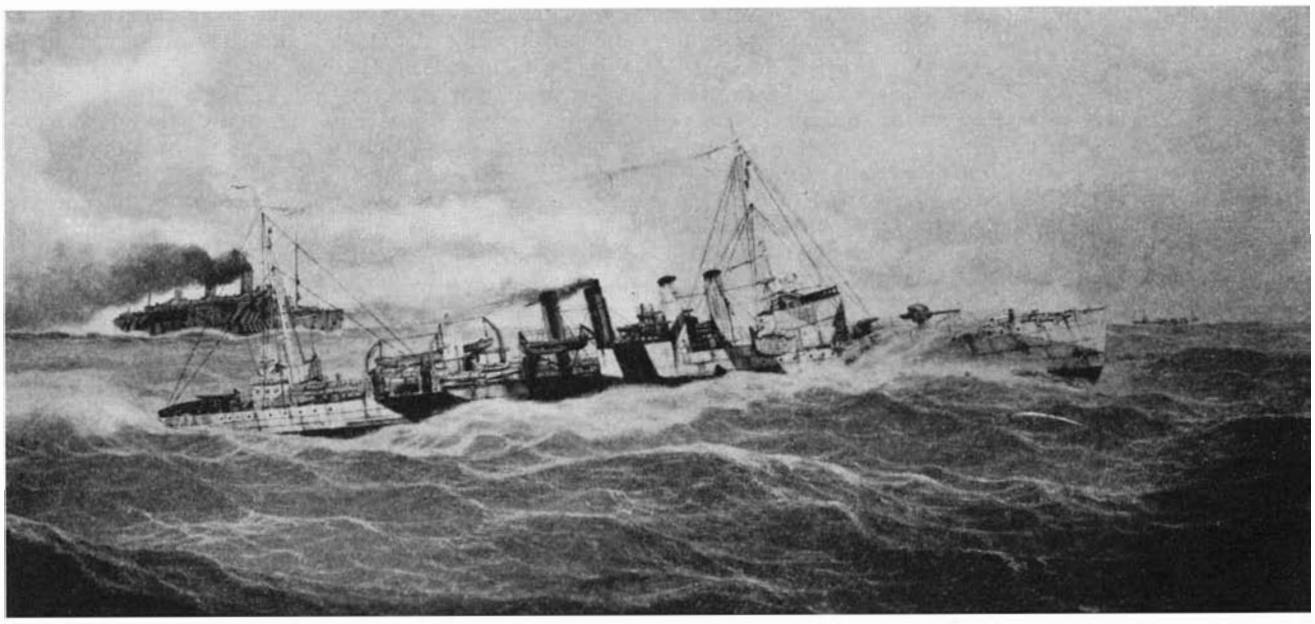


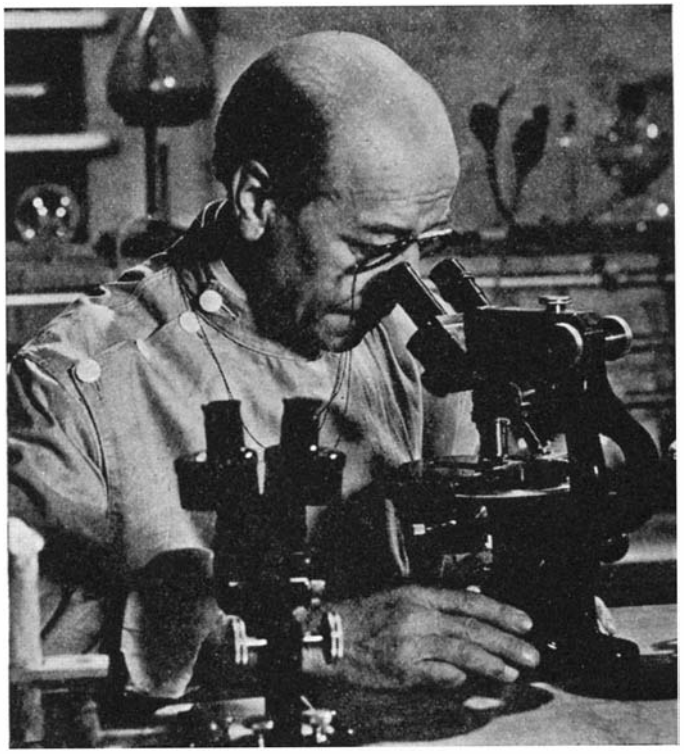
Destroyers of the United States during wartime. From a painting by Burnell Poole

THE AMATEUR AND HIS MICROSCOPE—X

MOUNTING SPECIMENS

By JOHN F. BRANDT
Bausch & Lomb Optical Co.

IT may be well for us to pause in our exploration of the microscopic world to learn the fundamentals of permanently mounting the more interesting specimens which we discover, and so start our slide collection. The subject of mounting different types of specimens, with all the different techniques and reagents which are involved, is too broad to be covered in this article. What can be done, however, is to cover the general method and define the terms, thereby giving you a basis upon which to work when you go to the more technically worded reference books on the subject. An excellent book for the beginner is "Animal Micrology" by Michael F. Guyer. Two reference works which cover the subject quite thoroughly and should be in every microscopist's library are McClung's "Microscopic Technique" and Lee's "Microtomist's Vade-Mecum."



Using one of the finest and newest research microscopes

THE mount usually consists of a slide—3 inches by 1 inch is the standard size—upon which the specimen is affixed in a mounting medium with a cover glass over it. On the upper surface, and at the left-hand side of the slide after it is placed in the microscope for properly viewing the specimen, is a small square label giving the maker's name, and data concerning the specimen (see illustration). Notice that the word "usually" is used. Often such comparatively large specimens as crystals and minerals are mounted in pill boxes, but since this requires no technique we shall not need to consider it here.

The general plan in mounting a whole biological object is as follows: (1) Killing and fixing, (2) washing, (3) staining, (4) decolorizing, if necessary, (5) dehydrating, (6) clearing, and (7) mounting. Comparatively few objects can be mounted whole; they must be sliced to translucent thinness, or "sectioned." In the case of some specimens, such as plant stems, sectioning consists of nothing more than slicing it with the razor. However, with others, such as earthworms, this method would seriously distort the cell structure and give us an untrue image. We therefore mount the specimen either in paraffin or celloidin, which permeates the structure and holds it stiff while it is being cut.

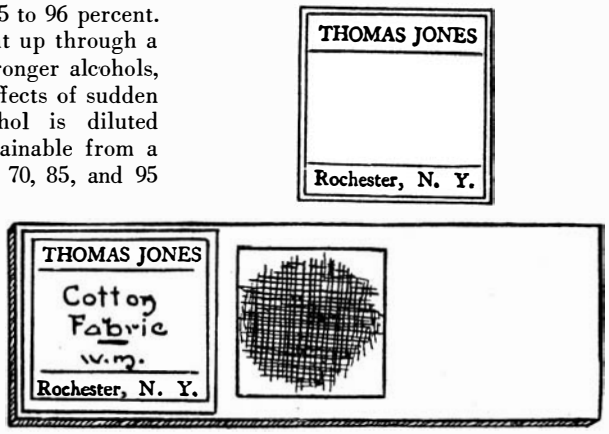
The first four steps of either the paraffin or celloidin method are the same: (1) killing and fixing, (2) washing, (3) hardening and dehydrating, and (4) absolute alcohol. For the paraffin method the added steps are: (5) de-alcoholization (xylol), (6) melted paraffin, (7) embedding, (8) sectioning, (9) affixing section, (10) removal of paraffin, (11) through alcohols to stain, (12) staining, (13) washing, (14) dehydrating (after decolorizing, if necessary), (15) absolute alcohol, (16) clearing, and (17) mounting. For the celloidin method the corresponding steps are: (5) ether-alcohol, (6) thin celloidin, (7) thick celloidin, (8) embedding, (9) sectioning, (10) staining, (11) washing (and decolorizing, if necessary), (12) dehydrating to 95 percent alcohol, (13) clearing, and (14) mounting. It is suggested that the reader put the above in the form of a chart in his notebook, so that he will have it for ready reference when needed.

Just reading over the steps necessary to mount a specimen is enough to make one throw up one's hands in despair of ever mastering such a complicated technique. But it is really not quite so hard as it looks. The thing to do, of course, is to start with some specimen which is quite easy, and gradually progress to the more difficult ones. Do not try to learn the method by heart; just follow directions in making up one mount and thereafter you will discover that you can rattle off the necessary basic steps without any effort.

KILLING, fixing, and hardening are often done with the same reagent. The purpose is to destroy the life in the tissues in such a manner that they will retain as nearly as possible the same form as they had when alive. This can be done by instantaneously killing and fixing, or by first anesthetizing and then killing. The purpose of fixation is also to make such changes in the organisms that later staining or other chemical treatment will bring out certain characteristics or parts of the structure.

The fixing agent is now washed out either with water, as is usually the case, or with alcohol if certain fixing reagents are used. After that it is necessary to dehydrate the specimen at once by passing it through a series of alcohol solutions of different strengths until it reaches a solution of from 70 to 95 percent alcohol, depending upon the clearing agent to be used. The alcohol referred to is regular grain alcohol, though denatured alcohol may be used on occasions. It must be remembered that denatured alcohol, besides being only 70 percent, also leaves some sediment on evaporation. Grain alcohol, as

regularly sold, is from 95 to 96 percent. The sections are brought up through a graded series of ever stronger alcohols, to avoid the distorting effects of sudden dehydration. The alcohol is diluted with distilled water obtainable from a garage. Solutions of 50, 70, 85, and 95 percent are most generally used. These alcohols, when used, are not necessarily useless thereafter. When you have finished with them, they may be poured into *separate* containers labeled "Used 50 Percent Alcohol", and so on. The used alcohols naturally contain more water, since they dehydrated the specimen, but the amount of water absorbed from one specimen is not enough to do any harm.

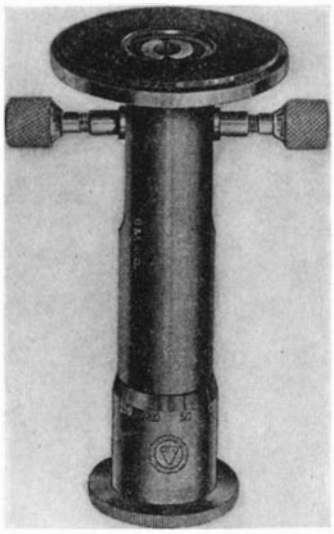


Above: **A typical finished microscope slide with label and, *at top,* the same label before filling out**

We now de-alcoholize and clear the specimen. Both operations are usually done by the same agent, and the purpose is to remove the alcohol to make way either for the embedding material or the mounting medium, and to make the specimen more transparent to light. Xylol may be used as a clearing agent; so may carbolic acid dissolved in absolute alcohol. (Absolute alcohol is made by adding a little calcium chloride to 95 percent alcohol. This settles to the bottom and does no harm, but absorbs the 5 percent of water.) Very often, however, one of the essential oils is used, such as cedar oil and analin oil. The general characteristics of a clearing agent are that it must be able to remove the alcohol from the tissues, must have a slightly higher refractive index than the tissues into which it is to penetrate, and must be miscible with the imbedding material or the mounting medium as the case may be.

THE de-alcoholization and clearing completed, we proceed to mount the specimen on the glass slide. Practically all specimens are mounted in Canada balsam dissolved in xylol, but this is not a necessity. Some specimens are mounted in glycerin or glycerin-jelly, and there are other mediums much the same as balsam, such as gum damar, hyrax, or euparal dissolved in either xylol, turpentine, or benzol. The amateur need not concern himself for quite some time with any but the Canada balsam dissolved in xylol; that is, the usual commercial liquid balsam.

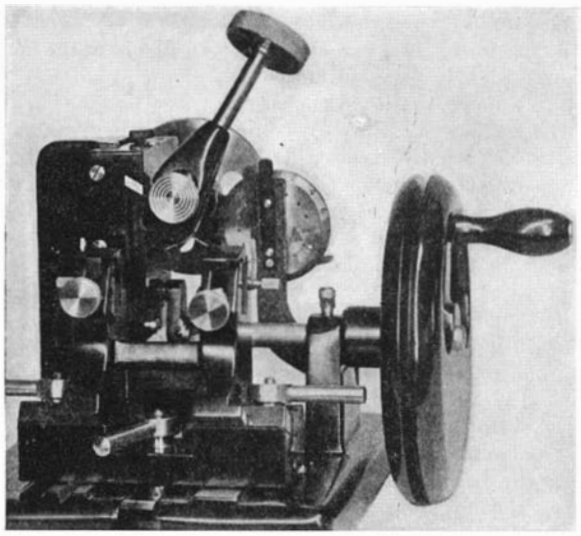
It is not always possible or desirable to mount the whole specimen. Sometimes we wish a cross-section. To do this we infilter the specimen with either paraffin or celloidin (these are the most common methods, though freezing and sometimes the use of other substances are resorted to) so that it will be stiff enough to cut without distortion. In general, the specimen is taken from the absolute alcohol and immersed in a mixture of one-half alcohol and one-half xylol. It is then immersed in plain xylol. Then it is removed and immersed in a mixture of one-half xylol plus one-half melted paraffin, and next into melted paraffin for a varying amount of time according to its size. Then it is transferred to a small mold of more paraffin. When the paraffin has hardened the specimen in the paraffin is taken out and the whole thing is sliced either freehand with a very sharp razor, or with the aid of a Well microtome or automatic microtome (see illustrations). The sections are then affixed to the slide, the paraffin is dissolved by xylol, and mounted in the usual way. The celloidin method is much the same, as can be seen from the general plan given above.



The Well microtome. The object is placed in the central part and is moved up by a micrometer screw, then sliced off with a razor

The purpose of staining, as was explained in the article, "Examining Milk for Bacteria" (March, 1934), is to bring out certain features of the specimen which we desire to study, or to heighten contrasts within the specimen. Sometimes only one color is used and at others two, three, or four, the further to increase the contrasts. Explanation of the staining has been left to the last because just where we make use of it in the process of mounting depends upon whether the stain is in aqueous solution or alcoholic solution. A stain in aqueous solution should follow the washing, and a stain in alcohol solution should follow dehydration—or whatever point in the dehydrating procedure the percent solution of alcohol equals the percent solution of alcohol in the stain. Some stains are dissolved in 70 percent alcohol, while others are in 95 percent alcohol. Stains can be used over and over again, almost indefinitely.

THERE you have the general groundwork for an understanding of the various methods of mounting specimens. Though it has been given as briefly as possible it may seem complicated, since methods of procedure and exact details have been omitted. These are given in the books named near the beginning of the present article. But we learn by doing, so let us take some simple specimen and mount it as the first step in forming our slide collection.



An automatic microtome (the new Minot rotary type). Such microtomes are equipped with automatic feeding mechanism and the worker makes his sections simply by turning the crank. They are essentially highly refined and glorified automatic ham slicers, but the slices taken can be made as thin as one 12,000th of an inch

THE following instructions were prepared by Julian D. Corrington, Ph.D., of Ward's Natural Science Establishment, Rochester, N. Y. Readers will recall that Dr. Corrington was the author of the article entitled "Exploring Unknown Waters," in the November and December numbers of this magazine. He writes:

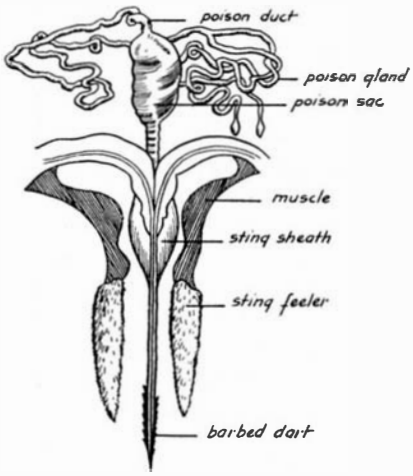
KILL a worker honey bee with cyanide, or by crushing or cutting off the head with scissors.

Allow to soak in water for 24 hours. Then place in a Syracuse watch glass of fresh water.

With forefinger of left hand press gently upon the abdomen of the bee, at the same time pulling cautiously upon the sting by grasping it with a forceps held in the right hand. Usually the entire stinging apparatus is expelled intact by this method. Even experts ruin an occasional specimen, so it will be best to have several soaked bees available.

Examine with hand lens, as the sting and its parts float in water, to see that all parts are present. Refer to the illustration. If these parts are not all present, or if any are torn or otherwise imperfect, try again with another specimen.

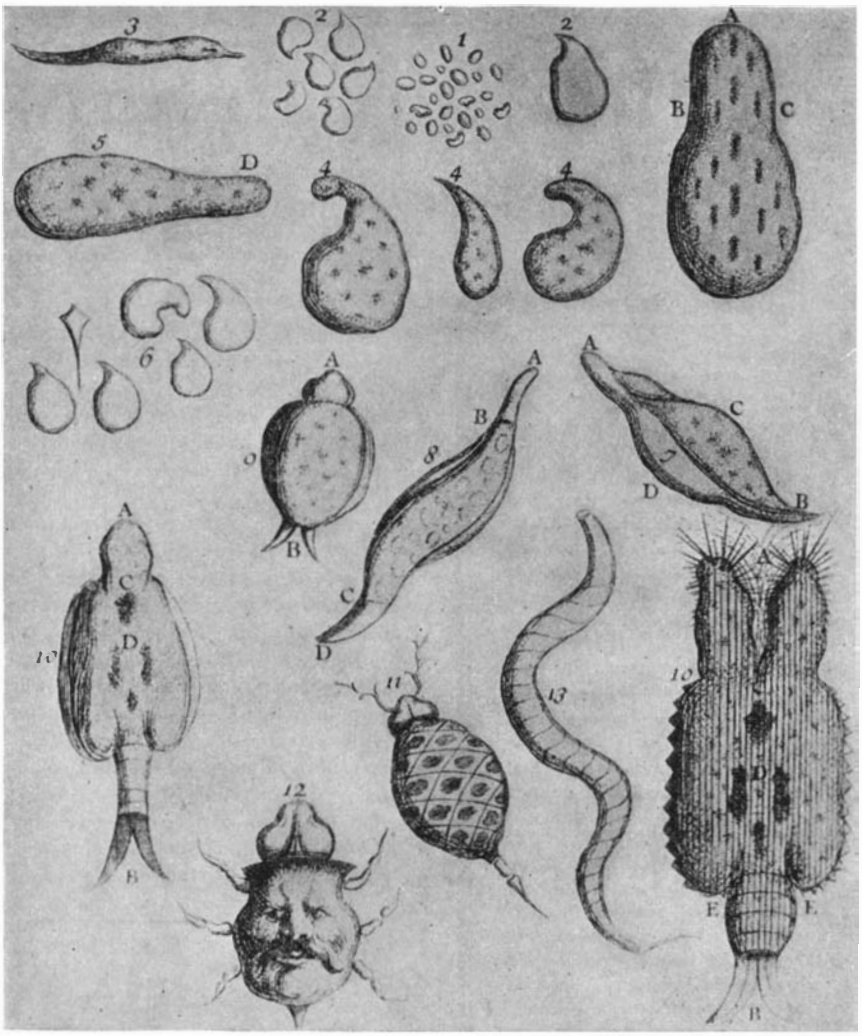
If the sting is complete, draw off the



Sting of honey bee, showing parts which should appear on the slide

water with a pipette and replace it with 10 percent formalin. This is the fixer. Prepare by adding ten parts of tap water to one part of commercial (full-strength) formalin. Allow to act for one-half to one hour. Each chemical throughout this technique is to be drawn off with a pipette, to be replaced with some other solution. Do not at any time allow the sting to become dry. It is best, if possible, to prick the poison sac with a needle, to insure penetration of the reagents.

Rinse the specimen and wash out the fixer by several (two or three) changes of tap water; five minutes each.



An old woodcut of what an early micrographer believed he saw in a drop of water. Note especially the (rotifer?) at 12, with the complete face of a man

Stain for five minutes with a 1 percent aqueous solution of either eosin or light green. Examine. If the stain is too weak, allow to act a longer time. Stains should not be too intense.

Wash in water, to remove excess stain and to check the action of staining.

Successively pass through 50, 70, 85, and 95 percent alcohols; 10 minutes each.

Examine. If the stain is too intense, apply acid alcohol (one percent of hydrochloric acid in 95 percent alcohol) for one minute, washing in fresh 95 percent alcohol to check the destaining. If not sufficiently decolorized, allow the destain to act for a longer time. The destain acts rapidly and may easily remove all of the color; if it does you must restain.

Apply absolute alcohol, 10 minutes. If not available, use carbolxylol (melted carbolic acid crystals, one part; xylol, two parts); likewise for 10 minutes.

Xylol (xylene), 10 minutes, or until the material is translucent (clear).

Transfer specimen to the center of a clean slide. This is best accomplished by using a small strip of cardboard as a lifter. Get under the floating material with the cardboard strip and lift up, depositing material on the slide, together with a few drops of xylol. A camel's hair brush or section lifter may also be used. Avoid forceps or other implements that might tear the delicate tissues.

With xylol to float the material, carefully orient it under the lowest power of your microscope. With needles, shift the parts around so that they are properly spread out for study. Avoid overlapping parts. Have the sting vertical to the observer.

Blot off excess xylol with filter or blotting paper, or slowly and carefully tilt the slide so that the xylol is drained off without disturbing the position of the specimen.

Add two drops of medium-thick balsam and apply cover glass. It is frequently advisable to place several fragments of a broken cover glass around the specimen, to act as cover glass props, preventing crushing of the material. Add the balsam carefully, so as not to disturb the position of parts. Place the slide away in a flat position for at least a week, to dry thoroughly. Then clean and label.

How Not to Swim Faster

By PETER V. KARPOVICH, M.D., M.P.E.
Professor of Physiology
Springfield College, Springfield, Massachusetts

THE author of the accompanying article tells how the science of physics has contributed definite knowledge to the sport of swimming. Swimmers have been experimented on just the same as ship models towed in towing tanks, to determine their water resistance. Athletes long since ceased to smile at such studies, for they are known to have caused too many records to be pushed up. One of the "secrets" of the longstanding successes of the famous crew coach Courtney at Cornell was the fact that he quietly called in some professors at the college of engineering at the same institution and caused technical studies of the dynamics of the rowing stroke to be made. These studies altered various ancient and honored preconceptions regarding the stroke, and helped bring Cornell regatta victories year after year.—*The Editor.*

AN airplane cannot fly without air, yet at a high rate of speed the resistance caused by the air becomes so great that a further increase of speed is almost impossible. To avoid rapidly mounting resistance, aviators attempt to fly in the stratosphere where the more rarefied air offers less resistance.

In the ship- and boat-building industry, engineers have tried to reduce the resistance of water by building vessels with streamlines, in imitation of the body of a fish. This, of course, has achieved its purpose, but when the necessary speed becomes excessively high—for example, in the case of a speedboat—even streamlines became inadequate. Modern speed boats are built somewhat like surf boards, so that when the speed becomes high enough the boat will leave the water and will merely glide on the surface, thus reducing the resistance considerably.

