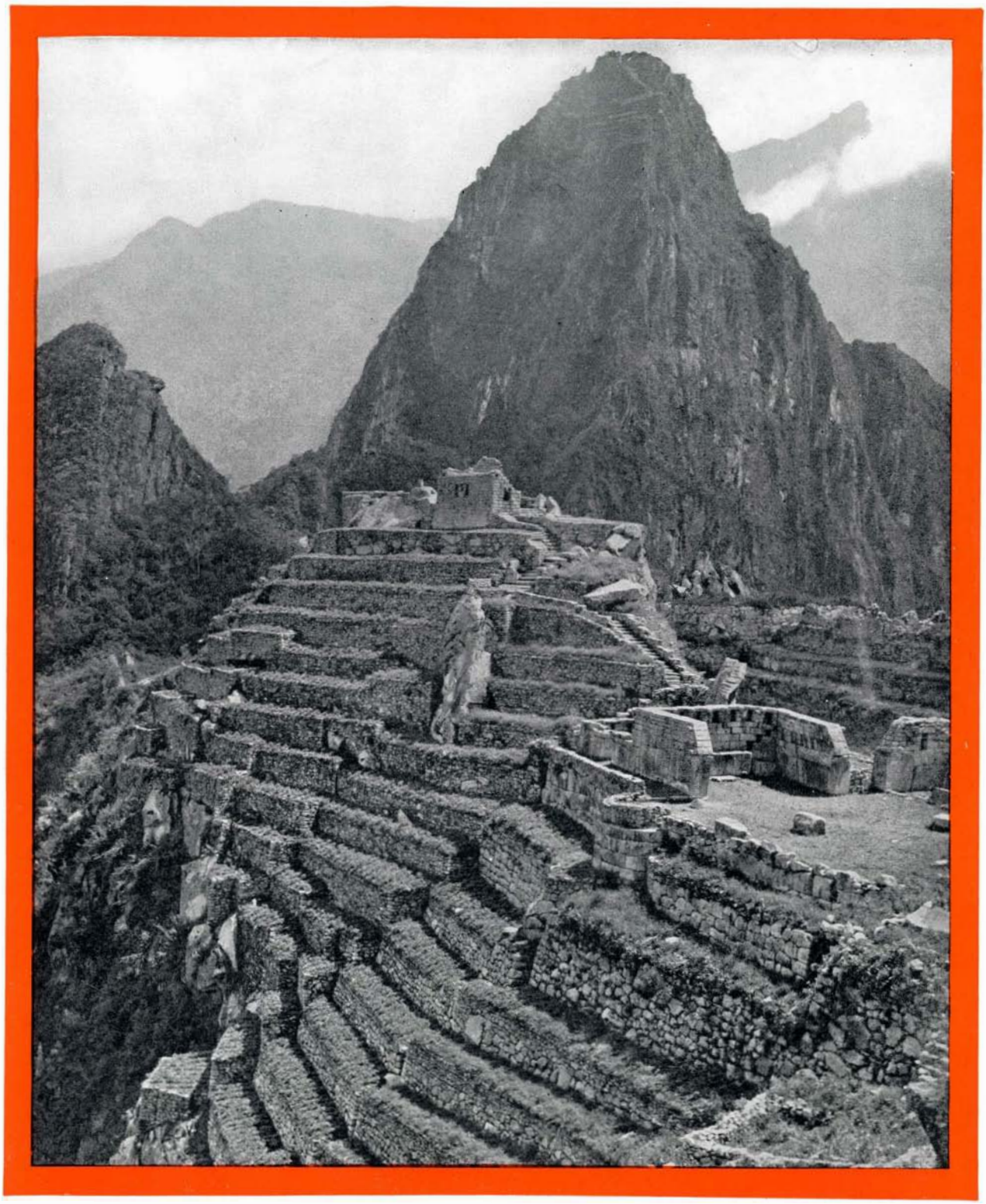
# SCIENTIFIC AMERICAN



Fortress Village of a Powerful Race (See page 113)

VOLUME 153
•
NUMBER 3

## COSMIC RAYS

By Arthur H. Compton

SEPTEMBER 1935
•
35c A COPY

# "Dear Editor"...

## ESTABLISHES READER INTEREST

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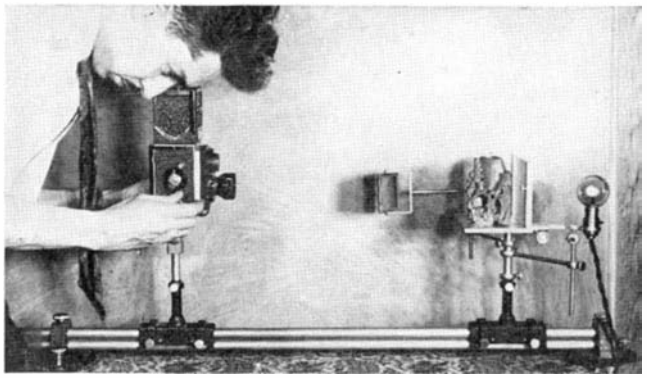

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PUBLISHED as a monthly magazine at 35 cents a copy—$4.00 a year—SCIENTIFIC AMERICAN is a national institution for the dissemination of knowledge of the discoveries of modern science. It keeps the public informed on new products directly available to the consumer, and others used by industry in its manufacturing processes.

The 90-year-old reputation that SCIENTIFIC AMERICAN enjoys for its editorial knowledge and integrity places the stamp of approval and creates an acceptance by the science-minded of every article we publish.

It appeals to and reaches the science-minded reader who reads the magazine for any one or all of the following reasons:

1. To keep informed on scientific progress.

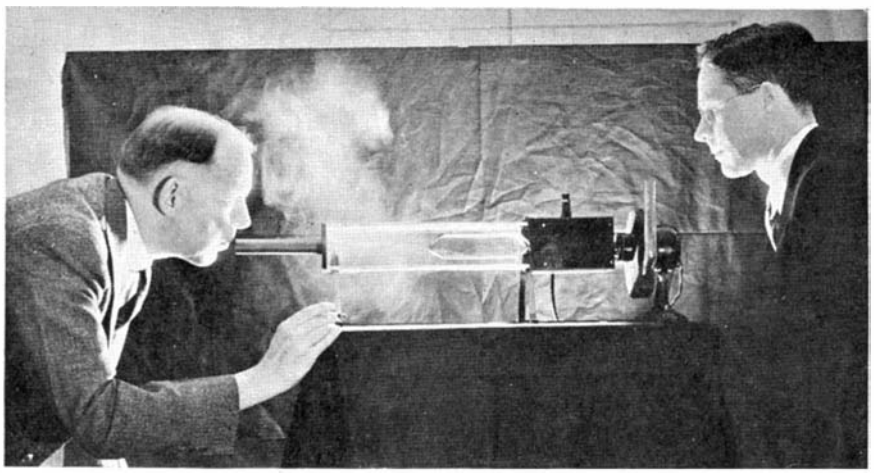
2. For scientific information useful to him in his work or business.

3. To pursue a scientific hobby.

IN its present circulation is included practically every important school, college and university throughout the United States for the value of its service. The number of individuals reached is far in excess of its actual circulation count.

The interest and confidence that the reader has carries over from the editorial to the advertising pages. The same high standard is maintained through censorship of the advertising we accept. We invite your inquiries for advertising rates and any further information that is desired.

ORSON D. MUNN
Editor and Publisher



An experimental model of the device for cleaning air electrically

# SCIENTIFIC AMERICAN

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor


## The SCIENTIFIC AMERICAN DIGEST

### Of General Interest



### Chemistry in Industry



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### COVER

**MACHU PICCU is the name of a ruined Inca village, one corner of which shows on the cover picture. It was discovered by a scientist—a professor at Yale—who later became a United States Senator, Dr. Hiram Bingham of Connecticut. It was a fortified city on a steep ridge in the mountains of Peru, with a still higher peak rising 4000 feet above the valley below. The terraces shown are about eight feet high and were both defensive and agricultural. The houses and temple were made of stone, carefully fitted and notched together, and without mortar. The roofs were thatched. Cover photograph courtesy *The Grace Log*.**


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# ACROSS THE EDITOR'S DESK

"MANY of the facts and principles upon which the modern agriculture of the nation and its major industrial relationships are based," writes James T. Jardine, Chief, Office of Experiment Stations, United States Department of Agriculture, in an article scheduled for early publication, "have been accumulated during the past half century as a result of the combined research efforts of the state agriculture experiment stations and the United States Department of Agriculture. Prominent among related industries are those engaged in the manufacture of a wide variety of chemical and biological products and by-products such as are used not only in improving farming practices but also in providing many of the essentials as well as the comforts and conveniences of the every-day life of the average citizen." Probably no one in this country today is better qualified to discuss this linkage of agriculture and industry than is Mr. Jardine, and we welcome the opportunity to present his views to our readers.

●

"PAINTED pottery peoples" is the name given by archeology to the prehistoric inhabitants of Tepe Gawra, the Great Mound in the Tigris Valley in Mesopotamia. In this mound, composed of 20 layers, each representing a separate civilization, have been found typical examples of painted pottery that are yielding data regarding the people who once lived there. Jotham Johnson, of the University Museum, Philadelphia, who has been working at Tepe Gawra, has prepared an article on the work being carried on, and the significance of the finds so far made. His article will be published next month.