The relation between the displacement of a boat and its shape and speed on the one hand, and water resistance on the other, is well known. About 60 years ago, W. Froude built the first experimental tank where models of ships could be towed at various speeds and the resistance automatically recorded. This was a great boon to shipbuilders. Now they could build a model of a proposed ship, experiment with it, find all the faults in its construction, correct these faults, and then proceed with the building of the real ship. This eliminated guesswork to a great extent and reduced the risk involved.

The problem of water resistance in swimming becomes apparent only with the increase of speed. In every attempt to increase the speed of the movement a paradoxical situation is created: the medium which makes the motion itself possible becomes the main obstacle which limits the speed of movement. Water resistance was also responsible for the invention of the modern swimming strokes. A man who wishes merely to remain on the surface of the water can make any movement with his legs and arms, provided that the direction of the pull is not upward. A man who wishes to swim forward should remember only one rule—to pull backward. But if a man wishes to swim fast and break the existing records, then all his movements should be studied critically and those that increase resistance should be eliminated if possible. In the breast stroke, for example, as the writer has previously shown in this magazine (March, 1930), the recovery position of the legs and arms has a great effect on the speed of swimming. In this position the arms and legs are drawn close to the body and retard the progress so much that the speed may drop from four and a half feet per second to one foot per second within a single swimming cycle. This can be readily observed on any breast stroker. The English overarm side-stroke represents a step forward because at least one arm is taken out during recovery. The crawl stroke is the most efficient stroke thus far discovered, because both arms recover outside the water and do not retard the motion.

The experimental studies of water resistance in swimming were started in 1905 by R. DuBois-Reymond of Germany, who towed swimmers behind a row boat and measured the resistance by a spring scale attached to the tow rope. In 1919, G. Liljestrand and N. Stenstrom of Sweden towed swimmers by means of a windlass, which stood on the shore. In this experiment the towing rope ran over a pulley attached to a spring scale, which recorded the ten-

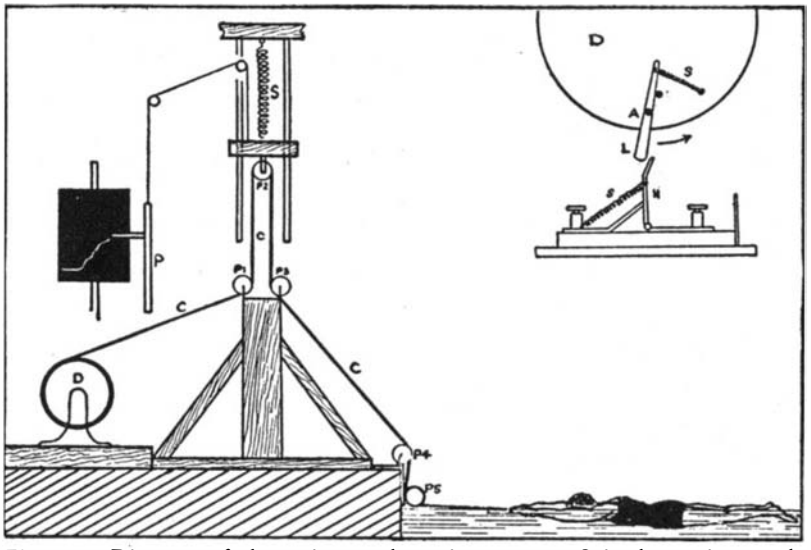


Figure 1: **Diagram of the resistograph towing a man. *C* is the towing cord, *P1-P3* are ball-bearing pulleys, *S* a calibrated spring. D is a drum rotated by an electric motor. Each revolution of the drum is equivalent to a distance of two feet covered by the swimmer. In the upper right-hand corner is a switch for recording revolutions of the drum. *L* is a lever rotating around *A*; *H*, hinge making contact. In operation, *L* breaks the contact at the switch shown, interrupting an electric current. From *The Research Quarterly*, Ann Arbor, Mich.**

sion on the rope. Recently the writer completed his research on resistance, in which not only men but also women were tested. In this study the swimmers were towed in a 60-foot swimming pool. The speed of towing and the resistance of the water were automatically recorded on a smoked paper by means of a specially devised apparatus called the "resistograph." Figure 1 represents the resistograph, and Figure 2 a sample of the record. Every person was tested from 60 to 200 times.

After the last Olympic games, where the Japanese were so victorious, the findings of this study took on a greater interest because some of the typical Japanese swimmers had been tested. Incidentally the assistant coach of the Japanese Olympic swimming team, Mr. Yanagitta, was also tested by the writer.

BEFORE discussing the results obtained, let us briefly consider the main factors responsible for water resistance. The total water resistance consists of:

1. Wave-making resistance.
2. Eddy resistance.
3. Skin friction.

The first of these factors is due to the waves produced in swimming—the faster the movement the greater the waves. The eddy resistance is due to the physical discontinuity of the streamlines. Take for example the breast stroke. When the person is gliding with the legs and arms extended straight, his streamlines are at their best, but when the same person assumes the position of recovery, the lines become distorted or discontinued. In this case water cannot follow the streamlines and backwash will be produced behind the flexed limbs. Everybody knows that one can ride a bicycle faster when following closely behind a motorcycle with a large windshield. The eddies created by the windshield produce an actual suction effect upon the cyclist behind.

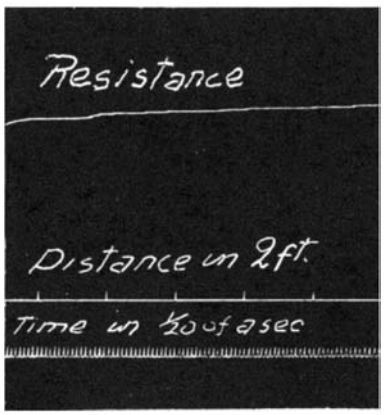


Figure 2: **The upper line represents water resistance. Marks on the middle line represent revolutions of the drum around which the towing rope is wound, each equal to two feet. The lower line is marked in time intervals of 1/20 of a second**

The third factor, skin friction, represents the major resistance factor in the glide. Its degree depends on the dimensions of the wetted area and the smoothness of the surface.

The study of each of these factors separately involves extreme technical difficulty and therefore only the total resistance has been tested.

It has been found that the total resistance depends of course on the size of the person; for example, the resistance for the Japanese swimmers being the same as that for medium-sized American girls. The position of the body in the water is another important factor. Some smaller men in the tests had a greater resistance than the larger men because they could not assume a good flat position in the water.

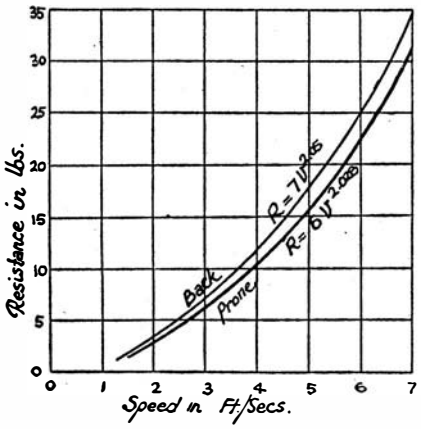


Figure 3: **Curves showing water resistance for Subject S. See text**

The general formulas for water resistance may be expressed as follows:—

Skin surface area in square feet	Resistance in water in pounds (V=velocity in feet per second)	
	Prone Glide	Glide on back
Men 24—19	.65V²*	.75V²
Men and women 19—16.5	.55V²	.6V²

From these formulas we can see that water resistance increases in proportion to the square of the speed. Figure 3 shows the relation between the speed of swimming and the water resistance. It can be seen that in this case the resistance increased at a rate even greater than the square of the speed. When Subject S was making two feet per second the resistance was 2¾ pounds. At the speed of four feet per second it became 11 pounds. If he attempted to swim, let us say, seven feet per second, his resistance would reach 31 pounds. Additional experiments showed that this subject could develop only 27 pounds of maximum propelling force; therefore he could not possibly attain a speed of seven feet per second—unless, of course, he decreased his resistance or by superior effort attained a greater propelling force.

Experiments showed that if a small man uses a poor technique—if his body rotates too much—the resistance will increase a great deal more than the square of the speed and will be out of proportion to the size of the body. The attempt on the part of swimmers to reduce resistance has led to the "discovery" of a hydroplaning position of the body, with shoulders and head riding high in the water. Although the arguments in favor of this position (by analogy with the speed boat) sound logical, the experiments prove that this position of the body *increases* the resistance, as Figure 4 clearly shows. The mere lifting of the head out of the water tends to increase the swimmer's resistance.

*The square here is an approximation; actually it is slightly more.

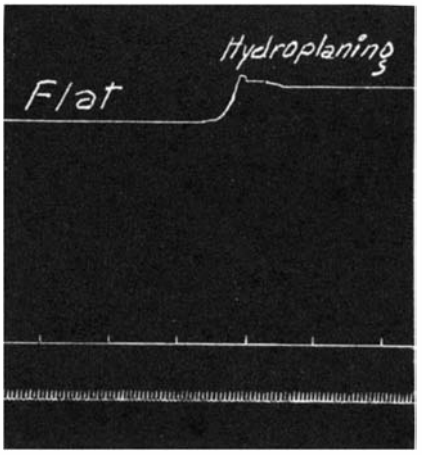
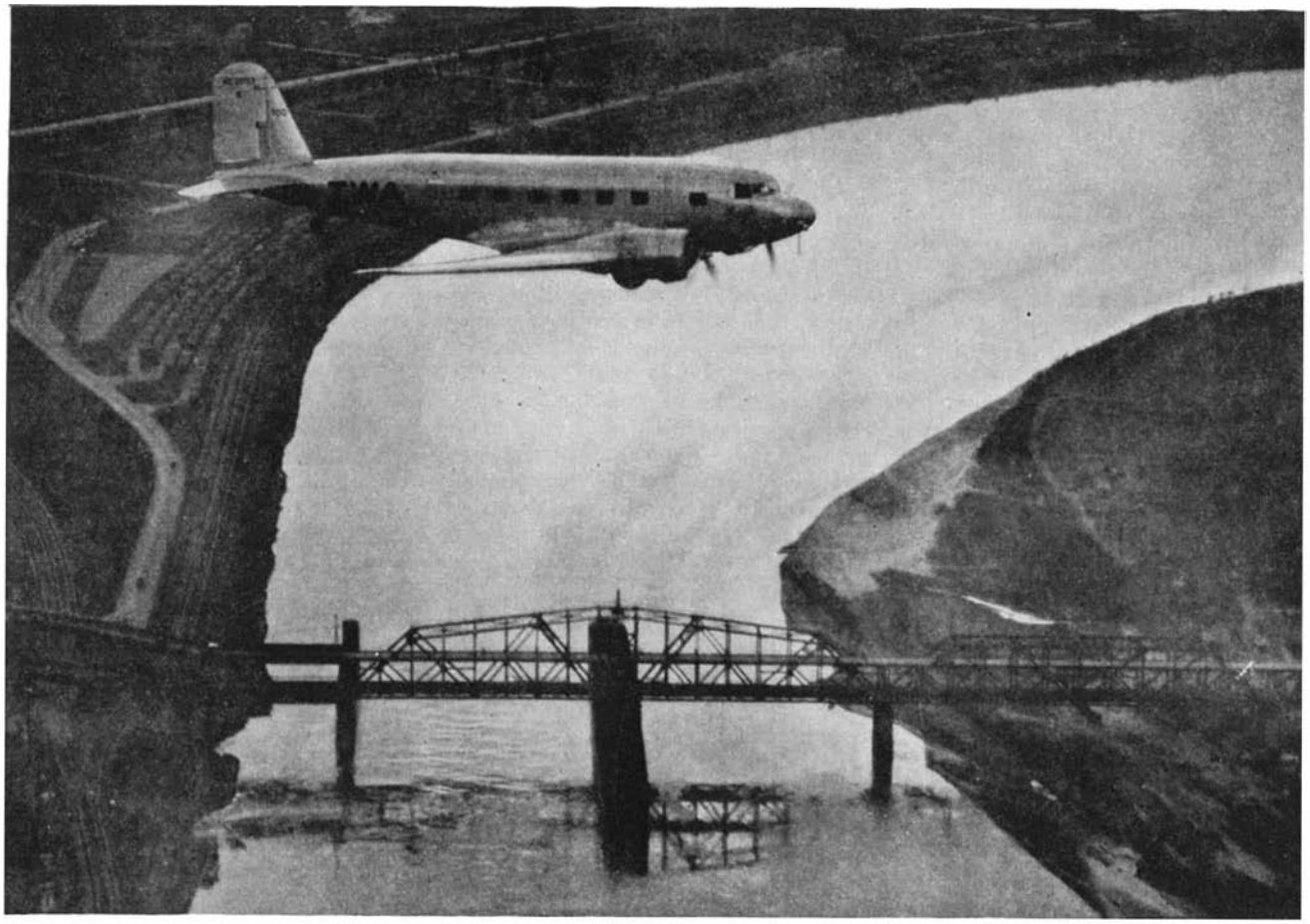


Figure 4: **The hydroplaning argument, like the swimmer, was "wet". Theory favored it but experiment showed just the reverse was true**

NEXT, it is to be noted that uniformity of pace has a direct bearing on water resistance. Coaches recognize the importance of a proper pacing, although there is no unanimous agreement as to what the basis of a proper pacing should be. From a mechanical standpoint a proper pace can easily be defined as merely a uniform pace. Experiments showed that resistance becomes excessively high with every attempt to regain the lost speed.

The shape and the texture of the bathing suit also has a certain effect upon resistance. It was found that a well-made silk bathing suit does not increase the resistance to any appreciable extent, whereas a suit made of worsted may increase the resistance half a pound for a speed of five feet per second. A suit with a loose upper part and tight trunks acts as an anchor and may be the cause of considerable resistance when swimming.

Contrary to the findings of other experimenters, the present writer found that the resistance in the glide on the stomach is less than that of the glide on the back. The explanation of this disagreement may be found in the better technique used in the present study.



One of the high-speed transport planes, described in the article below, makes a striking picture against a background of other methods of transportation. The Hannibal Bridge across the Missouri at Kansas City is in the lower part of the photo

BUSINESS FLIES AT HIGHER SPEEDS

By REGINALD M. CLEVELAND

SPEED is the life blood of commercial aviation. To secure it, coupled with safety and comfort, the best aeronautic brains in the United States have been, and are, at work. The accomplishment in this direction, bearing in mind the adolescent immaturity of aviation as a whole, has been almost incredible. The accomplishments which lie ahead for this year of 1934 are hardly less astonishing.

We shall see a race in transport schedules which will make the historic competitions of the railroads in the era of competitive coast-to-coast runs look like an exciting contest among snails. We shall certainly see the map of the United States so shrunken by the devouring speed of scheduled air-transport that the time from New York to Los Angeles will be around 17½ hours, and in the reverse direction with the favorable prevailing westerlies, around 15 hours. The goal of an air journey between any two points in the United States without the loss of a business day will come close to attainment. Its significance will be emphasized by a much more extended use of sleeping planes with real berths.

BY the time this article reaches its readers, interested folk in the east as well as the west will have had an opportunity to inspect the new Douglas airliner, 41 of which, each powered with two Wright Cyclone 700-horsepower engines, and equipped with Sperry automatic pilots, will make up the fleet of Transcontinental and Western Air. Commander D. W. (Tommy) Tomlinson, one of the former famous trio of Navy "Sea Hawks," has been test flying this transport. It cruises, he says, on 62.5 percent engine power, at 183 miles an hour. Its top speed, with full load, is 217. Full load means 14 passengers, 600 pounds of cargo, and crew of three. Range, on 400 gallons, is 1000 miles; on 510 gallons, 1350 miles.

This plane is expected easily to maintain a "block to block" schedule of 160 miles an hour. Block to block is the form in which the airlines express their elapsed time from the start of taxiing away from the loading apron at one terminus to the moment the wheels stop rolling at the unloading block at another.

On this basis, schedules something like this are contemplated: Leave New York at 4 o'clock in the afternoon, leave Columbus at 6:15, leave Kansas City at 9:45—1097 air miles in 5¾ hours—leave Albuquerque at 2:30 in the morning, and arrive at Los Angeles at half past six in the morning. Or, reversing the picture, leave Los Angeles at 5:40 in the evening, and arrive at Newark at 11 the next morning. The hours given are local time to which must be added or subtracted the difference in time between terminals.

It must not be supposed that Douglas and T.W.A., as well as Pan-American

Airways, which has also ordered a small fleet of these transports for some of its land operations, will be left in undisputed possession of speeds of this kind. Far from it. United Airlines, largest of the transport companies, which has put behind it 60,000,000 miles of scheduled flying, will meet the challenge with its all-metal Boeings. The 247, outstanding accomplishment of the 1933 air-transport field, will be stepped up beyond its present very high speed by the use of geared Wasps, and there are rumors which will not down of a still larger and faster ship as well.

At the time of the All-American air races at Miami, the executive plane of the United company, powered with 14-cylinder geared Wasp Juniors, carried George S. Wheat and a party of newspaper men between New York and Miami at a pace which indicated what was to come. Controllable pitch propellers, which will be used on the line, were not fitted, but there was no difficulty in cruising at 170 and 180, with the engines turning up only about 2000 of their rated 2400 revolutions. Jacksonville to Miami, 329 miles, with cross and head winds, was flown in 1 hour, 47 minutes; Washington to Newark, 200 miles, in 1 hour, 5 minutes; Miami to Newark, 1210 miles, in 7 hours, 5 minutes flying time. The stepped-up Boeings will shrink the map as effectively as their rivals.

And there will be other very fast transports with rated top speeds above 200 miles an hour; the Lockheed Electra, the General Aviation tri-motored ships, the new Fairchild amphibian, and, perhaps, the Vultee.

IN its 19th annual report, the National Advisory Committee for Aeronautics told the Congress that increases in the speed of multi-engined airplanes, military and commercial, from 1932 to 1933 approximated 40 to 60 percent with practically the same engine power. Among the factors which have made this extraordinary accomplishment possible, many of them primarily based upon the study of the NACA at the world's most complete aeronautical laboratory at Langley Field, Virginia, the Committee lists the following:

The NACA cowling, the results on which were published in 1928, and the optimum location for engines, results of which were issued confidentially to the Army, Navy, and industry in 1930, and were kept confidential until 1932, when the first American airplanes embodying the results of these researches had been designed and constructed; the development by the Army, Navy, and industry, of reliable retractable landing gears; increased horsepower with the same size and weight of engines, involving increased revolutions per minute, higher compression ratio, improved fuels, and improved cylinder cooling; the development of satisfactory controllable pitch propellers; the development of new and more efficient wing sections; improved streamlining and use of flaps, assisted by the Committee's researches.

While the percentage of increase in cruising speed for transports cannot be expected to be as high for 1934 as it was in 1933, it still may confidently be expected to show a marked rise due to further utilization of the studies made at Langley Field, at Wright Field, in the wind tunnels of leading universities, and in the engineering departments of the aircraft and aircraft engine builders themselves. It will be due to still further elimination of drag, to still greater development of high lift devices, to better control of longitudinal and lateral stability, and to further pushing forward of engine and propeller efficiency.

THE immense significance of the new speeds for business and the business man are not yet fully realized. The executive in New York, facing an important problem in New Orleans, will be enabled to have dinner with his family and yet come in for a landing on the magnificent new Shushan Airport on Lake Pontchartrain in time to keep an early morning appointment. The sales manager in Seattle, disturbed by a telegram from headquarters in San Francisco, will be able to emplane after breakfast, have lunch with his associates at the Golden Gate, and be back in Seattle almost in time to close his own desk for the day. The Boston merchant, worried about pending legislation, will be able to finish his lunch on Beacon Street, and be in Washington, D. C., while the afternoon sun is yet high. The motion-picture star can easily put in a matinée personal appearance at Hollywood and walk on the stage in Times Square, New York, at 2 o'clock the next afternoon for another.

Before the year is out, the over-night journey in many instances can doubtless be made in a berth quite as comfortable and a good deal less noisy than the familiar lower over the shining rails.

And it must be remembered that the advantages of new speeds are not confined to the limits of continental United States. The business man and the traveler whose goal is Latin America, will also benefit by the acceleration of wings. On certain stretches of its far-flung network, Pan-American will fly Douglases, like those that are to knit the Atlantic and the Pacific for T. W. A., and Lockheed Electras, like those that are slicing off the minutes for Northwest Airways, up towards Spokane. The big new Sikorsky for Pan-American, too, will cruise around 150 miles an hour, with 32 passengers, across the Caribbean, and quite possibly before the year is out, be making the 800 miles from New York to Bermuda in six hours, or even pointing its questing prow beyond, to the eastward.

Nor is the saving of his own time the only way in which the American business man will find new benefits in 1934 from air transport. His important mails will, of course, share in the results of the higher speeds. Some of them will be carried, too, on the specialized mail ships, the swift Northrops and Lockheeds, still the romantic couriers of the night, but more agile, nerved to a swifter pace, better armed than ever before against the hazards of fog and ice.

GOODS also—important samples, styles, film, documents, and perishables—will shuttle across the invisible warp and weft of the airways at the same headlong pace that carries the air traveler upon his mission. A new horizon will have been opened for the alert man of business. The merchant will find his zone of reasonable coverage immensely expanded; the flower and fruit grower will be able to make the most of distant and formerly unobtainable markets; the buyer on the Pacific coast will need only to be 18 hours behind New York in the display of the latest Paris gown.

Finally, the new speeds of air transport have significance as a bulwark of national defense which is too little appreciated. Fleets of transport planes, able to carry 20 men each in 600- to 800-mile jumps at 200 miles an hour, mean a mobility for specialized groups that could be attained in no other way short of magic. In an emergency, an entire anti-aircraft unit, with its sound locators and 800-million candlepower searchlights, its trained personnel and its rapid-fire guns, could be whisked from coast to coast almost overnight. The ground organization which makes possible in large measure these scheduled speeds in the air—the airports; the repair bases; the immense privately operated weather services, in addition to those of the government; the plane-to-plane and plane-to-ground radio communication—all could not fail to have military significance of the highest importance.

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The foregoing article accurately outlines the situation in the air-transport and airmail fields at the time of writing. Just before this issue went to press, however, the government investigation of airmail activities by the large transport companies of this country placed the whole matter under a cloud, and the outcome is still not apparent. How the airmail will be carried in the future depends upon the findings of the present investigation. —The Editor.

Refrigerator to Cool

THE mass concrete being placed in Boulder Dam which is now under construction by the Bureau of Reclamation of the United States Department of the Interior in the Black Canyon of the Colorado River near Las Vegas, Nevada, is being artificially cooled during its setting or hardening period. This is an important innovation in the art of mass concrete construction, and is made necessary by the unprecedented dimensions and other conditions involved.