●

THE statement that light waves make possible, among other things, the modern automobile may be at first received with questioning glances. But it can be readily explained. Mass production of any single item depends upon accurate tools; accurate tools depend upon accurate gages; accurate gages depend upon wavelengths of light. By the application of certain principles of optics, modern applied science has placed in the hands of the engineer a method of checking, within an accuracy of a millionth of an inch, the gage blocks which are used as standards of measurements in machine tool work. The story of these gage blocks, their uses, and the way in which they are rigidly held to a pre-determined standard, is told in an article that will appear shortly in these pages.

**COMING**

**¶ James T. Jardine, Chief, Office of Experiment Stations, United States Department of Agriculture**

**¶ "Light Waves in Industry," by Everett W. Melson**

**¶ "Nature Faking Again," by S. F. Aaron**

**¶ The Two-Fold Program of Wheeler Dam, by Herbert F. Gough**

**¶ "The Great Mound of Tepe Gawra," by Jotham Johnson**

**¶ "What is Scientific Proof?" by T. Swann Harding**

●

NEWSPAPER editors seem to have a yen for publishing short "fillers" dealing with odd and unusual aspects of animal life. But, unfortunately, they seldom have the opportunity to check the authenticity of their stories. As a result, much misinformation is released by writers who are often ignorant of the subject with which they are dealing, or are not conscientious enough to check their facts. In an article to be published next month, S. F. Aaron takes these nature fakers to task, pointing out some of the errors which are frequently made. Mr. Aaron's lucid style, coupled with his undisputed knowledge of his subject, permits him to put forth some of the true facts of animal life that are just as interesting as the wild yarns of the nature fakers.

●

A TWO-WAY control program for the Tennessee River is the crux of the Wheeler Dam project, an important part of the present development of the Tennessee Valley. Seasonal floods on the river carry millions of tons of eroded soil, building up sandbars and reducing the river's effectiveness as a navigable waterway. These same floods do an approximate 2,000,000-dollar annual damage. The Wheeler Dam project will cope with both of these problems, dealing as it does with reforestation for checking soil erosion at the headwaters of the river and the control of the waters of the river itself. The whole picture of the project and the reasons for it will be explained in detail in an article to be published soon.

●

"WHAT is scientific proof?" is a question asked by T. Swann Harding and ably answered in his article scheduled for next month's issue. Readers who are familiar with Mr. Harding's writings will know that they may expect a pungent, forceful presentation of facts; others will find this to be true when they read this article. (See also page 138, this issue.) Some of the examples which Mr. Harding cites as being attempts at proof seem ludicrous when objectively examined, but they are actually "proofs" which have been offered as being "scientific." The true scientific approach to the solution of any problem is clearly outlined in the article.

Orson D. Munn

Editor and Publisher

# *Personalities in Science*

HENRY ELLIS WARREN

HENRY ELLIS WARREN, president of the Warren Telechron Company, Ashland, Massachusetts, who received the John Price Wetherill Medal last May from the Franklin Institute in Philadelphia in recognition of his invention of the Telechron motor—a small, limited-power, self-starting, synchronous motor having strong starting torque and synchronous torque characteristics—was also presented the Lamme Medal at Cornell University during the summer convention of the American Institute of Electrical Engineers, in June.

The John Price Wetherill Medal is awarded to individuals every year who have discovered or invented something in the field of physical science, or who have made new or important combinations of principles or methods already known. The Lamme Medal of the American Institute of Electrical Engineers is given each year to a member of the institute "who has shown meritorious achievement in the development of electrical apparatus or machinery."

Mr. Warren was born in Boston, Massachusetts, May 21, 1872. He graduated from the Massachusetts Institute of Technology with the degree of S.B. In 1902 he became engineer and general superintendent of the Lombard Governor Company and made improvements in the design of hydraulic speed governors which were installed in many of the largest water-power plants of the United States. During the World War he designed several types of hydraulically operated machines which were used in the production of heavy shells. A new type of fire control mechanism was also developed by him at this time.

Settling on a farm in the town of Ashland, Massachusetts, he became seriously interested in designing and constructing various forms of electric clocks as an avocation. He used one of the farm buildings as a workshop which was the forerunner of the Warren Clock Company's factory. The Warren Clock Company was organized in 1912 to build and sell battery-operated clocks.