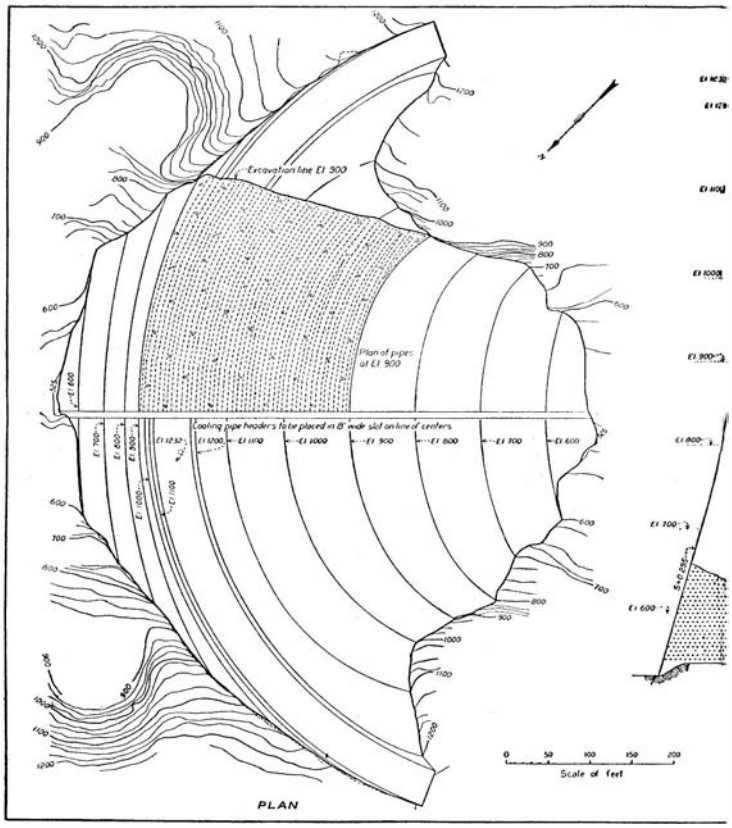
The chemical reactions which accompany the setting of the Portland cement in concrete release a considerable quantity of heat which in this case may be expected to raise the temperature of the concrete mass an average of about 40 degrees, Fahrenheit, above the temperature at which it is cast. While the concrete begins to harden and lose its plasticity within an hour or so, the setting process is not completed for a long period of months although the generation of heat becomes negligible after a few weeks' time.

Concrete expands and contracts with changes in temperature and therefore has a greater volume when it has a high temperature due to the setting heat of the cement than when this excess heat is later dissipated and the concrete assumes the temperature of its surroundings. As the mass concrete shrinks in this process, it opens up the construction joints between the adjacent blocks in which it is poured. The open joints are afterwards filled with cement grout under pressure to render the structure monolithic.

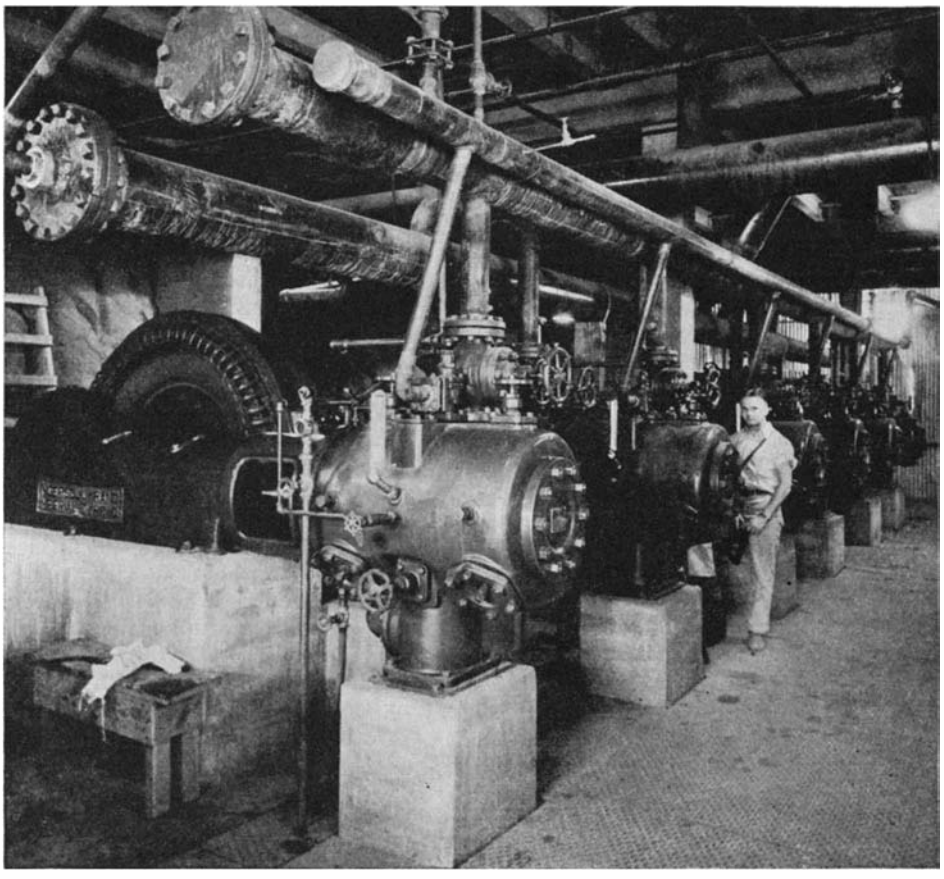
IF the cooling process is incomplete when the joints are grouted, harm may result since the possibility of adjustment between different parts of the dam no longer exists and the dam, which is restrained by its connection to the abutments, can then make the necessary adjustments only through elastic distortions with their accompanying stress changes or, if these become too severe, by actual rupture of the material of the dam to form cracks along which the necessary movements can take place. Failure of a dam as a whole would not occur as a result of these readjustments but they are detrimental to the extent that they decrease the safety and shorten the life of the structure. The purpose of the cooling is therefore to bring the shrinkage to completion before the dam is made into a structural unit by the grouting process. The cooling will also permit more effective grouting due to the wider openings to be obtained at the construction joints. A good job of grouting is essential if even distribution of stresses throughout the dam and a proper distribution of the loads to the abutments are to be obtained.

The amount of excess temperature at

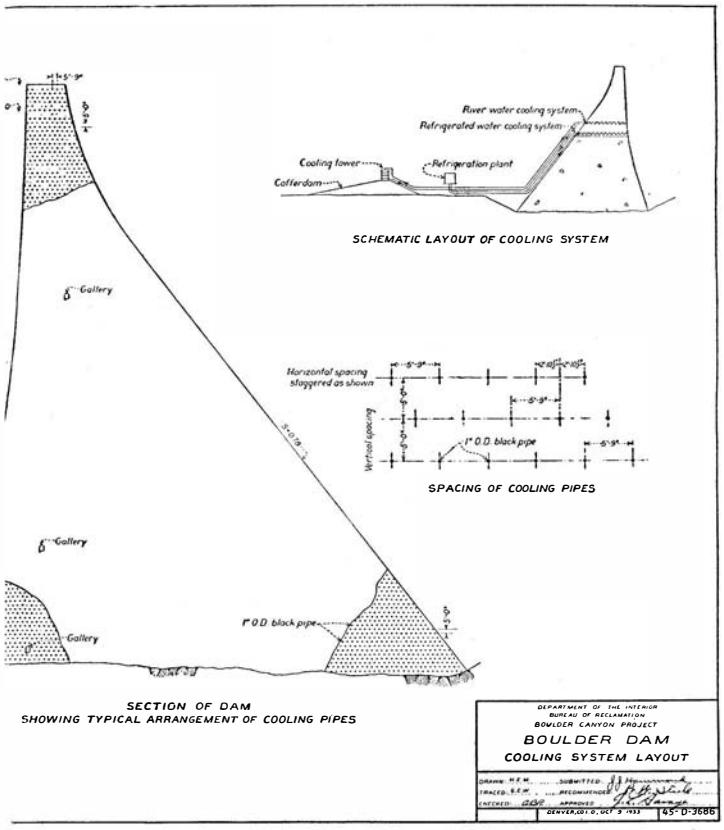
Right: **Plan and elevation of Boulder Dam with sections showing the layout of the elaborate piping system used in cooling the concrete mass while it is setting**



Below: **The ammonia compressors in the refrigerating plant. It will be noted that large compressors are necessary—sufficient for a sizeable job of cooling**

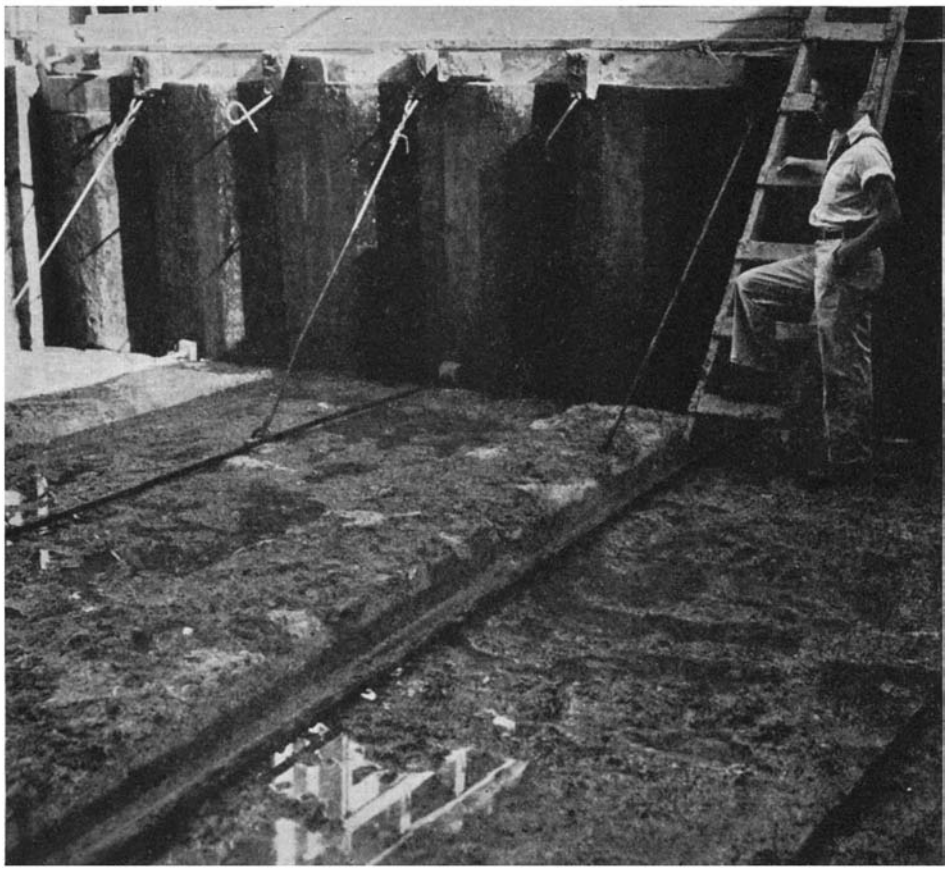


Boulder Dam Concrete



Below: **Cooling pipes in place on a cement pour. These pipes are laid on five-foot nine-inch centers, horizontally, and on five-foot centers vertically. Totalling many thousands of feet throughout the mass of the dam, these pipes will, of course, have to be left in place. They will thus act as reinforcing rods in the finished concrete structure**

Illustrations courtesy Bureau of Reclamation



the end of the construction period depends to some extent upon the rapidity with which the construction is carried on, but more directly upon the dimensions of the dam. A study of the laws of cooling reveals that the time required for such a structure to lose a given proportion of its excess heat by natural processes is, if other things are equal, proportional to the square of the thickness. Thus, while a concrete wall five feet thick would lose about 90 percent of any excess temperature it might have above that of its surroundings in less than a week, a wall 50 feet thick would require approximately a year and a half, and a structure 500 feet thick would require a century and a half to lose the same proportion of heat. The thickness of the Boulder Dam will vary from 45 feet at the top to about 660 feet at the bottom. It is therefore sufficiently massive to require that some means be employed to accelerate the return of the concrete to normal temperatures if it is to be brought to a stable condition at the end of the construction period.

THIS excess heat in the concrete at Boulder Dam is being removed in a relatively short period of time by circulating cold water through one-inch diameter horizontal steel pipes embedded therein as the concrete is placed. The pipes are spaced approximately five feet nine inches center to center throughout the mass. The drawing indicates the enormous footage of pipe used and the manner in which it is laid and spaced.

A large refrigerating plant and cooling tower provide the necessary equipment for cooling the water. The construction contractor supplies the ammonia compressors for the refrigerating plant by installing the proper type of cylinders on air compressors which had been previously used in the work of driving the tunnels. These units have sufficient capacity to produce about 600 tons of ice per day.

The cooling tower is designed to cool a flow of 6000 gallons of water per minute. A part of the cooled water from the tower is used to carry away the heat discharged from the refrigerating plant and the remainder is pumped directly to the dam through a 14-inch diameter main and there distributed by means of headers to the pipe embedded in the concrete. The heated water is collected in a second 14-inch diameter main and returned to the cooling tower. More than half the total heat will be extracted by means of water pumped directly from the cooling tower and the embedded pipes will then be connected to the refrigerating plant which will bring the cooling process to completion. Approximately one foot of embedded pipe is required for each cubic yard of concrete to be cooled.

SUNDIALS AND THEIR CONSTRUCTION—III

The Construction of North, East, and West-Facing Dials, and Polar Dials

By R. NEWTON MAYALL
Landscape Architect
and MARGARET WALTON MAYALL, M.A.
Research Assistant, Harvard College Observatory

DIRECT vertical dials are seldom placed on walls, because they must face the cardinal points of the compass. Since few walls face the cardinal points, the four direct vertical dials are usually combined on one plinth, and this combination is known as the pillar dial. Many pillar dials are left blank on the north face; but if the north dial is added, the pillar dial will then be complete and, owing to the brief time the sun shines upon the north face, sufficient room may be left for a suitable inscription, which is often placed on this face in place of a dial.

The preceding article described the construction of the direct south vertical dial. The construction of the direct north, east, and west vertical dials, is as follows:

THE plane of a north dial (Figure 3) is perpendicular to the plane of the horizon and faces the true north. The diagram shows the construction of the hour lines for latitude 48°30′.

The style points to the celestial pole.

The substyle is the 12 o'clock line and lies in the plane of the meridian.

The height of the style is equal to the complement of the latitude, which in this case is 41°30′ (90°—48° 30′=41°30′).

Draw the horizontal line *FAG*, Figure 1. (This will be the 6 o'clock line.)

At *A* draw the line *AC* perpendicular to *FAG*. (This will be the 12 o'clock line.)

Draw *AD* so that the angle *CAD* is equal to the height of the style, or 41° 30′.

From *B*, on *AC*, draw *BE* perpendicular to *AD*.

Make *BC* equal to *BE*; then make *FA* and *AG* each equal to *AC*.

Draw lines *FC* and *CG*. Through *B* draw a line parallel to *FAG*, cutting *FC* at *L* and *CG* at *M*. Through *L* and *M* draw lines *LK* and *MH* parallel to *AC*.

With radius *BC* and centers at *F* and *G*, describe the arcs *PQ* and *SR*. Divide these arcs into equal parts of 15 degrees each. Draw lines from *F* and *G* through the points thus found, until they cut the lines *LK* and *HM*, respectively.

From *A* draw the required hour lines through the points found on *LK* and *HM*.

Figure 2 shows the hour lines transferred to the dial plate, and the way in which they should be numbered.

Figure 3 shows the position of the dial when in use.

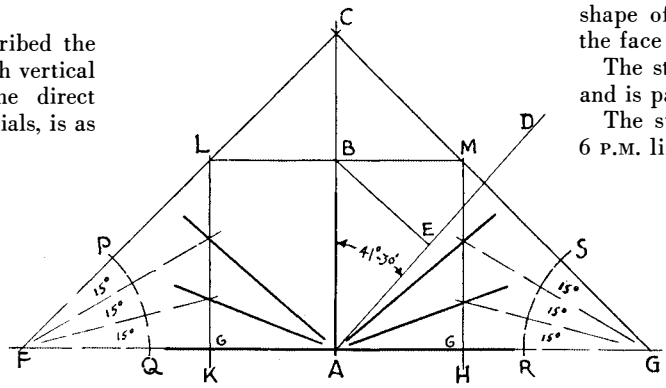


FIGURE 1

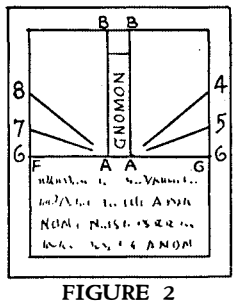


FIGURE 2

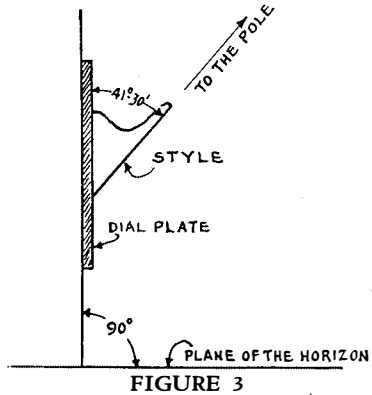


FIGURE 3

The sun will not shine upon this dial between the hours of 6 in the morning and 6 at night; therefore it is necessary to inscribe on the dial plate only those hours from sunrise to 6 A.M. and from 6 P.M. to sunset.

This dial must be placed in a perfectly vertical position, so that the substyle line lies in the plane of the meridian and the face of the dial looks to the true north point of the horizon.

THE planes of the direct east and west vertical dials (Figure 5) lie in the plane of the meridian, and for this reason they are sometimes referred to as meridian dials. The hour lines for each dial are calculated in exactly the same way, so it is necessary only to describe the construction of one of them. Figure 4 shows the construction of the hour lines for the east dial, in latitude 52°30′.

The gnomon is usually made in the form of a flat rectangular bar or in the shape of a pin. It is perpendicular to the face of the dial.

The style points to the celestial pole and is parallel to the dial plate.

The substyle is the 6 A.M. line (the 6 P.M. line in the west dial) and points to the celestial pole.

The height of the style is measured in inches, and is determined by the size of the dial. It is usually from 2½ to 3 inches in height.

The hour lines are parallel to the substyle.

The construction is as follows:

Draw the horizontal line *AC* (Figure 4). This represents the plane of the horizon.

At *B*, on *AC*, draw *DE* so that the angle *EBC* is equal to the latitude of the place (52°30′). *DE* will also be the substyle line and the 6 A.M. line.

Make *BD* equal to the desired height of the style in inches. Through *D* draw the line *KL* perpendicular to *DE*.

With *B* as a center, and the radius *BD*, describe the arc *GDH*. Beginning with the point *D*, divide this arc into equal parts of 15 degrees each, on each side of the line *DE*. From *B* draw lines through these points until they cut the line *KL*.

Through the points thus found on *KL*, draw lines parallel to *DE*, which will be the required hour lines.

Figure 5 shows the hour lines transferred to each dial plate. Note the position on each dial.

Figure 6 shows the most commonly used gnomon on this type of dial.

The east dial will show only the hours from sunrise to noon; the west dial, the hours from noon to sunset. These dials

will not show the noon hour, because they lie in the plane of the meridian. The sun's rays at that time are parallel to the face of the dial; therefore the shadow cast by the gnomon will be infinite in length, and the edge of the shadow cannot be seen.

The plane of each dial must be perfectly vertical, and lie in the plane of the meridian.

THE equatorial dial and the polar dial are reclining dials, but take their names from the planes in which they lie. For this reason they are not usually classed with the reclining dials.

The plane of the polar dial is parallel to the axis of the earth (Figure 9), and, if produced, would cut the celestial pole. Figure 7 shows the construction of the hour lines for any latitude.

The gnomon is usually made in the form of a flat rectangular bar or in the shape of a pin, and is perpendicular to the face of the dial.

The style points to the celestial pole and is parallel to the face of the dial.

The substyle is the 12 o'clock line and lies in the plane of the meridian, and if produced would cut the pole.

The height of the style is measured in inches and is determined by the size of the dial. It is usually placed about 2½ to 3 inches above the face of the dial.

The hour lines are parallel to the substyle.

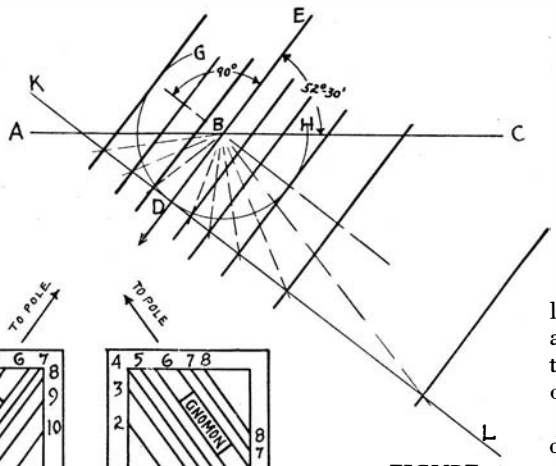


FIGURE 4

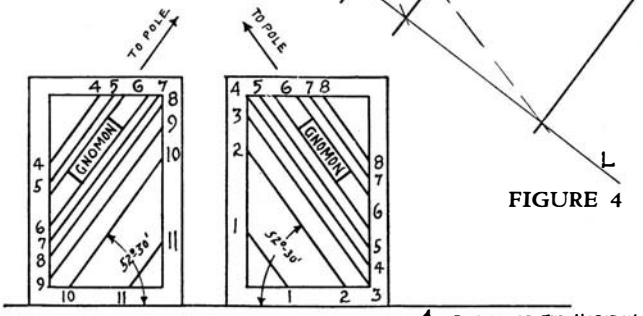


FIGURE 5

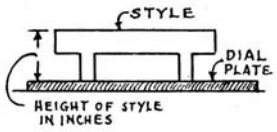


FIGURE 6

The construction is as follows:

Draw the horizontal line *AC*.

At *B*, on *AC*, erect the perpendicular line *BE*. (This will be the 12 o'clock line and the substyle.)

Make *BD* equal to the desired height of the style, in inches.

With *D* as a center and the radius *BD*, describe the arc *FBG*. Beginning at *B*, divide this arc into equal parts of 15 degrees each, on both sides of the line *BD*.

From *D* draw lines through the points found on arc *FBG*, until they cut the line *AC*. From the points thus found on *AC*, draw lines parallel to *BE*, which will be the required hour lines.

Figure 8 shows the hour lines transferred to the dial plate, and the proper way of numbering them. Figure 9 shows the position of the dial when in use.

It is necessary to show on this dial only those hours between 6 A.M. and 6 P.M., because the plane of the dial, if produced, would cut the east and west points of the horizon. At 6 in the morning and 6 in the afternoon the shadow cast by the gnomon is infinite in length; therefore the 6 A.M. and 6 P.M. lines cannot be placed upon this dial.

When setting the dial elevate the plate above the plane of the horizon, at an angle equal to the latitude of the place, as in Figure 9, and orient the dial so that the 12 o'clock or substyle line lies in the plane of the meridian. If this is done correctly, the style will then point to the celestial pole.