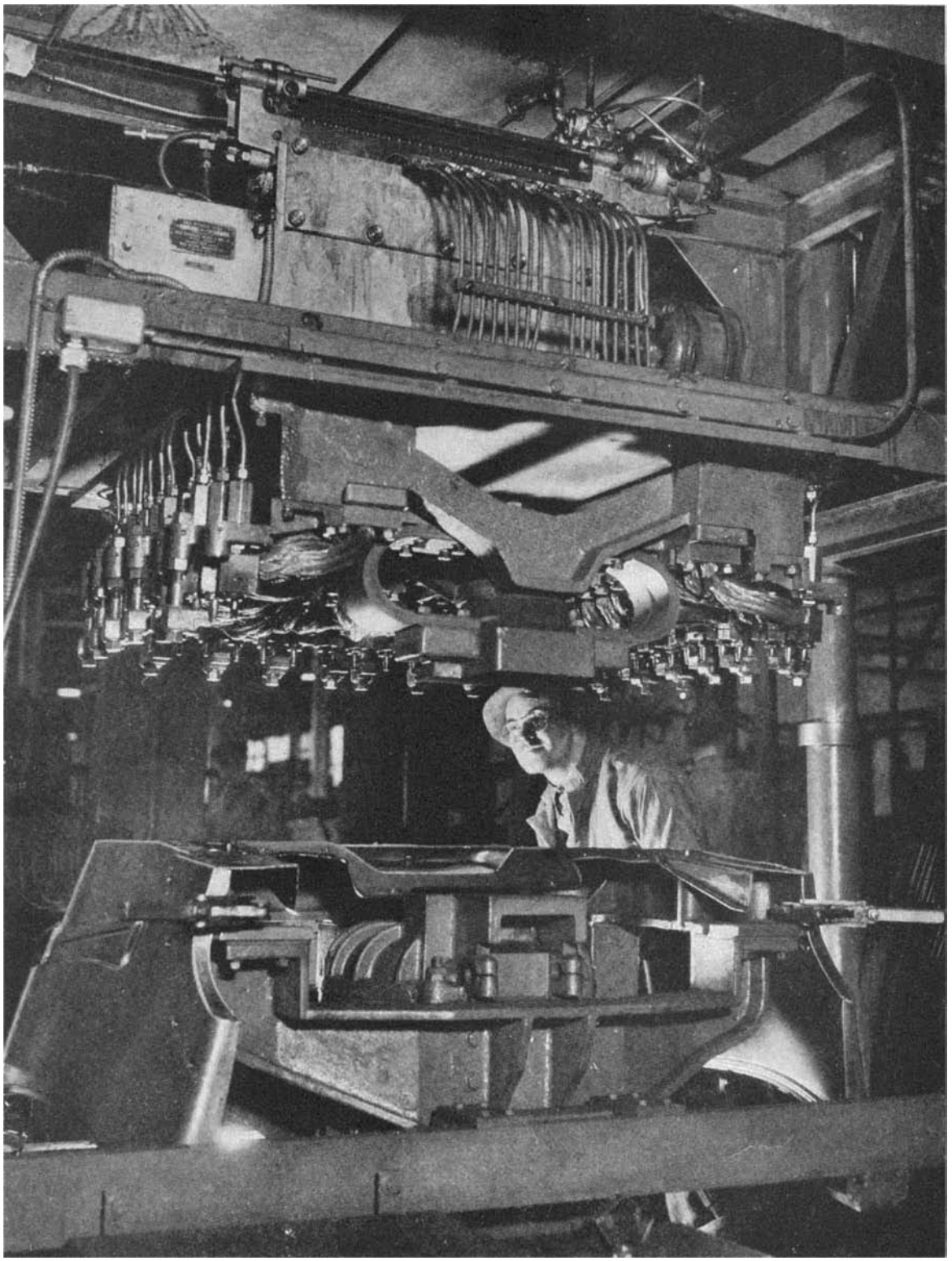
In 1916, Warren tackled the problem of utilizing commercial alternating current for the purpose of time-keeping. It was necessary to invent a new form of self-starting synchronous motor which would be adaptable for use in clocks under different conditions from those to which ordinary power motors are subjected. Next, it was necessary to perfect an instrument for measuring frequency with great precision. This instrument later became known as the Warren Master Clock.

By the end of 1916, engineers of the leading power companies had been persuaded to use this instrument so that the frequency of alternating current might be controlled with sufficient accuracy.

The first to adopt the new method of frequency regulation by means of the master clock was the Edison Electric Illuminating Company of Boston. Within ten years the use of the regulated alternating current as a new kind of time service became general. As a result, the proportion of electric clocks to all clocks exclusive of alarm clocks produced and sold annually has risen from less than 2 percent in 1916 to more than 60 percent in 1933, with the increase steadily climbing.

Mr. Warren has been engaged since 1916 in adapting time-keeping synchronous motors to many fields of usefulness and in providing improved devices for frequency control. More than 100 patents have been granted to him. During the past 15 years he has served as president of the Warren Telechron Company and consulting engineer for the General Electric Company.