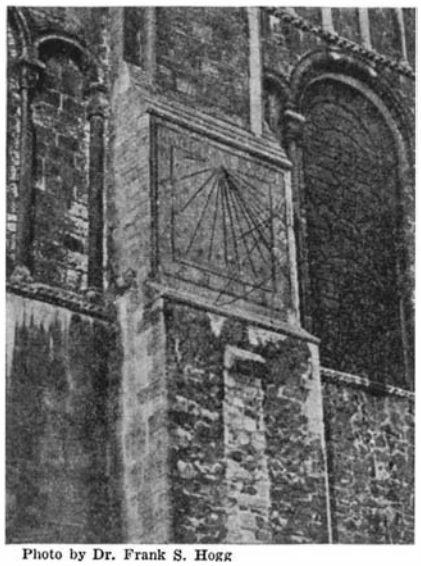


Photo by Dr. Frank S. Hogg

A dial of the vertical declining type, high up on the wall of Ely Cathedral, one of the oldest of the cathedrals of England. As the gnomon is light such a dial will not long remain intact unless it is placed well out of reach of the hands of persons of a too investigative turn of mind, also of vandals

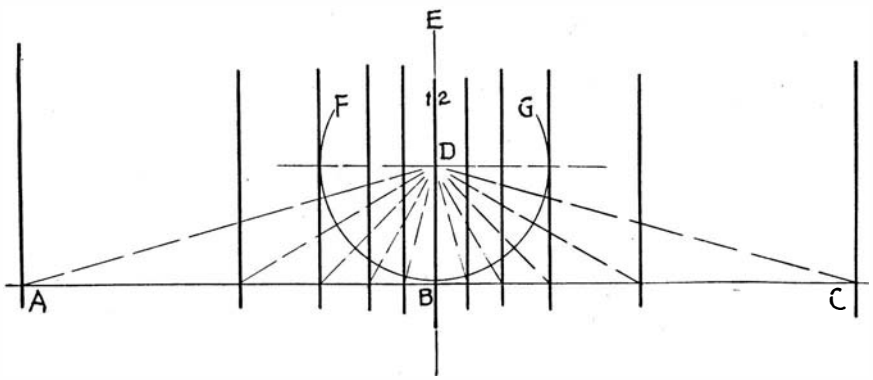


FIGURE 7

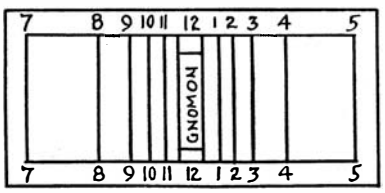


FIGURE 8

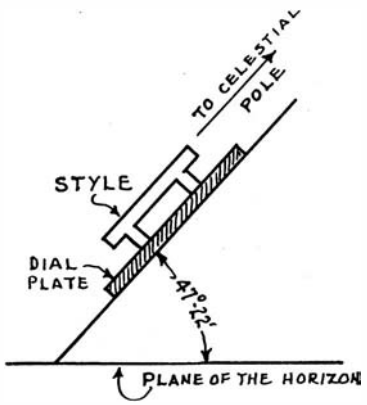
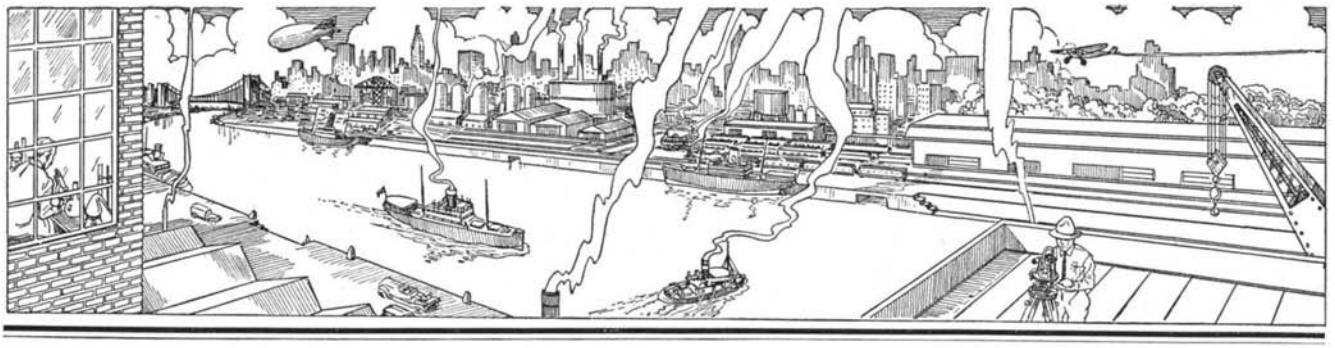


FIGURE 9

●

This article concludes the description of the regular forms of the sundial. The next article will deal solely with the vertical declining dials.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
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Lehigh University

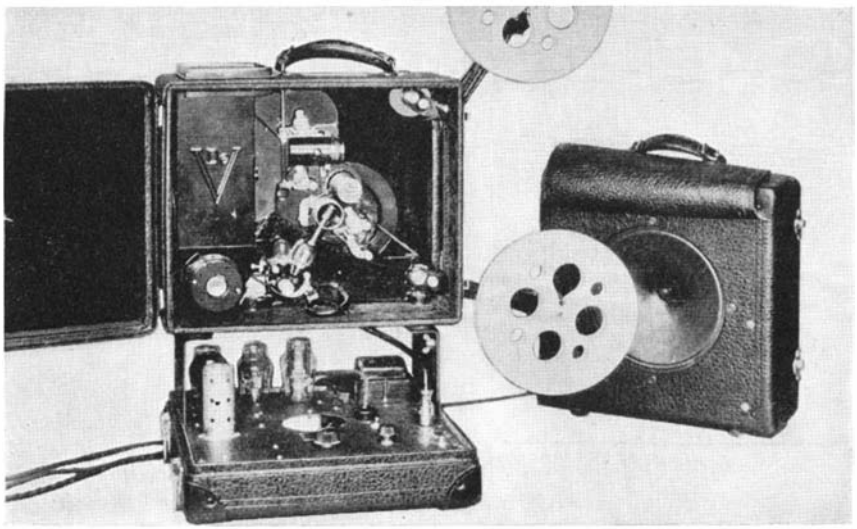
Talkies in a Suit Case

IT is just as much a scientific achievement to refine existing processes or machines, as it is to discover new ones. The term *refinement* is especially applicable to reducing weight and bulk in machinery, and it is happening conspicuously in the "talkie" projector field, just as was the case with the silent movie.

The new DeVry 16-millimeter sound-on-film projector succeeds in packing an elaborate theater installation—hitherto measured in ton units, and filling two trucks—into two small suit cases that weigh but 55 pounds, total.

In the first place, 16-millimeter film is one quarter the area of 35-millimeter film, and, in a general way, permits a reduction to one quarter the size, weight, and cost of a theater installation. A refinement in the size of photographic silver grain on the film emulsion permits as delicate response to sound images as the larger sound track. Increases in power in small projector lamps up to 750 and 1000 watts provide ample illumination for audiences up to 1500. Suitcase construction gives necessary rigidity—and handy portage. Photo-cells and exciter lamps have been stepped up in efficiency in the smallest sizes, and amplifiers and loud speakers have followed suit.

The result is a form of entertainment and instruction now within easy attainment of schools, churches, and business. For the advertising of commercial products, it furnishes the salesmen and executive, in two small cases, the one appeal that attracts and holds the attention of the masses—old and young, educated and uneducated alike.



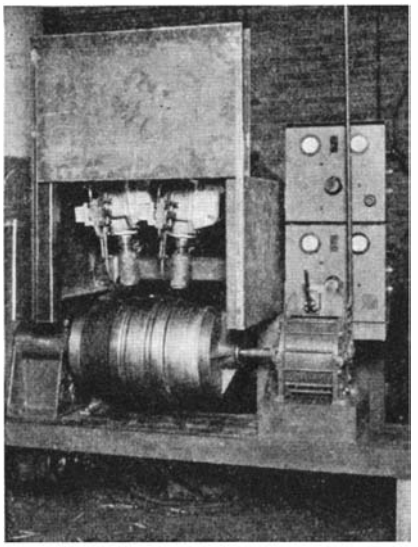
The two units of the talkie in a suit case equipment

This Factory Can't Stop

TWO plants to make one product are necessary in sulfur mining by the American process of melting the sulfur underground and pumping it to the surface, says Lawrence O'Donnell, in *Chemical and Metallurgical Engineering*. And once the plant is started, it can't be shut down, but must operate until the sulfur is exhausted. If the factory stopped for any reason, the hot liquid sulfur in pipes and pumps would solidify, causing immense damage and loss. Hence, all the boilers, heaters, pumps, and piping systems are built in duplicate, so that if one fails, the other can be thrown into service.—*A. E. B.*

Machine Welds Beer Barrels

AN automatic machine for arc-welding metal beer barrels by the shielded arc process has been announced by The Lincoln Electric Company, Cleveland, Ohio. The machine is reported to have a production capacity of 30 barrels or more per hour, depending upon the type and size of barrel.



Welding a metal beer barrel

The machine is made for producing barrels of different types of construction according to the manufacturer's requirements. Barrels welded by this machine are either single or double shell types. Both inner and outer shells of the latter type are automatically welded with this machine.

High Strength Copper Alloys

THE ancients discovered a so-called method of hardening copper, the secret of which is said to be lost. In recent times similar methods have frequently been rediscovered but all of them, both ancient and modern, involve the use of alloying elements which have reduced the electrical and thermal conductivity.

For use in commutators, slip rings, and other electrical devices, a hard metal is necessary and high conductivity of heat and electricity very desirable. A new group of copper-base alloys, called Cupalloy, has a most interesting combination of desirable characteristics. Cupalloy is much harder than pure copper, with much higher elastic strength, and the electrical conductivity ap-

Dr. John Martin Hiss measuring a foot by means of the Classifootometer described in these columns

proaches that of pure copper. Furthermore, the creep strength of this alloy is considerably greater than that of cold-drawn copper and the strength does not deteriorate with time at elevated temperatures as is the case with cold-drawn copper.

Many interesting tests have proved the qualities of this group of alloys but due to its newness it is not yet in commercial use.—*A. E. B.*

A Doctor's Foot Classification Instrument

ARE you a pedevert? You need not be too alarmed if you do fall into that class, for you have a lot of company. Fully 40,000,000 people in America are pedeverts.

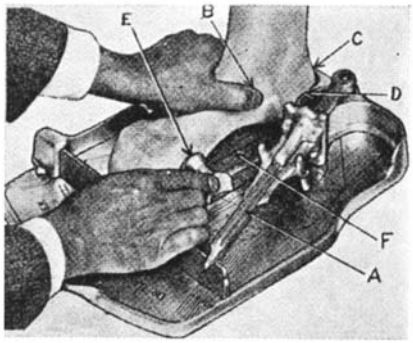
It isn't strictly speaking a disease, but if you turn your feet outward when you walk, you are in the pedevert class. Or you may be a digiped; that is, if you can sport a bunion or a nice case of so-called "hammer" toes.

If you are one of those lucky few who have normal feet, you are a pedalign type. A flat footer or a hollow-footed (unusually high-arched) individual goes into the pedeform class while the possessor of a pair of rigid, painful feet goes into the "inflaped" class.

Today you can have your feet classified in the above manner and can, therefore, know exactly what kind of feet you have. You can thus be sure of having shoes fitted accurately by scientific measurements.

The system was originated by a Los Angeles orthopedic surgeon, Dr. John Martin Hiss, for use with his own patients, and is today being adopted throughout the country by doctors and shoe men alike.

Doctors have long been handicapped in treating foot ills by the fact that they could not be sure of having their patients correctly fitted in shoes. There was no common



Close-up of the Classifootometer, showing the various parts, and how the foot is placed in order to obtain measurements for fitting shoes

language between themselves and shoe dealers, because there was no classification system and no instruments to determine types of feet.

Foot trouble was generally diagnosed as "broken arches," with no attempt being made to distinguish degrees of bone displacement or of testing feet against a standard.

Dr. Hiss' system is the first attempt to bridge the gap between the medical profession and shoe fitters. Termed the Classifoot System of Shoe Fitting, it consists of an instrument, known as the Classifootometer, and a manual of instructions. The instrument is used to measure feet and also to spot variations of each foot from the normal. This is done in degrees (of a circle) and is therefore named the Metric Foot Test. The manual of instructions describes the five classes of feet mentioned above and the 14 types under them, and explains the methods of fitting shoes under the system. Because the system is adaptable for use in both the doctor's office and the shoe fitting room, it is proving to be the needed common denominator.

Beverage Alcohol

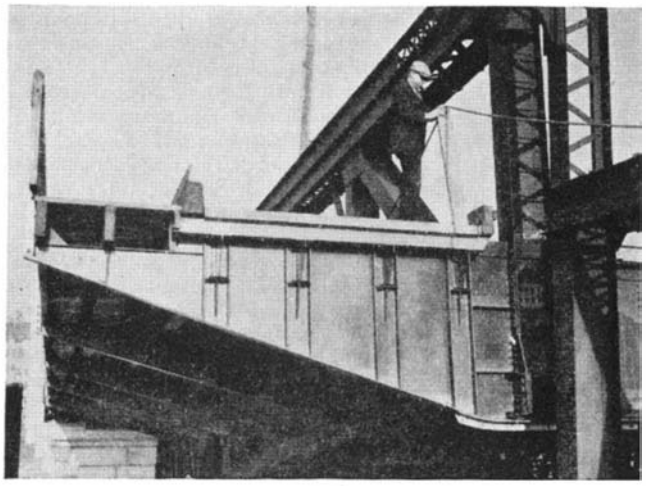
THE repeal of prohibition has brought many new problems to industry, not least of which is the predicament of the producers of grain alcohol. Every chemist knows that alcohol produced from grain is identical with the alcohol produced from molasses. However, the Government regulations covering distilleries specify that only the alcohol derived from domestic grains may be used for beverage purposes. This rule is obviously designed to alleviate the farmer's plight by giving him a new market for his grain, but it apparently closes the door on the industrial alcohol producers, most of whom use "blackstrap" molasses as a raw material.

Producers of alcohol who use molasses and sugar as raw materials have entered vigorous protests against this feature of the marketing agreement. These objections, however, appear to have been overruled as reports from Washington state that although producers of alcohol from molasses and products other than grain are voicing vigorous objections to the provisions in the distillers' marketing agreement which restricts the use of their product in the manufacture of alcoholic beverages, the AAA does not contemplate altering present regulations.—*A. E. B.*

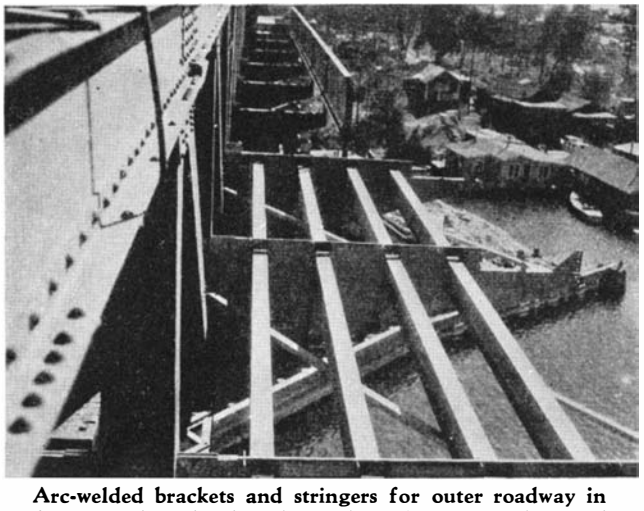
Welding Reduces Weight of Remodeled Bridge

ARC welding played an important part in reducing the weight of the recently remodeled and widened University bascule bridge at Seattle, Washington. Traffic on the bridge, built some 17 years ago, had increased from 8000 vehicles per day in 1919 to 38,000 per day in 1931 when it was decided to widen the bridge.

Widening was accomplished by building roadways outside the bascule trusses. These traffic lanes are supported on arc-welded brackets securely tied to the floor beams through slots cut in the vertical truss members. The brackets have tapered bottom flanges and vertical stiffeners arc welded to the web. The stringers extend through slots in the bracket webs and have plates welded to the upper and lower flanges.



Bascule leaf raised to show outer roadway brackets of remodeled bridge. Welding was used in all shop fabrication



Arc-welded brackets and stringers for outer roadway in foreground; old sidewalk brackets show in background

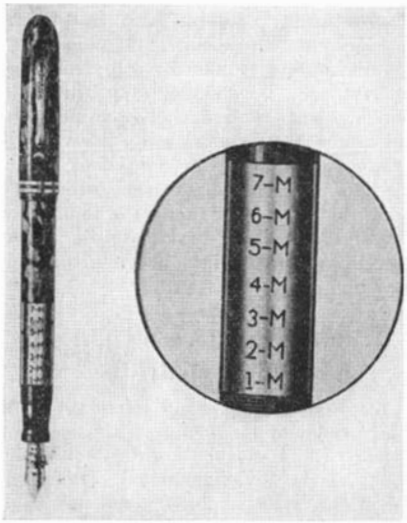
Hand rails for the bridge were also arc welded.

Welding was done by the Puget Sound Bridge and Dredge Company, contractors for widening of the span. All welding was done with equipment manufactured by The Lincoln Electric Company.

"Word Gauge" Fountain Pen

THE "Word Gauge" is the newest thing in the writing equipment industry. This new device enables the writer to learn by a glance at his pen just about how many words he has written since he filled the pen and how many he can write with the ink remaining in the pen.

The "Word Gauge" was developed by the engineering department of The Conklin Pen Company and is standard equipment on one of the models of the Conklin Nozac, a sackless fountain pen made by that company. The "Word Gauge" is a scale engraved on the transparent ink section of the



Fountain pen with built-in "word gauge": *Circle;* close-up of gauge

barrel of the pen and on which the ink level inside the barrel indicates in thousands the number of words written since the pen was filled, and the remaining writing capacity in words.

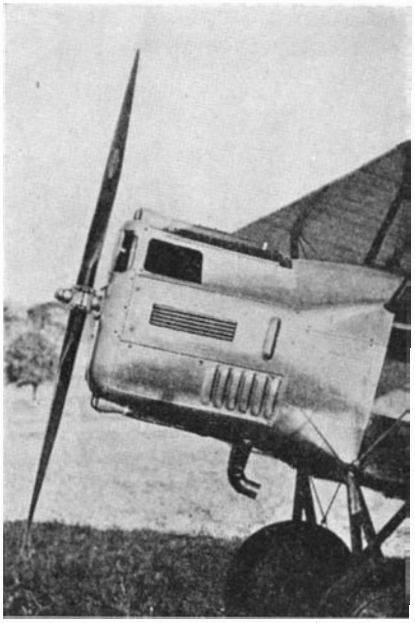
Although ink capacity of a pen measured in terms of cubic centimeters and comparative percentages are common, such computations fail of significance in indicating actual word capacity. To determine the actual word capacity of the Conklin Nozac a pen selected from stock and filled was put into the hands of a professional amanuensis and she was told to write it empty. The writer worked steadily for 9 hours and 27 minutes, time out for food and rest not being included in the figure. When the last drop of ink had been used it was seen that she had written 7034 words. The transparent ink chamber of the pen was then divided into 7 equal sections, these bearing legends of 1- to 7-M.

Novel Engine Arrangement

TWO-CYLINDER opposed, and four-cylinder opposed aircraft engines have been made in the past. Now Captain Robert W. A. Brewer, a well-known aviation pioneer, has brought out an eight-cylinder opposed motor, which can be mounted either vertically or horizontally at the nose of an airplane. As can be seen from one of the photographs, the engine is very compact, and above all very narrow. Therefore when mounted vertically it impedes the pilot's vision very little indeed—much less than the radial air-cooled type. With the four cylinders in line and suitably cowled in, the air is admitted through a comparatively small opening at the front end and the air resistance of the engine is small.

Another original point in the design is that the motor can be mounted directly upon the firewall, hung in cantilever fashion. Six mushroom-shaped feet are provided at the rear of the crankcase, and rubber washers are placed between these feet and the firewall. This means that demountability is good, and torsional and other vibrations are not transmitted into the fuselage.

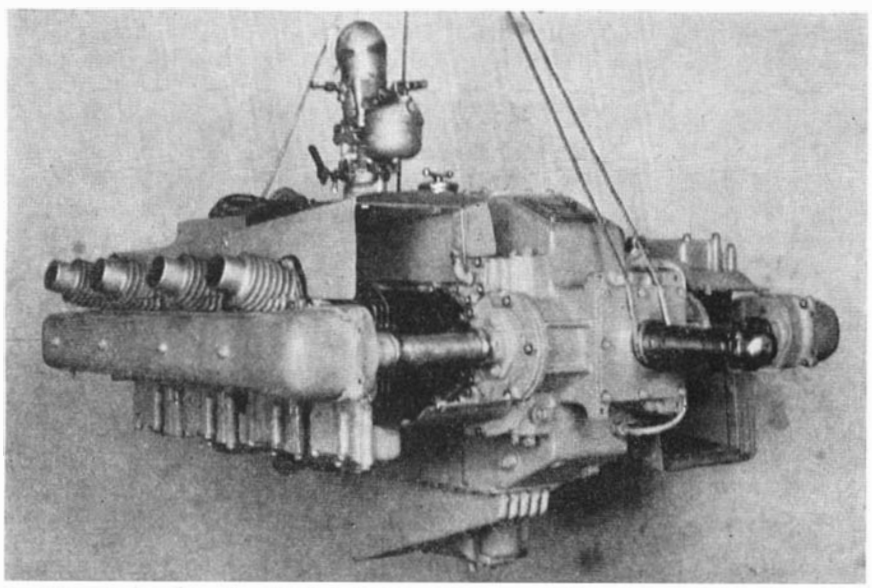
The designer has also provided flexibility in the mounting of the carbureters. These can be either of the vertical updraft, downdraft, or horizontal type. Cylinders and heads are all similar and are so mounted on the crankcase that all nuts can be operated by speed wrenches. Two complete sets of oil pumps—scavenger and pressure—are mounted in the line of the vertical drive, and each can be removed without disturbing the valve gear. Each unit part is self contained; for example, the over-head valve gear comes down without disturbing any other parts.



The Brewer engine mounted vertically, showing compact arrangement

With these features, the engine, while working on conventional principles, has a decided appeal for those who have to consider maintenance and servicing problems.

Compact in overall dimensions, the engine delivers 158 horsepower at 2200 revolutions per minute and weighs 428 pounds including oil tanks, but without propeller hub or starter. Bore is 4⅜ inches, and stroke 4¼ inches.—*A. K.*



Three-quarter front view of the 8-cylinder opposed Brewer airplane engine

How to Make an Airplane Quiet

WE recently gave the views of American authorities on the subject of reducing the noise of an airplane cabin. Dr. A. H. Davis gives an equally authoritative English view in *Aircraft Engineering.*

The propellers should be geared down. When the propeller tips are revolving near the speed of sound, they give off a piercing and powerful noise which should be avoided, even though the gearing itself introduces some noise.

The noise of the engine valves is hard to reduce. Perhaps the sleeve valve would be a step in the right direction. Also, since noise may be transmitted by resonant vibration, the engines should be as well balanced as possible, and, if possible, should be rubber mounted. It is preferable, of course, not to place engines in the nose of the fuselage. The exhaust should be carefully led under the wing. The propellers should not be mounted in line with the cabin, nor for that matter in line with the pilot's cockpit—it is the baggage compartment alone which should be permitted to be in the vertical plane of the propeller rotation.

Noise precautions do not end here, however. For example: Air borne noise can be diminished by avoidance of open windows, and cracks and gaps 'round doors. Resort to artificial ventilation is indispensable, and the inlet for the ventilating air must be placed where noise is least—say at the very front end of the fuselage.

Furthermore, the cabin must be insulated

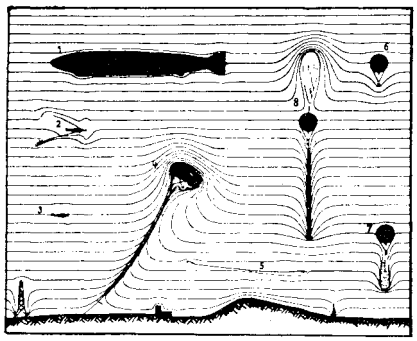
against noise penetration as far as possible. Windows should be heavy—say 3/16-inch glass, and to keep down window weight, they should not be too large. The cabin walls should be built up of an outer reflecting skin of metal, an inner lining of plywood or imitation leather, with a fluffy material such as "kapok" or "eelgrass" in between.

The cabin itself should be provided with noise absorbent material, such as soft curtains.

With all these rules kept in view, truly remarkable results can be achieved.—*A. K.*

Lightning and the Airplane

THE dangers of lightning in aircraft work are the subject of many conflicting views. Sometimes it is said that the airplane is not in electrical connection with the earth, cannot "draw" electricity, and is therefore immune to lightning dangers. Sometimes the opinion is given that if an



How various types of aircraft distort the electric field of the atmosphere. 1; dirigible. 2; airplane with antenna. 3; airplane without antenna. 4; captive balloon. 5; towed glider. 6; free balloon. 7; free balloon releasing ballast. 8; free balloon valving gas and with wet drag rope. See discussion of lightning and airplanes in these columns

aircraft runs into the path of a lightning discharge, it must be immediately destroyed by the powerful current or at least burst into flames. The correct view of the situation lies somewhere between these two extremes.

Heinrich Koppe, a German meteorologist, writing in scholarly fashion in *Zeitschrift für Flugtechnik* sets us all straight.

The earth is an excellent conductor. The atmosphere is a poor conductor up to a height of about 50 miles. Above the 50 miles the very thin air is again an excellent conductor. The earth and its surrounding atmosphere therefore constitutes a species of gigantic condenser. Between the two "plates" of this condenser there flows a very small but perceptible "ionic" current, the ions being split-up molecules. This electric current is 1360 amperes for the entire surface of the earth. It is induced by the famous cosmic rays.

Since there is an electric current between the outer thin air and the earth's surface, there is a potential difference between the two parts of the condenser. The entire voltage difference is 200,000 volts. This sounds large, but the actual pressure gradient is slight, because the distances involved are so great. In the atmosphere there are lines of equal electrical potential or pressure, which lines are normally parallel to the earth's surface.

The presence of flying objects in the air distorts the electrical field in the manner shown in one of the diagrams. This distortion is much less for an airship, which lies parallel to the lines of equal potential, than for a free balloon whose axis of length is perpendicular to the potential lines. The airplane alone distorts the lines much less than the airplane equipped with a long trailing antenna.

When the electric lines are distorted, the pressure gradients between adjacent lines become much greater. The airplane with trailing antenna can multiply the pressure gradient by 10 or even 20.

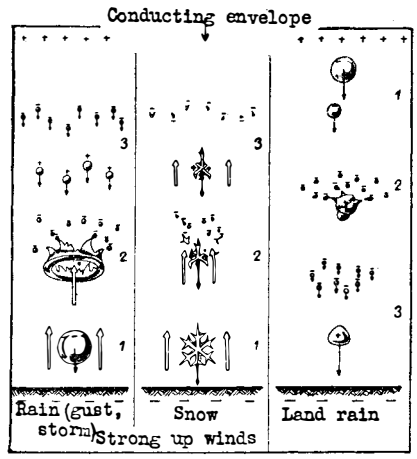
Now when rain drops are acted upon by a violent wind, the molecules may be split. Relatively heavy positive ions continue their downward path; light, negatively charged ions are thrust upward; and the normal pressure gradients are far exceeded.

There is a critical pressure gradient at which electrical discharges occur; namely, when there is a difference of 30,000 volts in pressure for one centimeter of distance.

It is very rare indeed that an airplane is struck by the ordinary lightning discharge, because airplanes do not fly in typical thunder-storm weather. Such weather gives ample warning to the pilot with even negligible knowledge of meteorology, and the weather services are always on the lookout for thunder-storm conditions.

The danger lies rather when gusts of wind and rain drops or snow flakes have made conditions propitious not for one of nature's own discharges, but have simply raised the gradient to say 3000 volts per centimeter. Then if the airplane multiplies this value by ten by distortion of the electric lines, the critical value of 30,000 may be reached.

The consequent discharge may damage the trailing antenna, fuse the radio wires,



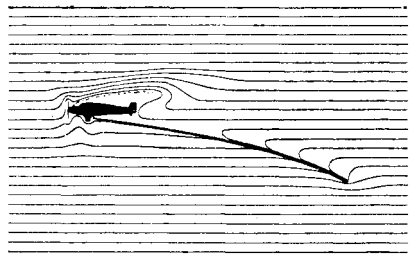
How splitting up of rain drops or snow flakes leads to formation of strong atmospheric electric charges

damage the tanks, even cause a fire. No airplanes of any type are immune to electric trouble. Cases of serious damage have been noted in the all-metal type just as in the stick and wire type of airplane.

The dangers of electric discharge, however, have been much over-rated. The electric discharge strives to pass from the tip of the antenna or other point of voltage breakdown to the very tip of the machine, where is found the heavy metal mass of the engine.

In the all-metal airplane, there is the protection of the conducting metal skin. Even in wooden-type fuselages there are always wires or other conductors which may lead the discharge past the occupants without great physical injury.

Nevertheless it is not pleasant to think that the airplane can make its own lightning flash. The precautions to be observed



Field distortion caused by airplane flying with trailing radio antenna

are first of all a recognition by the weather services that conditions leading to electric discharge may be present even when the sky is free from ominous lightning discharges. Secondly, metallic bonding or shielding, from tail to tip, so that the current will always have a ready path to follow and one which does not lead through the bodies of the occupants, or the gasoline tanks. It may be advisable, for example, to have the propeller copper bonded to the engine. Thirdly, either the elimination of the trailing antenna or particular care in shielding it electrically. Even in the case of the antenna which is mounted above the body of the airplane some bonding precautions are essential.

Our story may be lengthy, but it is better to know than to listen with credulity to some of the yarns which circulate in hangars and on the flying field!—*A. K.*

Activated Alumina—A "Chemical Sponge"

A CHEMICAL sponge, with which moisture can be "sopped up" from air, or other gases, "squeezed out," and used over again, is the latest tool of the chemical engineer, made possible by the introduction of activated alumina by the Aluminum Company of America. Activated alumina (oxide of aluminum) is a white granular substance which is chemically inert and which will selectively adsorb moisture, not only from gases and vapors, but also from liquids and solids. It will adsorb moisture from air and gases at 100 percent efficiency until it has increased in weight from 12 to 14 percent and will thenceforth continue to adsorb at lower efficiencies until a 20 to 25 percent weight increase has been reached. When saturated, it may be reactivated by aspirating heated gases thru the activated alumina or by radiating heat from an electrical element or from hot oil or steam coils. After reactivation and cooling, the adsorbent is again ready for service and there is practically no deterioration in its effectiveness with continued use.

Applications of activated alumina embrace many uses, typical examples of which follow: Drying gases, dehydrating liquids, drying refrigerants, air conditioning (household and industrial), clarification of liquids, solvent recovery, gas masks and canisters, removal of oil vapor from compressed gases,

drying air for blast furnaces, cupolas, converters, and so forth, catalyst and catalyst carrier, conditioning of warehouse atmospheres, complete drying of air, selective gas adsorption and purification and deodorizing of gases, liquids, and solids.—*A. E. B.*

Seaplane Terminals for Cities

QUITE recently Eugene L. Vidal, Director of Aeronautics in the Department of Commerce, announced the allotment of 10,000,000 dollars for the purpose of establishing 2000 aircraft landing fields.

George B. Post, of Edo Aircraft, the constructors of the floats used by Colonel

George B. Post, who suggests seaplane terminals for large cities

Lindbergh in his recent 30,000 mile tour, suggests that 2 percent of this amount might be profitably employed in establishing seaplane facilities. Mr. Post advances some excellent arguments.

For example: If New York were provided with adequate seaplane passenger facilities, and if at the same time similar facilities were provided in the waters of a number of nearby cities such as Boston, Albany, and Philadelphia, the elapsed time between cities would be reduced by at least 30 to 60 minutes—a saving of perhaps 50 percent of the elapsed time under present schedules.

Not only would the centers of cities be brought closer together by such seaplane terminals, but the world's largest commuting populations would be immediately interested. There are seaplane commuters now, in spite of the lack of facilities. Thus Richard F. Hoyt, Chairman of the Board of Curtiss-Wright Corporation, commutes daily in the summer between Lloyds Neck, Long Island, and his office in down-town New York. In the absence of any seaplane passenger terminals Mr. Hoyt lands in the East River, taxies up to a pier at the foot of Wall Street and scrambles up the side of the most convenient tug boat or barge. We cannot expect all our possible air commuters to be similarly athletic and adventurous.

Mr. Post, after a careful study of the situation, believes that suitable water terminals could be constructed at a trifling cost. They would be of the type described in a recent issue of SCIENTIFIC AMERICAN, and could be placed in operation for between 10,000 and 12,000 dollars. These terminals would consist of wood or steel barges, providing storage space for a limited number of planes, with accommodations for passengers and an operator. One end of the barge would be fitted with an inclined turntable, such as shown in the photograph, which would provide a means of removing seaplanes and amphibians from the water and turning them about in the same operation.

We believe that Mr. Post's suggestion is thoroughly deserving of support.—*A. K.*

"Everyman's" Aerial Camera

AERIAL photography may be anybody's hobby or business with the new highly efficient Cyclops aerial camera, the first high performance aerial camera ever produced for less than 200 dollars.

This rugged and dependable aerial camera has been made available by the Fairchild Aerial Camera Corporation specially for owner-pilots, non-piloting flyers, and commercial operators desiring less expensive equipment than has been available in the past. There has been a growing interest, Fairchild engineers state, in simple but efficient aerial photographic equipment.

The Cyclops is so simple to operate that anyone may secure highly satisfactory results with it in connection with commercial operations or private flying. Weighing less than 15 pounds and equipped with two full-sized handles it may be handled with ease in either open cockpit or closed cabin aircraft.

The camera is fitted with an *f* 4.5, 9½-inch lens of the Tessar type, specially selected for aerial photography. It takes a four by six picture, which is the best proportion for obliques. The curtain may be opened at any time, making the rear element of the lens readily accessible for inspection and cleaning. The camera has a variable tension, focal plane shutter which is highly efficient at all speeds from 1/10 to 1/1000 second.

Filters may be installed by means of a cap which can be fitted over the rear element of the lens and in this position the filter can give unsurpassed results without danger of being blown off or becoming dusty. The maximum cross-section, exclusive of handles, measures only eight by six inches and the overall length is about 15 inches. The camera is constructed largely of aluminum. The brilliant view

"Everyman's" aerial camera. Note the small size shown by comparison

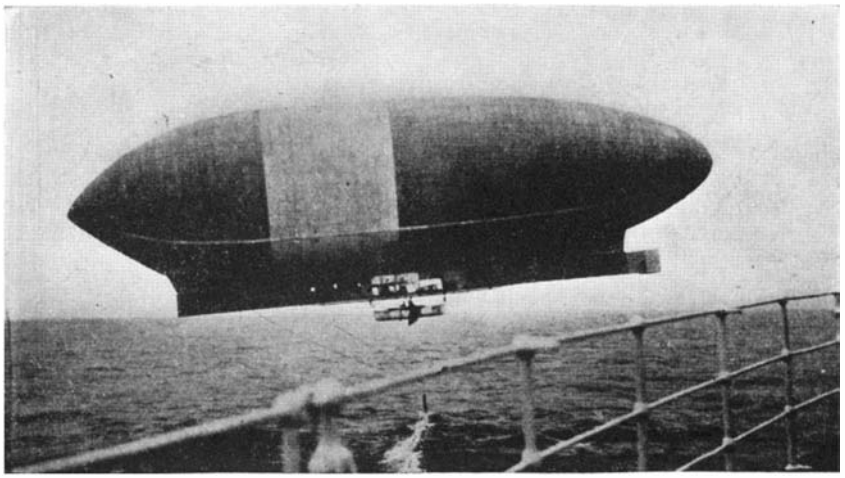
finder folds into a recess in the cone when not in use and is prevented by a lock from folding up under wind pressure when in use. The Cyclops is suitable for close-range photographs, even time exposures on the ground, in addition to oblique aerial photographs.

Walter Wellman, Air Pioneer, Dies

THERE recently passed away, in his New York residence, a man whose name is indelibly written in the history of aviation. Walter Wellman, who, at the age of 75, ended an eventful life of exploration and adventure, was the first man to attempt to fly across the Atlantic. Prior to that time, he had made many attempts to reach the North Pole, the last two efforts being by air. When Peary reached the coveted goal, Wellman gave up his polar aspirations and in 1910 attempted the Atlantic crossing in a dirigible 228 feet long, 52 feet in diameter, and with a lifting capacity of 12 tons.

The *America*, as the dirigible was called, embodied what were then many new and ingenious devices. It was powered with two 80 to 90 horsepower gasoline engines which gave a speed of approximately 20 to 26 miles per hour. The bottom chord of the structure of the airship was a steel tank 75 feet long, in which gasoline was carried. The most peculiar feature of the *America*,

A turntable for use at seaplane terminals



The end of the first attempt at a transatlantic flight. The *America,* commanded by Walter Wellman, disabled at sea. Note the equilibrator dragging in water

in light of present day knowledge, was the "equilibrator" which was a series of cylindrical tanks connected together by a steel cable and which was to be towed from the dirigible. The lower tanks were to float on the surface of the water and when the gas in the bag expanded and the ship tended to rise, the effective weight, increased by raising the tanks from the water, brought the ship back to normal altitude.

The transatlantic flight failed after 71½ hours in the air, during which 1008 miles were covered; both figures were records for the time.

It is with regret that we record the death of one who did so much to build up interest in aerial flight when the science was in its infancy. Glancing through the pages of Volume 103 of SCIENTIFIC AMERICAN, we find many pages devoted to the activities of Mr. Wellman. It is as though a personal friend had passed on; may his achievements always be accorded the honor they deserve.

Powerful Brakes

ONE of our photographs shows a Douglas airliner, in service with Transcontinental & Western Air, about to make a landing with its rear flaps or air brakes depressed. These air brakes have a double effect: They increase the lift capacity of the wing and hence decrease the landing speed, and they increase the drag and hence the steepness of the landing path. As a result, an airplane equipped with such air brakes can clear an obstacle at the edge of the landing field and alight much nearer the obstacle than a similar airplane unequipped with such aids to safe flying. The effect of these brakes is graphically illustrated in the diagram. Coming in over an obstacle 100 feet high the plane lands 500 feet from the obstacle with brakes. Without brakes, 1500 feet are needed.—*A. K.*

Nikola Tesla Writes:

Editor, SCIENTIFIC AMERICAN:

Engineers attach no importance whatever to static electricity generated by belt friction or otherwise. They are apt to dismiss it with the thought that the energy is infinitesimal. That is true. A little water leaking through some joint of a big low-pressure main is of no consequence, but in a pump designed for an extremely high pressure and very small delivery it is all-important. Exactly so in the electrical case. The belt or equivalent device is simply a pump capable of forcing the minute quantity of electricity produced into a condenser against a pressure and increasing the power up to the limit of working capacity of the means employed. Thus mechanical energy, in any desired amount, can be transformed into electric energy yielding direct and constant currents of many millions of volts.

Besides its value as an instrument of research, the Van de Graaff generator will be helpful in stimulating the interest in this neglected field of science and engineering which is of great promise. My comment upon it (Page 132, March, 1934, SCIENTIFIC AMERICAN.—*Ed.*) was based on publications in which the device was described in its primitive form. No signal improvements were suggested or mention made of the classical methods for increasing the output. According to the latest report, the normal performance is now 20 kilowatts, from which I infer that the belts are run in a medium under pressure exceeding that of the atmosphere. This is evident since at 10 kilowatts per unit, the density of the charge on the belt, conformably to my calculations, must be about 16.66 at the spraying and 24.27 at the sucking points, which is too high for ordinary conditions. In all probability, an absolute pressure of 30 to 35 pounds per square inch is used to prevent leakage of the moving charge. This method was first resorted to by Hempel in 1885 and more thoroughly investigated by Lehmann in 1891. Other experimenters confirmed these early findings and showed that the output of a static generator is proportionate to the pressure of the gas in which it is operated.

A still better way, also known for many years, is to employ a high vacuum for the same purpose. Both of these methods have their disadvantages. Compression increases proportionately the windage loss, while the vacuum is destructive. The real limit, however, is found in the mechanical strength of the belt and even under the best conditions the performance of such a machine, considering its size, will be small although, by the employment of a Diesel drive, the efficiency might be raised to a satisfactory figure.

The generator, operating with 10,000,000 volts, will accelerate a particle, as the electron, to a speed of 3.662×10^9 centimeters, equal to about 0.122 times that of light, but if projectiles 1800 times heavier are used, as proposed, their striking speed will be only 863 kilometers which is utterly insignificant as compared with that of the cosmic rays.

Nikola Tesla

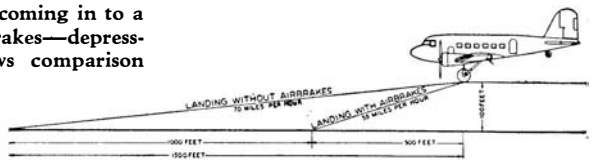
New York, February 8, 1934

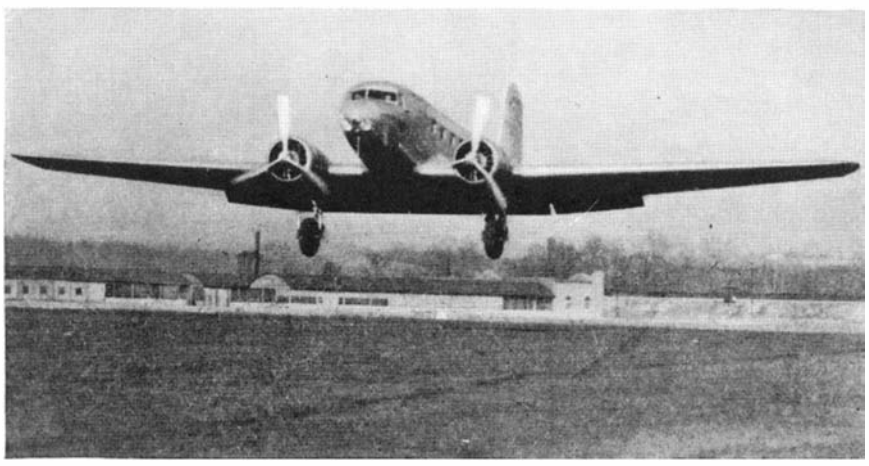
What a Twin Thinks About It

TWINS, and what they think about it, have always been subjects of considerable interest to the outsider. Dr. Alan Frank Guttmacher, a scientist who happens also to be an identical twin, devotes a considerable section of his recently-published book, "Life in the Making," to the matter. When it comes to confusion of twins, he relates an incident from his own experience that rivals the famous Mark Twain anecdote.

"I am an identical twin, and all my life my brother and I have had experiences, sometimes amusing, sometimes embarrassing, which testify to this likelihood for

***Below:* A Douglas airliner coming in to a landing with flaps—air brakes—depressed. *Right:* Diagram shows comparison between landing runs with and without the use of such air brakes**

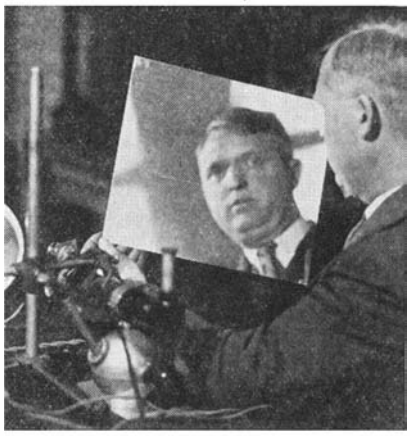




confusion," he writes. "People are constantly mistaking us for each other; and, in fact, on rare occasions we ourselves are not sure which is which.

"As recently as a year ago, my brother and I were vacationing at a small country hotel. As we were changing into swimming clothes, I asked my brother if he thought the river would be infested with sea-nettles. I was startled by complete silence, startled because my brother was standing directly before me and still he made no answer. At length, considerably irritated, I shouted: 'Are you deaf?' To my surprise a familiar voice came from a room across the hall. 'No, what's the excitement?' I had been addressing my own form reflected in the mirror."

Unlike a case reported by Galton, in which the twins were so much alike that



their own children up to the age of five or six did not know them apart, the children of the Guttmacher twin brothers have always differentiated from the first, never mistaking the father for the uncle.

Galton also suggested that it would be interesting for twins who were closely alike to try how far dogs could distinguish them by scent.

"We have never carried out this experiment exactly, but none of the several dogs my brother and I have owned in our separate homes has ever shown any difficulty in distinguishing us. It is not, however, the same for cats, as our Persian cats seem occasionally to confuse us."

When identical twins are brought up in the same home their existences are so interlocked that they are never completely independent entities, Dr. Guttmacher reports. Each is merely half of two persons.

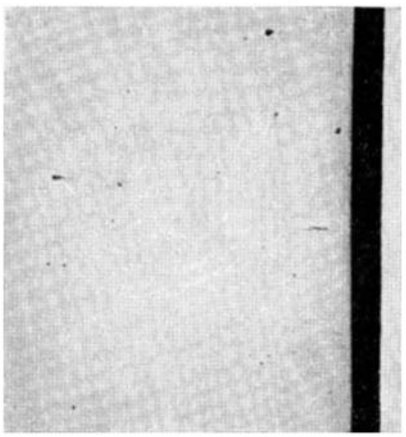
"In the case of my brother and myself, many memories return to attest this blending of personalities. I recall that, if one of us tore his clothes, we both had to go in and change. A casual remark made to a group of playfellows, that we had to go home and 'take our bath,' became a standing neighbourhood joke.

"Identical twins are somewhat pathetic, since until they are well grown 'my' is a non-existent word for them."—*Science Service.*

More About Aluminum Mirrors

IN the February number Professor Henry Norris Russell told how a new method had been found by which mirrors for astronomical reflecting telescopes could be made of aluminum, the metal being evaporated in a vacuum and deposited on the glass mirror disk. From the Aluminum Company of America comes, on the heels of the discovery just mentioned, another discovery of a related nature—the electrolytic brightening process which gives aluminum a reflectivity almost that of silver, coating it afterward with a protective oxide which preserves the brightness. This process was discovered by Dr. R. B. Mason, of the research laboratories of the Aluminum Company of America at New Kensington, Pennsylvania.