Among various technical papers by Warren are: "Clocks in the Field of Electric Light Appliances"—Proceedings of the National Electric Light Association, 1917; "Utilizing the Time Characteristics of Alternating Current"—Transactions of the American Institute of Electrical Engineers, 1919; "Synchronous Electric Time Service," the same, 1932.



## HYDRAULICS AND ELECTRICITY MAKE BETTER AUTOMOBILE BODIES

FIFTY contacts are made, one after the other, with lightning-like rapidity, as this hydraulically operated spot welder joins the metal dash to the outer shell of the steel front-end assembly in the production of "turret top" automobile bodies. Oil under regulated pressure clamps the welding electrodes to the exact spots where the welds are to be made, and an electrical timing device supplies the correct current for the proper length of time to first one and then another of the electrodes in rapid succession. In the photograph, the electrodes are lifted clear of the work, which shows directly below them.

Courtesy More Game Birds in America—A Foundation

**Scenes such as this, once frequent but now rare, can again become part of the picture of American wildlife**

# SAVE OUR GAME!

## Provide Reservations . . . Stop Useless Swamp Drainage . . . Game Conservation Has Wide-Spread Effects . . . Value to Communities and Individuals

By J. N. DARLING

Chief, Bureau of Biological Survey, Department of Agriculture

ONE of the inconsistencies of American behavior that will puzzle future students of our present era will be that we show an intense interest in our national wealth and an astonishing lack of it in the natural resources which produce wealth.

It required 300 years and a Theodore Roosevelt to make Americans realize that the wanton destruction of our forests then proceeding apace would be followed by conditions far more disastrous than defeat in war by a major power. The indifference with which we regard the exploitation and waste of our exhaustible resources of oil and coal is tragic, and any promoter or politician can do about as he wishes with our water resources, draining and damming without concern for effects on vitally important water levels of the country. The prod of a mosquito's "harpoon," admittedly irritating and sometimes dangerous, is enough to convince us that, after all, the ocean is the only proper place for water, and to set us at work draining every slough and pot hole and marsh into the sea. Dust storms, still a novel phenomenon in agricultural United States, are the first comparatively mild warnings of what to expect when an overconfident civilization attempts to set nature right on the matters of water and forest reserves.

Our native wildlife is one of the most valuable of the nation's resources, and it is certainly the most neglected of them. Yet even in its present diminished state the annual income from all its forms probably amounts to around a billion dollars. Not alone, of course, in the market values of fish, flesh, and peltry, but in wages paid for labor, in the value of farm crops saved by insectivorous birds, in land rentals, in profits to transportation companies, farmers, the hotel business, to merchants and manufacturers, publishers and printers—to name a few—and in taxes that help support the Federal and State governments.

BUT we have persisted in the notion that our fishes, animals, and birds were invested with some miraculous Providential dispensation that would enable them to take care of themselves regardless of abuse, and this charmingly naïve sentiment has nearly wrecked the resource. In half a day at any gathering of people particularly interested in the subject of American game, one can hear advanced with complete assurance in each case a score or more of causes why the resource has declined in two centuries from incredible abundance to its present attenuated state. The causes will range all the way from the predatory habits of the glaucous-winged gull to the position of the spots on the sun. And most of them will have some bearing on the truth, as a matter of

Courtesy Wisconsin Conservation Department

**Winter feeding does much to conserve game. Here are sharp-tailed grouse at a typical feeding station**

fact! But it seems to me that our present distress is caused by our neglect of two matters of fundamental importance, and it may be alveliated and perhaps cured completely by remedying (1) our land utilization policies of the past —if one can so describe a non-existent thing—and (2) by adopting a more matter-of-fact and businesslike attitude toward our wildlife. There is still time to repent and to drive the unscrupulous politicians, game hogs, and fanatics back from the struggling victim.

WILDLIFE is a crop and like any other it must have land to grow on. The restoration of wildlife is therefore first of all a land utilization problem. Not even the most enthusiastic zoophile could insist that all the cattle and sheep be run off the western ranges so that the bison, elk, and antelope could have the freedom of their ancient domain restored, or that the rich farm lands of the central United States be allowed to revert to nature for the benefit of quail, deer, turkey, and rabbits; the modern lesson we are striving to learn is that in our two billion acres of terrain there is land sufficient to every use of industry, agriculture, and wildlife. For example, the reservation of enough grazing lands to maintain a reasonable supply of our big game animals can be accomplished without infringing upon the reasonable requirements of the stock growers. The same is true of small game species. A few large reservations of the hereditary ranges, supplemented by the development for wildlife purposes of waste lands, of odds and ends such as ravines, sloughs, roadside strips, fence rows, and submarginal tracts, will be sufficient to bring back the wild creatures, even in our intensively cultivated areas, in more abundance than has been observed for two generations.

By resort to desperate measures we have managed to acquire land enough to preserve our game species from any immediate danger of extinction, but our operations in the past have of necessity had little or no reference to any grand basic plan for a land use scheme to include wildlife. We have, for example, a few herds of bison on Federal refuges. These animals were literally turned back from the very edge of extermination, and we can no doubt maintain them at their present numbers or even increase them, if lands should become available for restocking. We have the antelope, the mountain sheep, and the elk similarly cared for, but a visitor with a more than ordinary respect for the fitness of things and some reverence for American traditions, might find cause to wonder if our gestures in behalf of these original inhabitants have been so generous after all. It might be more chivalrous perhaps to fall upon these remnants with the rifle, than to condemn them to a meager and unnatural existence on the thin and unproductive parings of land so poor that we can't use it ourselves.

IN the Jackson Hole region of Wyoming a herd of 20,000 elk still manages to exist under such aid as the State and Federal government can give them. There are refuge lands set aside for the protection of the animals, and their summer pastures furnish ample food during the warm months. But there is not enough winter range in the valleys to which the herd must come when cold and snow force them down from the heights. Then we have the curiously depressing spectacle of the largest remnant of our American elk, the descendants of the great herds that once covered the continent from coast to coast, the most majestic of all the deer tribe, crowding for the "handouts" of hay and grain furnished by the State of Wyoming and the U. S. Government, and being chased from adjacent farm lands like strayed livestock. Perhaps others do not feel as I do about these things, but it sometimes seems to me that the cruelest act that mankind can commit against these wild creatures is to pervert them from their God-given wildness of spirit and force them into a state of half servile, wholly degrading tameness.

We have heard much in recent years about submarginal lands. These are the soil types lying midway between fertility and barrenness. They tempt the farmer to occupancy, but they produce, as a result of unremitting toil, only enough to keep him from starving to death and never enough to permit him to move away. On most of these lands fish, game, and furbearers can exist with far better profits to humanity than when given over to a desperate sort of agriculture. The Chinese have been notoriously industrious in the manufacture of submarginal land, and after countless centuries of draining and deforestation they have fairly well managed to turn an Eden into a desert. We Americans with our boasted energy and resourcefulness have made in our brief occupation of the land proportionately more progress than the Orientals. In witness whereof about 17,000,000 acres of water areas—sloughs, shallow lakes and ponds, marshes and bogs—have been drained in the north central states alone. Throughout the United States the total drained areas amount to more than

**An ideal wildlife refuge such as will be made available work will include impounding water by diking and**

110,000,000 acres. Some of these lands now fall within the submarginal classification, much is quite barren, and only an insignificant acreage has proved to be of value for agricultural purposes.

The value to a community of a sizeable shallow water area is not generally understood. If it breeds a few mosquitoes—as of course it does—the owners of adjacent properties forget that it also produces furbearers whose pelts bring many a dollar into the district, and fish and waterfowl. They probably do not realize that the local marsh protects local water levels and that it is one of nature's most effective engineering devices to prevent flood and soil erosion. The dismal dust storms which have been tormenting the northern states are born and "brought up," literally, within the great north central

region mentioned above, where the drainage shovel has exposed 17,000,000 acres of land once under water.

Soil wash and wind erosion do not make headway in a territory that supports an abundance of wildlife. The environment that attracts our native birds and beasts does not promote dust storms and floods. It might be said that the disappearance of native wildlife from a region is the first sign of bad land practice and the first warning of graver disasters to follow. The melancholy and laconic observation of the Indian watching a pioneer farmer plowing under the virgin sod of the prairie, "Wrong side up, white man," has too often been realized.

For these mistakes of the past there is only one sure corrective—a sound policy of land utilization with a definite place in the program to satisfy the needs of wildlife.

I mentioned at the outset of this article the American eccentricity that permits us to enjoy a serene confidence in the renewability and indestructibility

**able under the Wildlife Restoration Program. The ditching, and the planting of attractive food plants**

of a billion dollar a year wildlife foundation. I do not know from whence this glorious bit of asinine assurance springs, but I suspect it is because the laws that govern the reproduction of most species of wildlife are little understood by the average man or woman. Wild ducks, or woodcock, or deer are creatures of mystery compared to domestic beasts or fowl, and it is difficult for many a man to realize that the wild blue goose nesting in the solitudes far up under the very fringe of the aurora borealis increases or decreases, thrives or starves, according to the same biological laws that control the tame white geese in the farmyard. Because of this it has taken us a long time to come to the point where we are willing to adopt a practical attitude toward our game and to endeavor to strike our balances in orderly fashion, as we do with our ducks and chickens or our financial nest eggs. More often than otherwise the game laws supposed to control expenditures of wildlife represent a compromise between the demands of those who wanted more restrictions and those who wanted less, and no one knows or cares whether there was an expendable surplus on hand or a dangerous deficit.