The usual reflectivity obtained with polished aluminum reflectors is about 65 to 75 percent. The electrolytic brightening



Left: **Showing the reflectivity of a new aluminum mirror.** ***Above:*** **Photomicrograph of a section of aluminum mirror; oxide at right**

process is carried out by immersing the aluminum reflector in an electrolyte of novel composition and passing direct current through the solution to the reflector, which is made the anode. Impurities in the metal surface which lower the reflectivity are dissolved out, leaving a bright aluminum surface. Dr. Mason took an aluminum surface having a reflectivity of 74 percent, gave it the electrolytic brightening treatment, and increased the reflectivity to 87 percent.

After the electrolytic brightening treatment, the aluminum reflector may be anodically oxidized in a different electrolyte to give the surface a thin protective coating of aluminum oxide. This oxide coating, practically invisible, is transparent, hard, and glass-like, and makes the reflector weather-resistant. If it collects dirt, it can be readily cleaned by washing.

The new finish, called "Alray," will be used by the General Electric Company on floodlighting equipment. According to R. T. Griebling of the Aluminum Company, this process will not prove practicable for telescope mirrors. "The electrolytic process," he states, "was developed primarily for commercial purposes and would therefore, in its present stages, be unsuitable for telescope reflectors, which insist upon a high degree of precision and accuracy not demanded in industrial uses."

Death by Fright

"THIS question has been presented to me several times," a physician writes *The Journal of the American Medical Association* (Chicago): "'Can a man die from fright alone, without any history of actual physical injury?'"

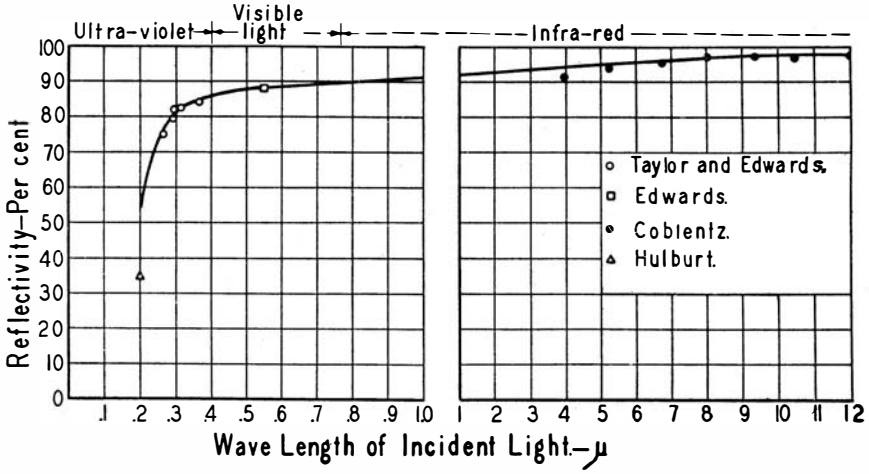
The same journal of medicine replies: "The question was referred to an eminent authority in legal (medico-legal practice.—*Ed.*, SCIENTIFIC AMERICAN) practice. He says that in a large experience of over 40 years of actual post mortem observation abroad and in this country he has not encountered a single case of death from fright in a person of sound physical condition."

This may help cool the ardor of sundry short story writers whose heroes, and especially heroines, they now and then choose to kill off by "sudden fright."

Innovations in Oil Refining

A FEW years ago, if a chemist had told a petroleum refiner that lubricating oils could be extracted by dissolving them out of the crude with suitable solvents, the practical refiner would have laughed the chemist back to his laboratory. The conventional cracking process seemed to be established beyond all chance of successful competition. Yet today, the extraction process is commercially feasible.

"Several years ago," says William Haynes in *Chemical Industries*, "research in the Acheson Oildag laboratories resulted in the patent for the separation of petroleum lubricants by means of acetone, and about 1930, the Imperial Oil of Canada, a Standard of New Jersey affiliate, began experiments with phenol as a de-waxing agent. Out of these researches has come a new solvent extraction of lubricants from hydrocarbons, similar in principle to the ether extraction of crude pyroligneous liquors. There is separation into two liquid phases: a light oil

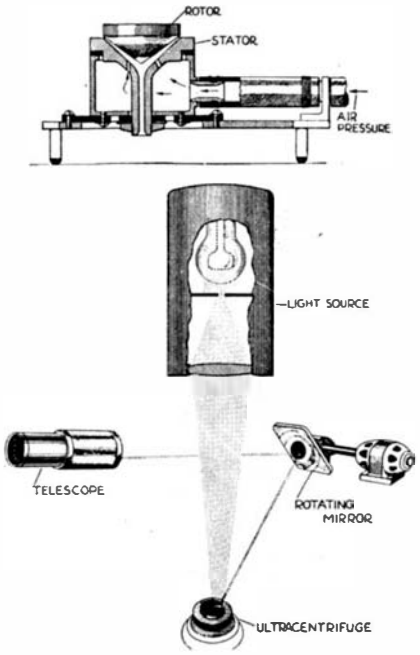


Reflectivity of aluminum in the various ranges of the spectrum

similar to the Pennsylvania paraffin lubricants and a heavy Gulf base type. A wide variety of solvents have been introduced including di-chlor ether, benzol, nitrophenol, furfural, and so on, and the process has begun to assume real commercial importance."—*A. E. B.*

1,200,000 R.P.M.

A WORLD'S record for rotational speed! At the Fourteenth Exposition of Chemical Industries in New York City, considerable public interest was aroused by an exhibit, in the booth of the Sharples Specialty Company, of a centrifuge that has



been operated at a speed of 20,000 revolutions per second. This represents a maximum centrifugal force of 7,600,000 times the force of gravity, and a peripheral speed of 1390 miles per hour. It is said to be the world's fastest rotational speed for any man-made article, without qualification as to type or category.

The rotor of this ultracentrifuge, designed by Dr. J. W. Beams, is of conical shape, having a maximum diameter of one centimeter. It is mounted in a cup, also of conical shape, but of slightly different angle, so that the rotor can contact the cup only at its largest diameter. The cone is grooved with a series of flutings, and apertures are provided in the cup so that compressed air or gas may be directed against these grooves at such an angle as to cause rotation.

It is obvious that speed such as this cannot be attained if there is bearing resistance, and the unique feature of the centrifuge is that the rotor rides entirely on a bearing of gas. The air that is used to cause rotation escapes between the cone and the cup at high velocity and floats the rotor entirely free of any mechanical contact, yet there is an apparent suction that holds the rotor from coming entirely out of the cup even though the entire machine should be inverted. (See page 234, April, 1932, SCIENTIFIC AMERICAN, for a complete description of an earlier ultracentrifuge which operates on the same principle.—*Ed.*)

The maximum speed so far attained has been developed by the use of hydrogen as a propelling medium, delivered at 160 pounds per square inch. The advantage of hydrogen over air is, first, the velocity of the hydrogen molecule is about three and a half times that of air, and second, hydrogen has about one half the co-efficient of viscosity, which reduces gas friction. The maximum speed attained with air at 140 pounds per square inch was 12,000 revolutions per second.

The most satisfactory method of measuring the speed of the rotor is as follows:

A white spot is painted on the top face of the rotor at a point eccentric to the axis. A light is focused on this spot. A mirror is located in a position where it can reflect the image of the white spot into a telescope placed horizontally. The mirror is rotated at a fixed speed. The rotation of the mirror makes each recurring image of the spot appear at a different point in the telescope field, and the speed of the rotor can be accurately determined by measuring the distance between two successive images of the spot, finding what arc of the mirror rotation this distance represents, and computing the unknown speed of the rotor from the known speed of the mirror. A graphic illustration of the amount of centrifugal force generated is the fact that frequently the paint spot will be thrown off before the rotor reaches full speed.

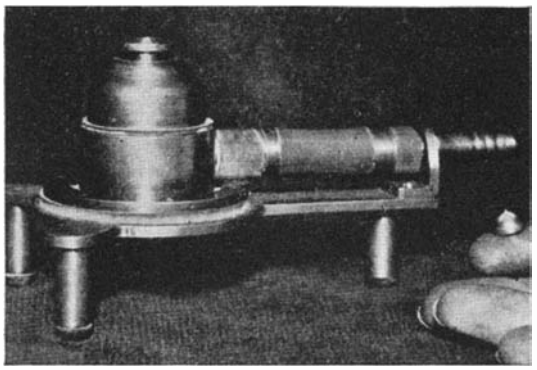
Eggs from Discontented Hens

CAKE bakers use frozen eggs by the carload; very good eggs, too, which were broken when fresh and frozen for mass production of bakery goods, to save time and get uniform quality.

But a Los Angeles cake bakery got some bad frozen eggs on a yearly contract, and called in Arthur R. Maas, consulting chemist, to locate the trouble. Mr. Maas, reporting the incident in his little house-organ *Chemistry and You*, says: "We took samples of the eggs—whites separate, yolks separate, and whites and yolks together. We baked cake with each kind, and with fresh eggs bought in the market. Cake made with the contract eggs was not light and had a bad flavor.

"Analysis of the eggs showed that they were deficient in protein, and in fat, and had excess moisture. This led to an investigation of the diet fed the hens that laid the eggs, and there we located the difficulty.

"Times have been bad, too, for the little red hen. Her product has not brought a price that covered her feeding costs, and so her boss, the poultry-man, has been tempted to cut down her rations, and while she has gone right on laying, the eggs have lacked the quality necessary for good cake. Even cake made in a big commercial bakery must have eggs from contented hens, and the little red hen that laid these eggs was not contented, and so a claim for inferior quality had to be met, and the little red hen lost a good contract."—*A. E. B.*



Left, above: **A cross-section of the stator of the new ultracentrifuge described here, showing how air is supplied to the underside of the rotor.** ***Left:*** **How the speed of the ultracentrifuge is measured.** ***Right:*** **Photo of the device. One of the rotors is balanced on the finger at extreme right**

How Loud Is "Half As Loud"?

APPARENTLY the human ear refuses to abide by rules of mathematics when it judges for itself how much louder or quieter one sound is than another, so experiments in the University of Michigan physics laboratories indicate.

Averaging the judgments of a group of student observers as to what volume of sound was "half as loud" as another sound, this half-way point as determined by the ear was found to be only one tenth of the power of the original sound rather than one half. A listener at a certain distance from a sound source must move to more than three times as far away to have the loudness fall to one half value, Dr. P. H. Geiger, research physicist for the University Department of Engineering Research, and Prof. F. A. Firestone, found.

Using the "decibel," the unit which science has adopted in recent years as a standard quantity of sound, it was found that for ordinary sounds the ear judged a sound "half as loud," when the level of sound had dropped by 8 to 10 of these units. This was not half of the total decibels of original sound, the workers found. For example, a sound of 50 decibels is half as loud to the ear as a 60 decibel sound. Fractions of loudness down to one hundredth and multiples up to 100 times were measured, with similarly unexpected results.

These experiments show that loudness, as heard by the human ear is not directly proportional to any of the physical characteristics of sound. Physical measurements taken together with information on how the ear acts, make it possible to compute the loudness of a sound as the ear hears it. The Michigan experiments, taken together with data from the Bell Telephone Laboratories on other aspects of hearing, indicate that the sensation of half loudness means that half as many nerve impulses reach the brain in a given time.

The Intelligence Rating Myth

A MODERN myth that has received wide acceptance is exploded by Dr. David Segel in *School Life*, official monthly journal of the Federal Office of Education.

This myth, arising from certain tests made of men drafted for the United States

Army during the World War, asserted that the average intelligence of adult Americans was that of 12-year-old children.

"That assertion is not true," declares Dr. Segel, expert on educational tests and measurements in the Office of Education. "Only 5 percent of our adult population have a mental age of 12 years or less.

"The statement that the intelligence of the adults of this country was about that of 12-year-olds came about through a misinterpretation of the data obtained from the intelligence testing carried out in the Army during the World War," he points out. "There are several factors at work which brought about this misinterpretation. The mental ages obtained on the intelligence tests used in the Army were based on equivalent mental ages found on the individual Binet intelligence test. This Binet test, however, underrates adult intelligence.

"Later researches have shown positively that the intelligence of adults of this country will average considerably above that of 12-year-olds."

By using research studies of typical cross-sections of American society, Doctor Segel found that intelligence, which is defined as the *growth and decline of the ability to learn* "rises rather sharply until about the age of 15 or 16, then rises less and less sharply until about the age of 22 or 23. From this age the curve begins to drop, at first very slowly, and then more and more precipitously. The mental age of the adults of the early twenties (20-25) is therefore above that of any age group in the teens. At no chronological age level does the *average mental age* obtained from investigations fall to that of 12-year-olds."

Applying the findings of research with typical cross-sections of American citizenry to census figures for the number of persons in the age groups between 16 and 50 years of age, Doctor Segel finds that the "average mental age of men and women of this country according to this method of calculation is 17.7.

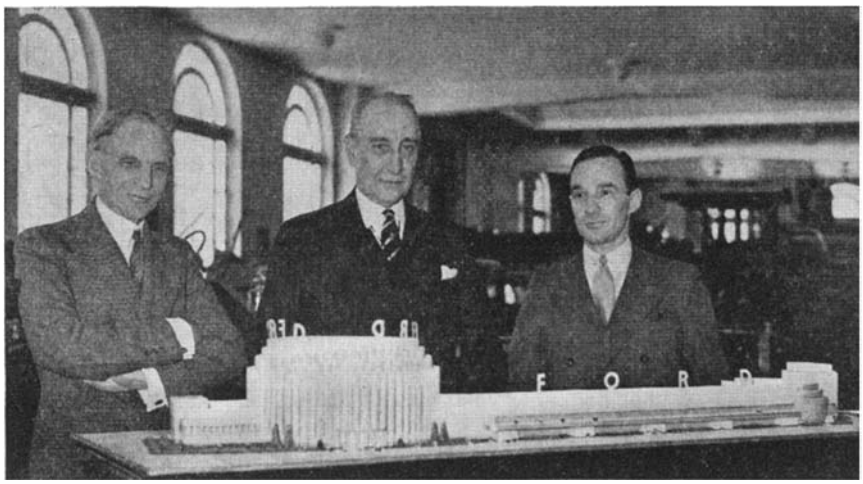
"The word 'intelligence,'" points out the Office of Education expert, "is very loosely used. To the scientist it does not mean the total, collective knowledge, experience and judgment of an individual. It means, in other words, the speed of mental reaction to a new situation—his capacity to grow mentally."

Inks for Marking Porcelain

COLORED markings on porcelain, quite permanent in character, are made with a special "ink" developed by L. Kebrick, who describes his method in the *Chemical Analyst.* Mr. Kebrick uses his method for marking porcelain vessels in the laboratory. Presumably, however, his formula is equally suitable for any porcelain surface which may be heated to bring out the color. The formula suggested comprises:

Sodium carbonate—1 part.
Crystalline sodium borate—2 parts.
Potassium chromate—3 parts.
Water—40 parts.

The marking is made on the clean porcelain surface and held near a Bunsen flame to evaporate the water, after which it is strongly heated in an oxidizing flame to develop the green color of the chromium compound. In this way a vessel may be marked in about one minute, since ordinarily sufficient solution runs from the pen



Henry Ford, left, and Edsel Ford, right, with Rufus C. Dawes, president of the World's Fair, examine a scale model of the Ford building to be erected in 1934

to impart a suitable depth of color to the characters. When a blast lamp is employed, the markings are greenish black, probably due to the formation of a chromium silicate.—*A. E. B.*

An All-Wave De Luxe Radio Receiver

WITH American and foreign stations operating on more or less consistent schedules on short waves, and with amateur conversations, police calls, and transoceanic telephony on wavelengths below the regular broadcast band, the demand is rapidly increasing for a really high-grade radio receiver capable of receiving all of these transmissions without the necessity of making troublesome changes.

One set that fills these requirements is the Scott all-wave superheterodyne illustrated in these columns. In this receiver, which incidentally is guaranteed for five years, there are to be found many up-to-date features that insure the best possible reception under all conditions. The wavelength bands are selected by means of a switch located on the front panel, turning of which throws into the circuit the required set of coils. The user does not have to change plug-in coils, as all the inductances are within the chassis and are controlled by the switch.

The set covers wave bands from 15 to 550 meters with one knob operating one dial. No trimmer condensers or other balancing devices are used. The audio amplifier is designed to give practically undistorted or lineal output at any amplification. An automatic volume control, which functions in about 1/20th of a second, preserves the sound level regardless of variations in the strength of received signals. A specially designed low-pass filter circuit in the audio amplifier makes possible a great reduction in static interference, a highly desirable feature in distance reception.

Ford at the World's Fair

PLANS for a giant Ford exposition at the 1934 Chicago World's Fair were disclosed recently by Henry Ford to Rufus C. Dawes, president of A Century of Progress International Exposition.

The Ford exposition, which will be housed in a magnificent building in the heart of the fair grounds, will portray to the millions of exposition visitors the contributions which the industries, arts, and sciences make to the motor-car industry. The Ford exposition building will be 860 feet long and will be located in an 11-acre plot fronting on Lake Michigan and bisected by Leif Ericson drive, the main fair boulevard.

"The scope of the Ford plans for the exposition is magnificent," said Mr. Dawes. "I am very enthusiastic over the project and am confident that it will mean a major contribution to the success of the 1934 fair."

"We want our exposition to be just as instructive as it is possible to make it," Mr. Ford told Mr. Dawes. "Wherever possible each exhibit will be in action, producing something. We want the exposition to be a moving demonstration of the contribution made by the various industries, arts, and crafts to the modern automobile."

"Creep" in Rocks is Like "Creep" in Steel

THE age of mountains may be determined from the "creep" of its rock formation, as a result of studies now being conducted on the stretch or "creep" of steel, scientists attending the Society of Rheology convention at Pittsburgh, Pennsylvania, were recently told by Dr. A. Nadai, research physicist of the Westinghouse Electric and Manufacturing Company.

Mountains rise out of plains and islands rise from ocean bottoms as a result of the slow flow or movement of rock, a phenomenon common to all viscous or plastic materials, he explained. Of far greater immediate importance is the similar flow of steel which is used in present day machinery.

This flow or "creep" is surprisingly similar in rock and metal. Even the formula which fits the "creep" movement is almost alike for both materials. Discoveries in the field of metals may interpret parallel behavior in rock behavior and vice versa.

The time element is the important difference in the two problems. Geologists are interested in rock "creep" that takes place over millions of years; physicists in the "creep" of steel only for the usual life of machinery—10 or 20 years.

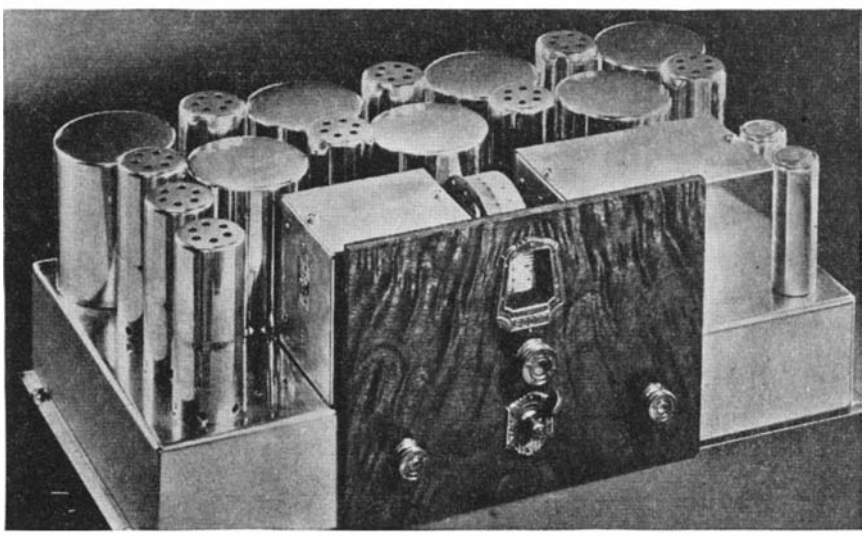
Research into the physical laws governing metal's "creep" has become necessary because engineers are ever designing larger and more efficient machines such as large steam turbines, with the result that the metal in the machines is called upon to work at higher temperatures, at higher pressures, at faster speeds and with smaller clearances between adjacent parts.

This evolution to more efficient machines and more exacting requirements of metals comprising them is particularly evident among manufacturers of steam turbines and steam boilers, and of cracking stills used in oil refineries.

Unfortunately, ordinary metals "can't take it." Metal, when subjected to high temperature and a steady pull tends to stretch or "creep" in the direction of the pull.

For example, the metal blades of a steam turbine motor are continually stretching, although only an infinitesimal amount, while they are being whirled around at the rate of 3600 revolutions per minute in superheated steam.

Clearance of 1/1000th of an inch is permitted in these high speed turbines. If the blades stretch more than the allotted clearance, they will rub the outer casing, generate terrific heat and probably explode the turbine, endangering lives and damaging property. Hence the importance of know-



Chassis of the all-wave radio receiver described on this page

ing how much the metal blades will stretch or "creep."

The solution to the problem lies with the metallurgist and physicist. The metallurgist must find a metal that will "stand the gaff" and the physicist must devise a method of predicting accurately how much the metal will "creep" when in service under a given set of conditions for 10, 20, or 30 years.

The method developed must be accurate and reasonably rapid to be of any value. If the method is too slow it will be used but rarely, but if rapid it will likely be used in everyday tests. Engineers look forward to the time when 15 minutes will be considered "reasonably rapid."

Dr. Nadai pointed out the difficulty which faces a physicist who attempts to predict in a short test the infinitesimal "creep" of metals. Steel that will creep 1/1000th of an inch in 10 years will creep approximately

0.0001	Inch	in 1 year
0.00001	"	in 1 month
0.0000003	"	in 1 day
0.00000001	"	in 1 hour
0.000000003	"	in 15 minutes

This means that, in order to predict by means of a 15-minute test, "creep" in steel at a rate of 1/1000th of an inch in 10 years it is necessary for the physicist to develop apparatus which can distinguish the stretch of three billionths of an inch in a one-inch sample of the steel.

Westinghouse research engineers have developed analytical methods and apparatus which reduce the duration of "creep" tests from three months to one month. New methods and apparatus now being developed may reduce the duration of "creep" tests to only one hour.

Cheap Source of Vitamin C

JUICE from the lowly turnip is recommended as a good substitute for orange juice or tomato juice. Attention is called to its value as a cheap source of scurvy-preventing vitamin C by Dr. E. W. McHenry of the University of Toronto School of Hygiene in a report to the *Canadian Medical Association Journal.*

In Toronto, one cent will buy 1100 vitamin-C units from turnip juice, whereas the number of vitamin-C units from one cent's worth of lemon juice are 180, from orange juice 220, from tomato purchased as juice 170 and from tomato juice prepared from canned tomatoes 180.