Let me give a single example from the many that occur to me. Ten years ago the state of Maine produced annually more mink pelts than are now being produced in the entire United States.

"What a frightful decrease!" someone exclaims.

Exactly, but more than that it is the evidence of bad business management and it should be a challenge to the modern wildlife technician, for we know now that, outside of normal seasonal fluctuations, such constant serious losses as are indicated in the mink population need not usually occur.

I believe that we are witnessing the beginning of the end of the doctrine of *laissez faire* as applied to wildlife conservation in this country and are ready to substitute a bookkeeping system for the old careless way and to exchange the divining rod prognostications of self elected or politically endowed wildlife authorities for the sober but wholesome facts dug up by trained game technicians. I hope so, anyway.

RECENTLY a leading American manufacturer of arms and ammunition set up an endowment fund of 30,000 dollars a year for five years, the money to be used for the restoration of valuable forms of wildlife. The gift was a voluntary one and carried no reservations except as indicated above. We may expect to hear the cry of "treason" raised in some quarters when this announcement is made, for there are still individuals interested in wildlife conservation who view with greatest alarm any attempt on the part of the manufacturers of sporting guns and ammunition to help our conservation agencies to solve the tremendous problems with which we are now confronted. They cannot believe that an industry that derives a portion of its profits from the sale of game-killing weapons can have any worthy motive behind its contributions. In past years such proffers have been regarded as thinly veiled bribes to obtain longer open shooting seasons, increased bag limits of game, and so on—measures that ostensibly, at least, would result in increased gun and ammunition sales. Perhaps in the years when game was still so abundant that only a few very observant men could note any decrease in its numbers there was a definite reluctance on the part of the industries associated with the sport of shooting to welcome restrictions on the gunner for which they saw no need. This was certainly true of a majority of the gunners themselves.

BUT the situation now is different. I know that this arms maker was strongly moved by sentiment when he offered to place 30,000 dollars a year for five years at the disposal of the Biological Survey for the purpose of teaching approved methods of wildlife restoration and administration in several of our state universities. He would be less intelligent than I know him to be if he failed to see that his endowment is also an investment for his company—one sure to bring increased profits in the years to come.

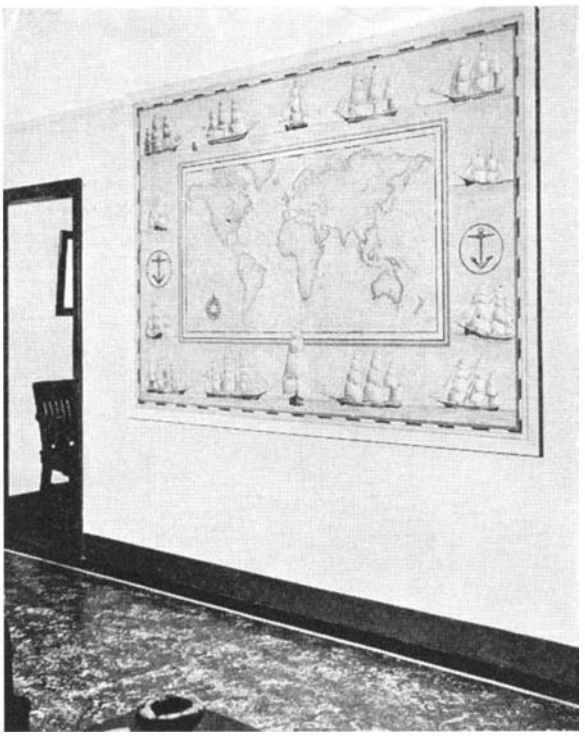
●

¶ *Advanced Amateur Photographers: Starting this month—"Camera Angles," a department devoted entirely to interesting and informative short articles on all phases of photography. Keep up-to-date in your hobby. See page 162 of this issue.*—The Editor.