Two pounds of ordinary turnips will give 15 ounces of the juice, which is said to be sweet and not unpalatable. Salt improves the flavor, but for infants the pure juice is advised. The juice may be easily made at home by grating a section of turnip and pressing the juice from the minced material in a linen or other cloth.—*Science Service.*

Some Geographical Oddities

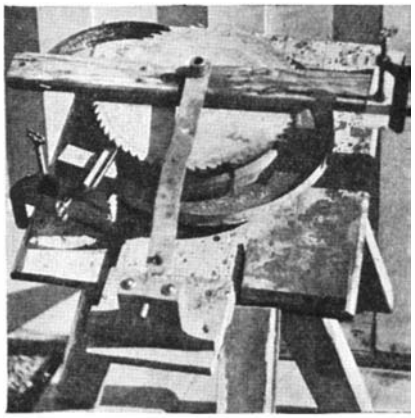
GEOGRAPHICAL facts which are quite contrary to established notions are brought to light by a careful examination of the map. Relative locations of certain points are often found to be quite different from the general impression concerning them. This is pointed out by the Touring Bureau of the California State Automobile

(*Please turn to page* 215)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

MACHINES for grinding and polishing the concave mirror disks which form the most important part of the reflecting type of telescope are not a necessity, as has been explained in the book "Amateur Telescope Making," and perhaps 95 percent of the mirrors made are done by hand, but it is fun to make a machine which will do this work and again it is fun to watch the wheels go 'round. This month we show



Hely's machine

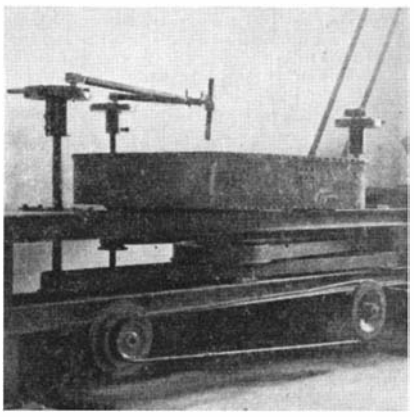
several such machines built by amateur telescope makers, also one or two used by professionals.

The first is the Lee machine (page 148, "A.T.M."), made by L. St. John Hely, M.D., 912 Macdonald Ave., Richmond, California. The reciprocating rod which leaves the picture at the right hooks up to a reducing gear with single belt drive and the ⅛ horsepower motor of a band-saw outfit. Dr. Hely finds this machine excellent and says anyone can make it who is "enough of a mechanical genius to open a can of oysters."

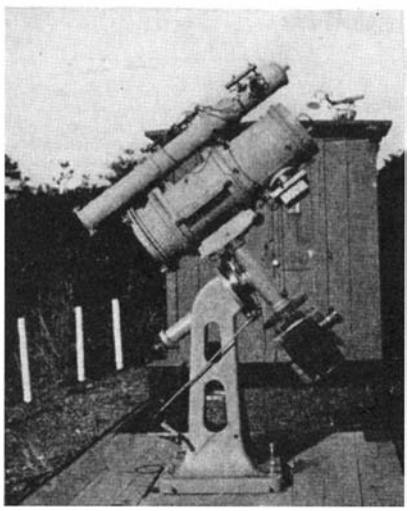
Leo J. Scanlon of the Astronomical Section of the Academy of Science and Art of Pittsburgh (address Valley View Observatory, 106 Van Buren Street, Observatory P. O., Pittsburgh, Pa.) writes: "I send a picture of a grinding and polishing machine built by Robert H. Marshall, member of our gang. Marshall would sooner spend a week building a machine than a few hours polishing a glass. His address is 120 Maywood Street. The machine is powered with a ¼ horsepower washing-machine motor, on the shaft of which is a worm gear, driving a 20-tooth worm gear, which reduces the speed of the vertical drive shaft to approximately 80 r.p.m. The table is driven at the rate of about 8 r.p.m.

"The grinding arm makes anywhere from 50 to 100 strokes per minute, and is usually run about 80 per minute on a 6-inch glass. The length of stroke can be varied between one and four inches, by suitably inserting a pin in an eccentric arm at the head of the drive shaft. The tool can be made to ride center over center, or can be varied to ride any intermediate zone between center and edge, by adjusting a pin in the bar in the foreground of the picture.

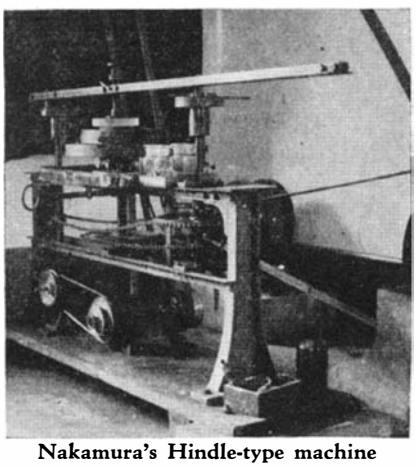
"The grinding or polishing tool is made to rotate either with the mirror or against it, and at various speeds depending upon the surface to be worked. Here's a point that is not generally known," Scanlon continues. "If you revolve the tool with the mirror you deepen the center; if contrary, you cut down the edges. This knowledge is handy in polishing, especially when the mirror doesn't want to clean up around the edges. Parabolizing can be attempted by suitably arranging the cutting speed of the tool by rotating it with the mirror. The tool usually makes 10 to 20 revolutions per minute. Capacity of machine, 12-inch mirror."



Nakamura's 30-inch machine



Nakamura's 10-inch reflector



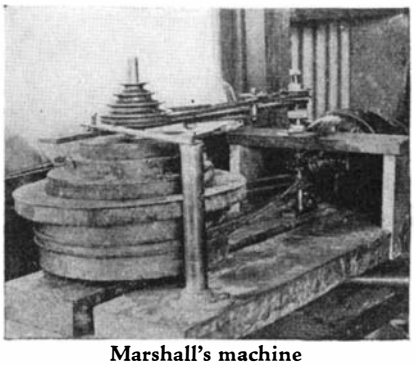
Nakamura's Hindle-type machine

DR. K. NAKAMURA of Kwasan Observatory, Yamashina, Kyoto, Japan, writes: "Two photographs are enclosed. One is the view of a large grinding and polishing machine of personal design at my optical workshop in the basement room of the Kwasan Observatory. The machine can polish 30-inch mirror easily. The other is the photograph of 10-inch, *f*/3.8 photographic reflector belong to Mr. Shibata. The guiding telescope is the four-inch reflector. The optical parts were made by me and the mechanical parts by Nishimura works. The 17th magnitude stars are easily photographed with one hour exposure." Dr. Nakamura sent three photographs, not two as he wrote, the third being that of a machine for grinding mirrors up to 12-inch diameter. There is a lot of amateur telescope-making activity in Japan. We have seen their instruction book but not read it!

J. W. Fecker, professional optician, 2106 Perrysville Avenue, Pittsburgh, Pa., has given us a photograph of a large machine, which is reproduced on the opposite page. This is the type shown in "A.T.M.," page 151, Figure 3, at *C*, but very much larger. Mr. Fecker states that this machine is used by him for giving a first polish to large surfaces, and that he uses other means for final polishing and figuring.

Edwin P. Martz, Jr., 726 North Elmwood Avenue, Oak Park, Illinois, sends a photograph of his own machine, which is of the same type as the one just mentioned. Martz has three telescopes and is making a special study of Venus, using filters for improving definition.

AMATEUR telescope making and astronomical activities reported are as follows: The Amateur Telescope Makers of Dayton (Ohio) have elected Mr. Loren Shumaker of 1608 Wyoming Street, Dayton, secretary of their organization, which has 25 members. Mr. Shumaker has worked out a method of making the Ronchi test quantitative. Dr. J. A. Anderson of the Mount Wilson Observatory has independently



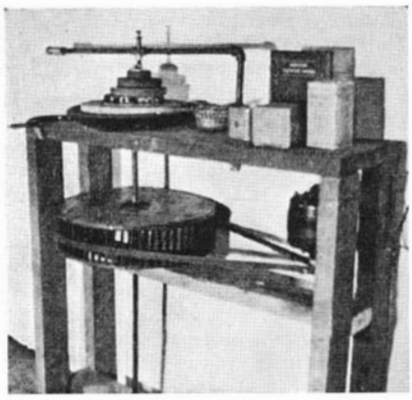
Marshall's machine

worked out a similar method, and Mr. Franklin B. Wright, 155 Bret Harte Road, Berkeley, California, Chairman of the East-bay Astronomical Association and co-author of "A.T.M." (pages 257-261), is said to have worked out something similar.

An astronomical society has been organized in New Orleans. Mr. Harry L. Lawton, 215 Stella Street, that city, is president.

The Westinghouse Club at Wilkensburg, Pa., has discovered an interest in telescope making and microscopy and has an Optics Section devoted to these hobbies, according to Mr. Fred C. Wilharm, Box 63, Homewood Station, Pittsburgh.

Fecker's pre-polisher



Martz' machine

SOME years ago the price of a six-inch mirror made by Zeiss was 150 dollars. Dealers who started in business after the telescope-making hobby was developed among our readers cut this price to about 50 dollars. Partly this was justified by the facts but partly, it is thought, this resulted from a feeling that a maker who was only recently an amateur ought not to charge as much as a professional. Nevertheless many amateurs can do work fully as good as professional work, and better than some that had been sold previously.

More recently all sorts of cheap mirrors have been offered. If you have made mirrors yourself you know that no one can afford to make good mirrors at very low prices. If you have not, be warned and do not take the lowest bid.

Recently a reader wrote us that his eight-inch mirror, refigured by a dealer, would not resolve detail resolved by a six-inch refractor which he had used. We asked him to send it to us. On test the difference in radius of inside and outside zones proved to be a half inch! (*f*/10 mirror). The dealer had called this mirror paraboloidal. It was not paraboloidal, nor was its curve even a conic section. If your purchased or refigured mirror seems suspicious we should like to hear from you.

CURRENT BULLETIN BRIEFS

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

EMULSIONS, WAXES, RESINS AND COSMETIC FORMULAE, give information on the latest methods of making these products. The two pamphlets are sold as one by the *Glyco Products, Inc., Bush Terminal Building, No. 5, Brooklyn, N. Y.—The two for ten cents.*

SLUM CLEARANCE AND KNICKERBOCKER VILLAGE is from an address by Fred F. French and describes what is to be done in one of the worst slums in New York. What has been done in Tudor City at the easterly end of 42nd Street is almost a matter of history. In a nut shell, the idea in both developments is to walk to business and thus cut hours of traveling time. *The Fred F. French Company, New York City. —Gratis.*

HOW TO KNOW THE MUSHROOMS AND TOADSTOOLS is a brief circular prepared by Professor F. C. Stewart, mushroom specialist at the Experiment Station at Geneva, N. Y. Every season newspapers chronicle instances of persons made ill by eating wild mushrooms, sometimes with serious consequences, with the result that the public becomes alarmed and large quantities of an excellent food go to waste at our very doors. The circular may be obtained from *New York State Agricultural Experiment Station, Geneva, N. Y.—Gratis.*

BAKERY MACHINERY LUBRICATION (*Lubrication*, Vol. XIX, No. 8, August, 1933). Efficient operation of baking machinery and the manufacture of quality products depends to a marked degree upon the manner of lubrication and the prevention of contamination of materials. This pamphlet describes the best lubricating methods. *The Texas Company, 135 East 42nd Street, New York City.—Gratis.*

AERONAUTICAL RESEARCH COMMITTEE REPORT FOR THE YEAR 1932-1933 gives data as to stability and control of airplanes, spinning, aerodynamics, and so on. Special attention is given to airplane noise. *His Majesty's Stationary Office, Adastrol House, Kingsway, London, W. C. 2, England.— Two shillings, postage extra.*

PULVERIZED FUEL 1932-1933 (Publication No. A 6). This report includes installation and operating data from 43 companies covering 181 boiler units. *Edison Electric Institute, 420 Lexington Avenue, New York City— 75 cents to members and their employes.—$1.85 to non-members.*

THE STREAM OF EXPERIENCE—commemorating the 25th anniversary of the Fuel Engineering Company of New York—describes a system of testing fuels; in six years 25,000 samples have been tested and the records classified. The pamphlet describes how fuel-engineering began and what it is now doing for other industrial corporations. The fuel valuegraph is a chart to compare the cost of steam, or the values of fuels at the same or different efficiencies. A pad of the blanks costs $1.00. *Fuel Engineering Company of New York, 116 East 18th Street, New York City.*

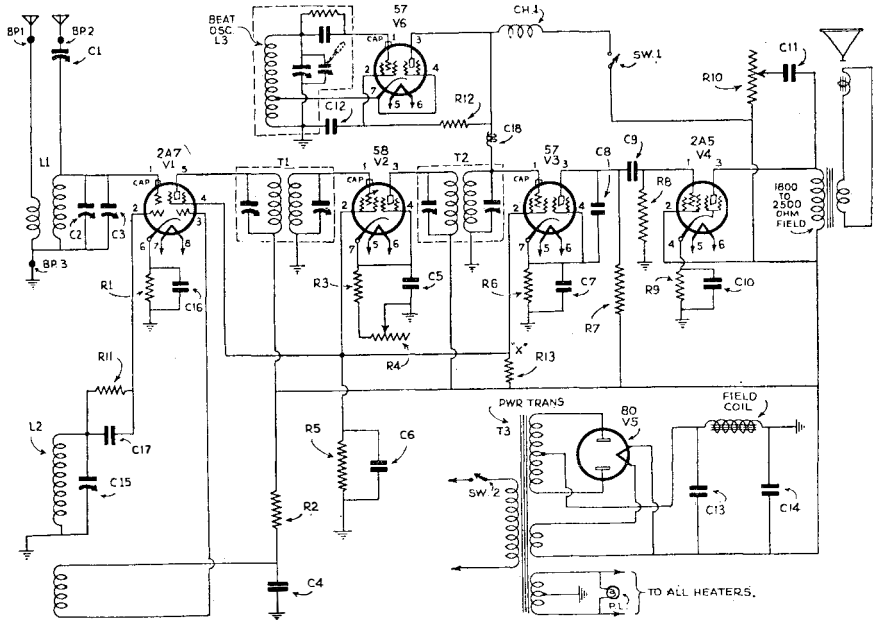
THE AMERICAN RAILROAD IN LABORATORY is a brief digest of research and experimentation conducted by railroads individually and collectively through the American Railway Association in the interest of constant improvement of their facilities and service. 544 pages. *American Railway Association, Washington, D. C.— 50 cents.*

SUN SPOTS AND WEATHER (Smithsonian Miscellaneous Collections, Volume 87, No. 18), by C. G. Abbot. Sun spots are associated with important modifications of weathers not hitherto recognized, says Dr. Abbot. *Smithsonian Institution, Washington, D. C.—5 cents (coin).*

KOHLER VILLAGE is a town-planned Wisconsin industrial community which created a great deal of interest when the Kohler Company removed a manufacturing enterprise from a city into the open country. A study of the garden cities of Europe showed that some of them are far ahead of the best of our industrial towns. Eventually, homes built by the people themselves materialized and what was a vision has become a reality, and is justifying itself both esthetically and in the practical business of living. *The Kohler Company, Kohler, Wisc.—Gratis.*

ST. CATHARINE'S, ONTARIO, AND THE WELLAND SHIP CANAL. St. Catharine's is called Canada's Garden City; it is fully illustrated and described in this pamphlet. It is a weird sight to see a large ship passing through the town. Interested parties can obtain a copy by addressing *Herbert H. Smith, City Clerk, St. Catharine's, Ontario, Canada.—Gratis.*

HARD-FACING WITH HAYNES STELLITE PRODUCTS describes the economies that have been introduced in hundreds of cases by the application of hard-facing materials to wearing surfaces. Where abrasion is intensified by heat, hard-facing proves to be doubly valuable. Hard-facing permits the utilization of cheaper base metals for wearing parts. The many applications are described in this 96-page booklet. *Haynes Stellite Company, Kokomo, Indiana.— Gratis.*



THE SUPREME SIX SHORT-WAVE SUPER. In this de luxe short-wave receiver, designed for the radio connoisseur, a type 2A7 Lafayette tube performs the double duty of first detector and oscillator. In the intermediate frequency amplifier is a type 58 tube. The beat oscillator is a 57, the second detector another 57, the power output tube a 2A5, and the rectifier an 80. This receiver uses the new air-tuned Hammarlund intermediate frequency transformer and Alden plug-in coils. The beat-frequency oscillator gives excellent selectivity for the reception of continuous-wave transmissions. A Trutest power transformer supplies all necessary voltages. Drawings of this set, a complete list of parts, and other data may be obtained from the *Allied Engineering Institute, 98 Park Place, New York, N. Y.—10 cents.*

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 211)

Association, which is called upon to answer requests from motorists for a wide variety of information. For example:

Reno, Nevada, is 100 miles farther west than Los Angeles, and Jacksonville, Florida, is farther west than Cleveland, Ohio.

The westernmost point of Alaska is farther west of San Francisco than New York is east.

In going from Detroit to Canada the traveler moves southward.

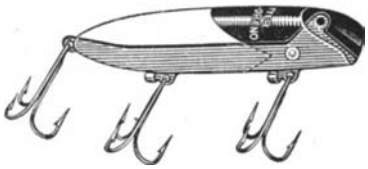
New York lies to the west of some cities on the Pacific Coast of South America.

Santa Barbara, by reason of its location, sees the sun both rise and set in the Pacific.

Through the Panama Canal from the Pacific to the Atlantic the direction traveled is not east, but northwest; from the Atlantic to the Pacific, not west, but southeast.

A Better Bass Bait

PLUG casting for bass and other game fish is many years old, and the available plugs take many forms. Recently, however, there has appeared on the market a plug that is so designed as to be worthy of special notice. This bait, a product of the South Bend Bait Company, follows the general lines of a time tested lure, but is



Phantom view of the bass bait described, showing aluminum plate

so mechanically improved as to constitute a radical departure from the usual construction methods.

The one outstanding feature of this plug is an aluminum plate that extends the length of the body and serves as a keel as well as making a direct connection between the hooks and the line. The plate is riveted and cemented to the wood body, and several coats of paint and lacquer make a continuous waterproof unit of the plug. Four eyes in the plate provide for the attachment of the line and three sets of hooks which are readily detachable.

27 Billion 'Phone Calls in U. S. Yearly

TELEPHONE statisticians have completed a survey of the use of telephone and telegraph facilities throughout the world. The survey covers the year 1931, the latest period for which comparable figures are available.

This study shows that, next to the United States, the country where the greatest number of telephone conversations take place is Japan. Canada holds third place, Germany fourth, and Great Britain and Northern Ireland fifth. The figures give 27,500,000,000 telephone conversations during 1931

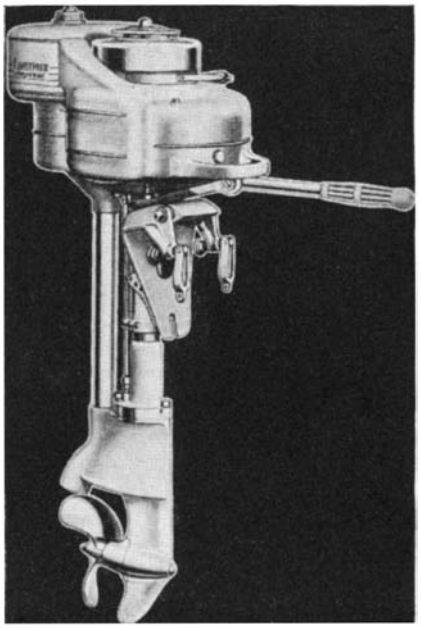
for the United States, 3,326,148,000 for Japan, 2,565,641,000 for Canada, 2,376,000,000 for Germany, and 1,590,000,000 for Great Britain and Northern Ireland.

Next come France and Sweden, with 847,206,000 and 842,000,000 telephone conversations respectively. They are followed by Poland, Spain, Denmark, Austria and The Netherlands.

Telephone conversations in the United States average 222 per capita. On a per capita basis, Canada outranks the United States in telephone conversations, and New Zealand is in third place, with Denmark and Sweden following.

Outboard Motor Improvements

"HOODED Power" is the term applied to the design of a new outboard motor in which the power head is enclosed in an aluminum housing that completely protects carbureter, wiring, and spark plugs from the weather, as well as guarding



"Hooded Power" in an outboard

against rough handling. Only two controls and a primer button project outside the housing.

Two entirely new models in both the Evinrude and Elto lines for 1934 present this improvement in outboard appearance and operating satisfaction. One is a 42-pound twin-cylinder motor developing 5½ N.O.A. certified brake horsepower at 4000 revolutions per minute. The other is a new four-cylinder model weighing only 55 pounds and developing 9.2 N.O.A. certified brake horsepower at 4000 revolutions per minute—the most portable four-cylinder outboard motor ever built.

Also in the Elto and Evinrude lines is an all-electric model weighing 60 pounds and capable of speeds up to four miles an hour. On lagoon boats, children's play boats and dinghies this model finds much favor, for silent power is at one's command by merely throwing a switch.

Peace By Starvation

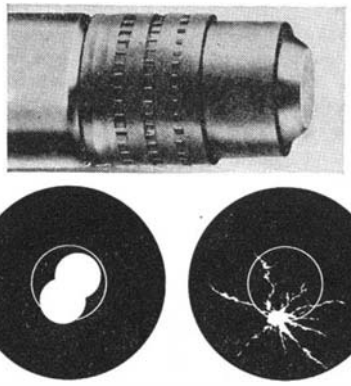
AN English writer was recently discussing the economic boycott as a peaceful substitute for war in the settlement of international differences. He concluded that

the economic boycott in the long run is simply "peace by starvation" which quite rightly it is. The question logically arises then, where is the great humaneness of the boycott? If by boycott a group is starved to submission or death there is not a great deal of sense in substituting lack of food in place of preponderance of machine guns, bombs, or artillery fire. In the final analysis both methods produce the same result. Which then is the more humane method?

Peace by starvation versus peace by open or closed warfare, any way you look at it, doesn't seem to have much to debate about because both horns of the dilemma are the infliction of physical suffering. Both will do that and both stand a likely chance of achieving the same end. The boys and girls who press for the boycott, however, paint in rosy hues. They say the economic boycott will take the barbarism out of war; that it will accomplish by moral suasion what mankind has tried to do only by physical force. For ourselves we cannot escape a homely example. If a gangster is about to assert himself along unfriendly lines, starvation may be tried, of course, but a rifle or an automatic will put the thug where he belongs much more quickly. If time is of no immediate concern the boycotting or starvation process can be tried. But whether this desperado is subdued by the pangs of hunger or by a few well placed shots, physical force of one kind or the other does the job. And nothing else will do it but physical force. The comical part about the theory of the boycott preachers is that when you starve a man or a group of men you are humane but when you don't starve them but make them come to terms by other kinds of force, then the thing is brutal, terrible and hellish!—*Army Ordnance.*

.22 Long-Rifle Sharp Shoulder Target Ammunition

FOR several years, there has been a need among small bore target shooters for a type of cartridge that would punch a clean hole in the target to facilitate spotting and scoring.



Top: **Enlarged view of .22 sharp-shoulder bullet.** *Lower left:* **Clean holes made by new bullet, and** *right,* **jagged tears made by old style**

At first glance the solution of this problem would appear to be reasonably simple, and amateur attempts were made by certain enthusiasts by the simple process of cutting off the nose of the bullet. These crude attempts of course were not conducive to good target accuracy, but they illustrated the principle desired. This prac-

tice furthermore reduced the weight of the bullet and consequently increased the muzzle velocity.

Actual design for production of the sharp shoulder type of .22 long rifle bullet presented many difficulties, in order to obtain absolute uniformity of shape and the desired degree of stability in flight. The sharp-shoulder bullet, as perfected by the Remington Arms Co., Inc., makes a perfect, round hole, which gives the effect of having been cut out of the target with a paper punch. This is in striking contrast to the jagged holes made by the ordinary bullet. The clean-cut holes made by the new bullet make more accurate spotting and scoring. The bullet has a nose that is practically flat instead of conical. Friction, caused by the contact of a bullet with the rifling of a rifle or pistol barrel, is diminished in the sharp-shoulder bullet by reducing the diameter of part of its length. The portion that takes the rifling, however, is sufficiently long to form a tight seal for the gas generated by the burning of the powder and thereby take full advantage of the propellant force. The bullet is lead lubricated and weighs 40 grains.

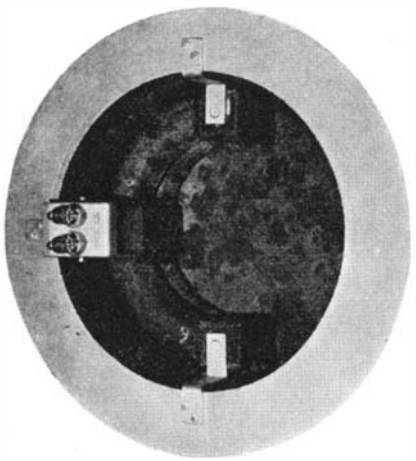
Despite the fact that the nose of the new bullet is practically flat and, therefore, sets up a greater wind resistance than the conical type, the sharp-shoulder bullet has more velocity. The bullet has an average speed of 1275 feet per second, while that of the old type is 1075 feet per second.

Immersion Melting With Gas

TODAY most users of soft metals in industrial operations realize that the mere application of heat is but one of the factors to be considered. A very definite demand now exists among progressive organizations for heating equipment which will control temperature, rate of heating, dross formation, and fuel consumption.

The C. M. Kemp Manufacturing Company has developed equipment which meets this demand. They have provided what are known as immersion melting units, the use of which gives controlled heating of any metal bath which must be maintained in a molten condition at temperatures not in excess of 1800 degrees, Fahrenheit. Certain specific applications, such as galvanizing, have not been advocated due to the lack of knowledge of a material that would withstand the dissolving action always present.

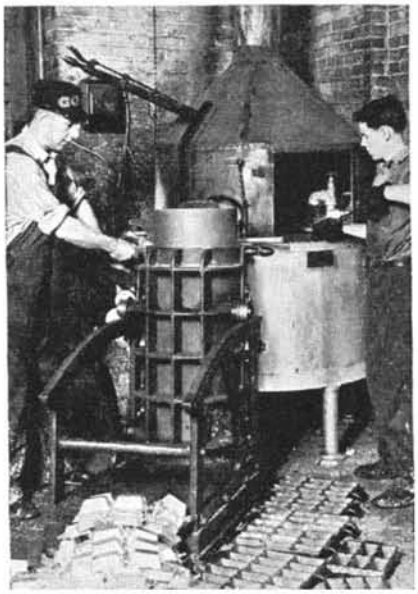
Regardless of the apparatus for which it



A straight-side steel stereotype pot with immersion gas-heating unit

is used or the temperature of the bath, the construction of the Kemp immersion melting element is always substantially the same. It consists essentially of a large tubular flue in the form of a re-circulating rectangle through which a gas flame is blown. This tubular flue is immersed in the bath of molten metal. Temperature control is maintained by control of the air and gas ratio, the requisite amount of heating surface having been carefully calculated for the specific job at hand.

Inasmuch as the immersion element



Controlled heating of metal pots may be had with the unit described

serves the purpose of a heat transfer medium only, and not that of a supporting container, the cross section is but a fraction of that usually encountered. Economies in operation are assured because of the reduction in radiation losses. This is due to the fact that the heating element is within the metal rather than in a combustion chamber surrounding the pot, as in external heating. With immersion heating there is virtually no stored heat, for that usually present in over-heated brick work and container is eliminated.

It is claimed that with the Kemp unit there is a lower initial and installation cost due to the elimination of expensive brick work and settings, the use of lighter pots or containers, and the use of smaller pots because of the unusually high heat rate.

Kovar

MUCH of the work of a research engineer can pass almost unnoticed even by those who use the product of his study. For instance, a large water-cooled electronic tube is an interesting device as a whole but a piece of metal forming part of the wall would attract little attention. Yet for certain tubes an alloy of new properties is needed and the tube would be impossible without it.

The alloy Kovar is new and has certain specific properties making it suitable for use as a cooling wall in large mercury-pool tubes. It has a thermal expansion which permits permanent sealing to glass. Copper has been successfully used in this place but when mercury is introduced into the tube the copper amalgamates and its strength is

quickly lost. Kovar meets all the usual requirements and is, in addition, unaffected by the mercury or mercury vapor.—*A. E. B.*

Automobile Elevator for Monster French Ship

A SPECIAL automobile elevator, the largest and most unusual ever projected for ship use, is being built by Otis-Pifre in Paris for the new French liner *Normandie*, the 72,000-ton ship that will go into service in 1935, it was announced by the International Division of the Otis Elevator Company.

With a lifting capacity of 11,000 pounds, the elevator will be by far the heaviest duty elevator ever to be installed in a commercial ship. In addition it will have a radically new feature in a turntable that will permit the easy storing of automobiles in the hold. This turntable will be manually controlled and will operate on the elevator platform.

Soap Bubble Glass

AN aid to the doctor in treating certain ills is the ultra-violet lamp. Such lamps with quartz bulbs have been used but are necessarily expensive because of the quartz. Glass is much less expensive and also much less effective, since only a fractional part of the ultra-violet rays filter through the ordinary glass bulb. The solution lies in making the glass as thin as a soap bubble—2/10,000 of an inch. Certainly a whole bulb made of this glass would also have about the durability of a soap bubble. The secret lies in making the bulb of normal thickness and setting into it a window made of the thin glass. This passes a concentrated beam of ultra-violet with which the doctor may treat various ailments.—*A. E. B.*

THE NEW NAVAL BUILDING PROGRAM

(*Continued from page* 188)

and are a tribute to the energy, resourcefulness, and elasticity of the Navy. Their achievement is something the nation may well be proud of, and their standard must not only be maintained but advanced wherever possible.

Due to the unbalanced state of the world today no one can predict how or when the United States will urgently need a strong navy to safeguard its immense interests, which are so intimately connected with its domestic security and economic welfare. We need, therefore, a treaty navy of ships, fully manned and adequately served by bases.

The situation that we will ever have to face in an emergency is the "now situation" and the force we will have to meet it will be our "now navy," and this "now navy" is the one that we must strive to maintain at full strength and 100 percent efficient.

The sea is our outlet for surplus material, and the highway for our foreign trade and all American participation in the life of the community of nations. In proportion, as America is strong on the sea, her voice in world affairs will be strong: in proportion, as America is weak on the sea, so is she weak everywhere.

COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY

Streamlined Motor Vehicles

WE have recently had brought to our attention a patent issued by the United States to Paul Jaray of Friedrichshaffen, Germany, on the 7th day of June, 1927, No. 1,631,269, for a motor car. The application was filed on the 19th day of August, 1922. In view of the streamlined automobiles being offered this year by various manufacturers, we believe that this patent will be of wide general interest.

The accompanying illustrations show two forms of motor car described in the patent.

The patentee states:

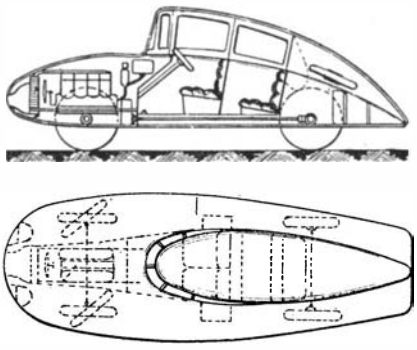
"My invention relates to motor cars and more especially to the construction and configuration of the body and the top of power vehicles, the intention being to reduce the resistance to air in the highest degree attainable, as well as to diminish as much as possible the raising of dust. I attain these objects by providing for an appropriate guidance of the currents of air. I am aware of the fact that it has already been proposed to shape, for diminishing the resistance to air of the vehicle, the various parts of this latter in such a manner that a more favourable discharge of the air could be expected.

"The motor cars hitherto built deflect in most cases the air to the sides of the car transversely to the road, there being at the same time produced a correspondingly great resistance, a loss of power, strong eddies, and, at the rear of the car, an obliquely upwards directed air current, combined with a very considerable partial vacuum, whereby the dust is torn upwards into the eddies following the car. These undesirable effects are favored by the many projecting parts of the car, such, for instance, as the driving-gear boxes, the differential axles, the springs, and the like, these and other projecting parts loosening and raising the dust already whilst the car is running. Besides, the rear car surface which, with most cars, is rearwardly inclined in upward direction, acts as a guide for the whirling-up dust-laden air.

"The present invention obviates the above-mentioned drawbacks by enclosing practically all material parts of the vehicle, i.e., the entire driving plant, the useful spaces, the seats, the baggage holder, the underframe, the upper portions of the wheel, and so on, in a body-forming shell having practically the shape of one-half of a streamline body, the section plane of which extends practically parallel to the road, this shell or body deflecting the air chiefly upwards, as well as rearwards over its top and then down to the bottom with the least disturbance possible.

"The half streamlined shell or body may carry another body portion or top which affords the driver and the passenger a free look-out and is shaped conformably to the lower main portion, especially at its rear, and with special consideration to the guidance of the air.

"In the constructional design the supporting structure of the upper streamline body is preferably continued to and into that of the lower streamlined body and is there supported directly by the frame girders which may extend underneath the axles of the car. This supporting structure forms the longitudinal bond or bracing proper of the vehicle, the upper girths of which, following, for instance, the course of the streamlines in the direction from bow to stern, extend to about the broadest place of the upper body, pass then upwards



Above and below: **Side and top elevations, taken from patent drawings, of the streamlined motor car bodies patented by Jaray in 1927**

to the top or the roof through the bracings of the window carriers, and finally extend downwards to the stern."

There are twelve claims in the patent, of which we reprint the most comprehensive:

3. A motor car comprising a complete hull shaped substantially like the upper half of a streamlined body.

4. A motor car comprising a hull shaped substantially like the upper half of a streamlined body, the rear end of which terminates in a transverse edge.

5. A motor car comprising a hull shaped substantially like the upper half of a streamlined body, the front and rear ends of which terminate in transverse edges.

6. A motor car comprising a hull shaped substantially like the upper half of a streamlined body, the rear end of which terminates in a transverse edge substantially at a level with the bottom of said body.

7. A motor car comprising a hull streamlined in front and on top, the bottom being substantially plane from fore to aft, and wheels having their upper halves surrounded by said hull.

8. A motor car comprising a chassis, a motor, a seat and wheels and an envelope having the form of one symmetric half of a drop and entirely surrounding said chassis, motor and seat and the upper halves of said wheels.

9. A motor car comprising a shell, the vertical longitudinal section of which substantially, resembles the vertical longitudinal section of the upper half of a stream line body, and a materially shorter hood similar in vertical longitudinal section mounted on top of and substantially on the rear half of said shell.

It will be noted that many of these claims are quite broad in scope.

We understand that the owners of this patent maintain that it covers the first *completely* streamlined automobile.

The advantages of streamlining a motor driven vehicle have long been known. It is contended that when a conventionally shaped motor car is driven at high speed the air pressure on the front not only resists forward movement but the back of the car creates a partial vacuum which retards its speed. By streamlining a car it is supposed to direct the flow of the air in such a manner as to practically do away with the air pressure at the front and the formation of a vacuum at the back as the car travels through the air at high speed.

The advantages and disadvantages of streamline construction have been put forth in the last two issues of this magazine. ("Streamlining and Your Automobile," by Professor Alexander Klemin, February, and "The New Terranautics," by William B. Stout, March.) If the car of the Jaray patent will approximate the advantages of fuel economy at high speeds that are now being sought, it would seem to have anticipated a long step forward in motor-car construction.

Denmark Reciprocal Copyright Relations With U. S.

A DANISH ROYAL decree dated September 12, 1933, provides that the provisions of the law of April 26, 1933, regarding authors' and artists' rights shall be applicable to literary and artistic works produced by citizens of the United States either when the works have not been published or when they are brought out for the first time within the territory of the United States or in another country which has not approved the Berne Convention for the protection of literary and artistic works, although only in so far as the works in question fulfill the conditions requisite for protection under the laws of the United States, according to Assistant Trade Commissioner Pearson.

Books SELECTED BY THE EDITORS

SHARK! SHARK!

By Capt. William Young and H. S. Mazet, F.R.G.S.

WHAT a book! It starts off with a bang on the opening page and either you won't lay it down till the final page or you are not half human. There are lots of shark stories that are thrilling, and lots of books about sharks that are scientifically accurate though stupid, but here is one that thrills and is scientifically accurate. Captain William Young is the world's leading shark shark. Here is what Count Luckner says about him in a foreword: "He is the outstanding expert with practical knowledge about all different kinds of sharks. I feel happy to say that I had the opportunity to meet Captain Bill Young and get well acquainted with him. For many hours we have been sitting together in the cabin on board my schooner and I have been all ears listening to this congenial man telling me about his hunting and adventures with different kinds of sharks. I have finally persuaded him to put his experience and knowledge in book form, assuring him he would gain the admiration and friendship of every deep-sea fisherman and sportsman."

The best thing about this book, from the point of view of readability, is that it is scientific—leading ichthyologists were glad to lend a hand and check the author's manuscripts for accuracy. But you won't be made conscious of this fact as you read, because it is all story (except the final chapter, where some nonnarrative sharkology is isolated). The details of the many stories are, however, scientifically accurate and thus you learn sharkology painlessly—unless the gruesome tales themselves should pain you. Some of these may "make your hair curl" and, if not, some of the numerous illustrations surely will. The book fully disposes of the myth that the man-eating reputation of sharks is a myth. Bound in a real sharkskin back. —$4.20 postpaid.—*A. G. I.*

NATURE, M.D.

By Richard Kovács, M.D.

A HUMANIZED explanation of the healing forces of heat, light, water, electricity, and exercise, written by a past president of the New York Physical Therapy Society, but *not* intended as a "self-treatment" manual. Rather, it is an explanation of the facts of physical therapy and just what this branch of medicine can and cannot do. Many of the claims of charlatans and faddists are here exploded and the reader is given the facts, unshrouded by extravagant claims couched in misleading terminology. You have read and heard much about the healing qualities of the agents mentioned above; here is an opportunity to get at the truth in one compact and concise volume.—$2.15 postpaid.—*A. P. P.*

BRASSEY'S NAVAL AND SHIPPING ANNUAL—1934

THIS latest edition of a famous authority contains discussions by well-known naval men on Naval Forces of the British Empire, Foreign Navies, Comparative Naval Strength, The Disarmament Conference 1933, Physical and Recreational Training, The Building of a Cruiser, and British Warship Building Resources. In addition, there is a Marine Shipping Section which covers various phases of world shipping in eleven chapters; also numerous references, tables, and profiles and plans.

As possessors of former editions will know, it is a volume indispensable to naval and merchant marine men and all those interested in marine problems, construction, and design.—$13.50 postpaid.—*F. D. M.*

JUNGLE BEES AND WASPS OF BARRO COLORADO ISLAND

By Phil Rau

THOSE who are interested in bees and bugs and natural history will enjoy this charming account of the wild bees of Panama—stingless bees, social wasps, solitary wasps, and so on—written by a biologist and ecologist and very favorably commented on by Professor William Morton Wheeler of Harvard, the ablest scientific authority on the social insects. 317 pages, illustrated.—$2.90 postpaid.—*A. G. I.*

URBAN SOCIETY

By Noel P. Gist and L. A. Halbert

A CIVILIZATION embracing a highly developed specialization of labor is necessarily focalized in urban communities serving extensive "hinterlands" or market areas. Activities in the city itself assume characteristic patterns, depending on geographic conditions, population traits, and economic functions. The authors have adopted as their frame of reference this selective distribution of urban phenomena. They survey from that standpoint the functions and institutions of the modern city, together with its social problems and pathologies. The comprehensiveness and thoroughness of their treatment make it indispensable to college students, community organizers, and others who would gain a deeper insight into urban society and the rôle it plays in modern civilization.

This book is written in the style of a textbook and contains 699 text pages. —$3.70 postpaid.—*A. G. I.*

A LIVING FROM THE LAND

By William B. Duryee, Secretary of Agriculture, State of New Jersey

SUBSISTENCE farmers having sprung up by thousands during the recent years, this exceedingly practical little book is most timely. Addressed directly to the city man who has turned to the farm, it gives detailed instructions on all phases of farming to the man who wishes to live in the country on a completely or partially self-sustaining basis. It answers thousands of questions which the author has received in his official capacity, concerning the construction of country houses, the production of crops, garden foods, home fruits, bees, poultry, milk supply, and marketing. Its 189 pages are well illustrated and a reference list in the back pages gives the titles of numerous publications, both books and magazines, helpful to the prospective subsistence farmer.—$1.65 postpaid—*F. D. M.*

APPLIED X RAYS

By George L. Clark, Prof. Chem., Univ. Ill.

THOSE who are interested in X rays from any point of view, whether purely scientific or industrial, will find this the recognized "standard" treatise on the subject, the first edition having appeared six years ago and won that place. The new edition is not a mere revision but is wholly rewritten, in order to bring it up with the recent great advances in X-ray knowledge. The 461 pages of text deal with two general aspects of the subject: the general physics and application of X rays (170 pages in all), and the X-ray analysis of the ultimate structures of materials

(291 pages). Of these the first covers the nature of X rays; their generation and properties; X-ray tubes; high-tension equipment; X-ray spectra; chemical analysis from X-ray spectra; absorption and scattering; radiography; and the physical, chemical, and biological effects of X rays. The second part deals with crystals and X-ray diffraction; the new crystal chemistry (a remarkable new science in itself); structure of alloys; crystal structure of carbon compounds; X rays in metallurgy; and so on. This is a *practical* book for the industrial research worker and general student. While its complete understanding presupposes a knowledge of college physics, other readers will derive relatively much from its pages. It has 239 illustrations and measures 6 by 9 inches.—$5.20 postpaid.—*A. G. I.*

NATURE CHATS

A Year Out-of-Doors

By John Harvey Furbay

EVERYONE who has the least desire to get closer to nature, to know intimately the plant and animal life of the out-of-doors, will find a wealth of material in this little book. Prepared in sections according to seasons, and the sections subdivided into a total of 52 chapters, the sequence of material carries the reader around the calendar in an easy and entirely readable manner. The author has eliminated "scientific" terms and other matter which would interest only the professional naturalist and has produced a book that has wide general appeal. The text is nicely illustrated with many drawings. Ten chapters in the appendix give explicit instructions on practical nature study: How to preserve plant and animal specimens, how to make an insect collection, nature projects for all year 'round, bibliography, and a short list of supply houses where materials may be purchased. Altogether an excellent guide for all nature students. 5½ by 8½ inches, 255 pages, stiff covers.—$1.90 postpaid.—*A. P. P.*

AMERICA SELF-CONTAINED

By Samuel Crowther

THAT America is virtually self-contained and therefore can and should stand alone, thereby remaining entirely free to control her own destinies, is the theme of this latest book by the widely known biographer of Henry Ford. The recent turning in our political destinies provides a ready means of making this change, all but existent anyway, in our economic destinies. The notion that foreign trade contains some magic to make us whole is fallacious. Our market is at home—we should ourselves make whatever we need and use it. Let us avoid entangling ourselves with other nations; we need no friends (and have none), and we fear no enemies. The plea all through this work, which is stuffed with economic fact and argument, therefore harks back to George Washington's well-known farewell advice to the nation.—$2.15 postpaid.—*A. G. I.*

SAILING CRAFT

Edited by Edwin J. Schoettle, with an introduction by A. Edward Newton

THIS handsome 7½-inch by 11¼-inch volume, of 786 pages, formerly sold for twelve dollars. This new edition, at reduced price, is identical with the original volume, is printed on heavy

coated paper and contains several hundred illustrations.

Mr. Schoettle is one of the best informed men in the country on small boat sailing and racing; and his Sailing Craft is a compilation of articles by him and his friends, among whom are to be found most of the expert boat designers and manipulators. There is a chapter on sailing canoes and a fine discussion of the many classes smaller than the *Shamrock* yet larger than a canoe. General chapters cover classification, ocean racing, aerodynamics of yacht sails, cruising, regatta committee work, and so on. In each are discussed all sorts of craft from a bilge-board scow, a Biloxi schooner, a Chesapeake bugeye, to a New York 30. This most complete volume may now be had at $4.50 postpaid. —*F. D. M.*

PHYSICAL OPTICS

By Prof. R. W. Wood

WOOD'S "Physical Optics" has been a standby for many years but it gradually became out of date, the previous edition having been published in 1911. Its author, who is Professor of Experimental Physics at Johns Hopkins University, has now very largely rewritten it, bringing it up to date—a monumental task, its length being 831 pages. Workers in optics will rejoice to know that this famous book is once more available. Amateur telescope makers who have been making a general study of optics should own it, either as a study or reference work. The scope is best indicated by the chapter heads: Nature and Rectilinear Propagation of Light; Reflection of Light from Surfaces; Refraction; Absorption and Dispersion; Origin of Spectra; Interference; Diffraction; Interference Spectroscopes; Polarization; Double Refraction; Meteorological Optics; Theory of Reflection and Refraction; Scattering; Raman Effect; Theory of Dispersion and Selective Reflection; Optical Properties of Metals; Rotary Polarization; Resonance Radiation and Fluorescence of Atoms; Resonance and Fluorescence Spectra of Molecules; Fluorescence and Phosphorescence of Solids and Liquids; Magneto-Optics; Electro-Optics; Thermal Radiation; Relative Motion of Ether and Matter. The language is clear and lucid. The text is partly mathematical (calculus). This book is not recommended for beginners. It is the "last word," however, when looking up obscure corners of optics, also for gaining a better than superficial background. 6 by 9 by 1½ inches. 462 illustrations.—$7.75 postpaid.—*A. G. I.*

MYSTERY, MAGIC, AND MEDICINE

By Howard W. Haggard, M.D.

THIS pocket-sized book, written by the author of "Devils, Drugs and Doctors" (a best seller), who is Associate Professor of Applied Physiology at Yale University, contains in 191 pages a survey of the rise of medicine from superstition to science—from ancient times to our own age—and is a compact, informative, authoritative history of medicine which has the especial merit of being really readable. A true romance is what the history of the rise of medicine has been, and the reader of this book will live it through vividly with the author. The volume is nicely produced—nice type, paper, covers, and illustrations.—$1.10 postpaid.—*A. G. I.*

FORD MODELS V-8, B, AND A CARS

By Victor W. Page

THIS practical treatise describes the principles of operation of all the parts of the latest model Ford cars, and gives complete instructions for driving, repairing, and servicing them. This book is heartily recommended to all owners and drivers of Fords, as well as those who have occasion to work on them in any capacity. The treatment of the V-8 and the A models is remarkably complete, but the model B is given scant attention. Numerous drawings and photographs illustrate the text and aid in elucidating obscure points.—$2.65 postpaid.—*A. P. P.*

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