Courtesy Bureau of Biological Survey

**The elk refuge at Jackson Hole, Wyoming, is one step in the right direction, but it is not enough. The elk living here do not have sufficient winter forage**

# PHOTO-MURALS GAIN FAVOR



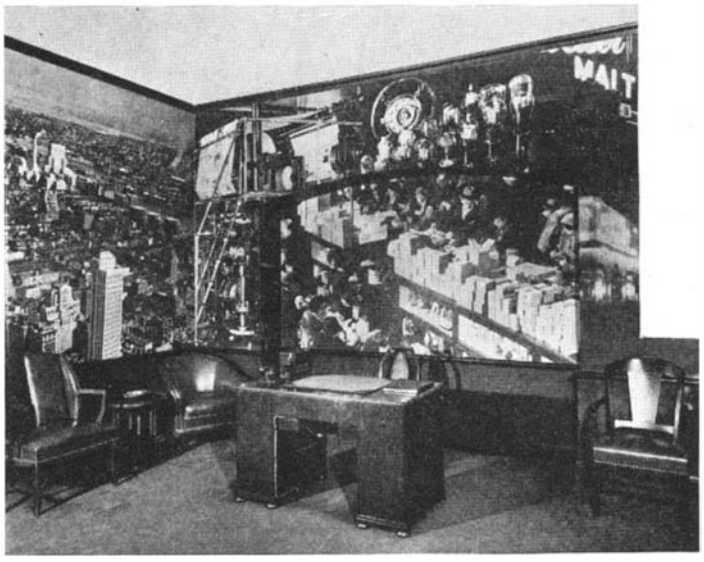
*Upper right:* A mural map illustrating the history of the American merchant marine, in the office of a shipping company. *Below:* Murals in transparent oil colors, decorating the walls of a private residence, were made from snapshots taken by the owner. *Lower right:* Murals depicting the history and development of New York City. *Lower left:* The walls of an advertising agency's offices tell in photo-murals the story of their business

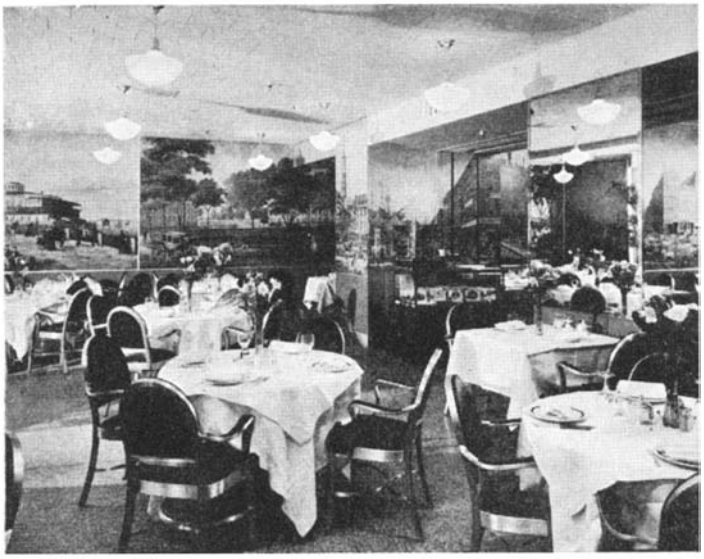
Murals by Drix Duryea, Inc.

MURALS by photography offer a new form of wall decoration unlimited in its range of pictorial design. Through extensive research and experimental work in laboratories and projection rooms, photo-murals have become a recognized process for the reproduction of any subject that can be seen with the human eye and some that can be rendered visible through the use of infra-red and X rays.

Photographic murals are usually produced on a specially sensitized rag paper. Where a fabric surface is required, sensitized canvas or heavy duck is used. The mural is usually composed of strips of material 40 to 50 inches wide, the length depending on the height of the mural. After the photographic illustration has been projected onto the sensitized surface and processed, the strips, which are numbered in sequence, may be assembled and hung by any competent paper hanger. Such murals may be obtained in any monotone, or may be colored in transparent oils.

Photo-murals offer an attractive yet relatively inexpensive method of producing unusual wall decorations for homes, offices, stores, and display rooms. One of the fascinating aspects of their application is the fact that the photograph or designs may be made directly applicable to the place in which they are hung. The sportsman may use murals of his various hobbies; office walls may reflect the spirit of the business conducted therein; industrial offices may be decorated with murals showing the exteriors and interiors of factories.



# OUR POINT OF VIEW

## Wildlife in Curricula

IN the United States it has long been possible for a student to find at many colleges and universities courses in almost any subject under the sun—almost, but not quite; game conservation and game management have been neglected by our institutions of learning. The hiatus has now been partly filled. Mr. Darling hints at this in his article on page 117 of this issue, when he mentions one arms manufacturer's contribution of 30,000 dollars a year toward this cause, but doesn't go into details for lack of space.

In a recent announcement from his office it was said that several state universities will now set up courses in game management. These are to have the active support of the Bureau of Biological Survey, which is prepared to supply instructors and to co-operate to the fullest. To the contribution mentioned above, the Bureau will add 42,000 dollars, and the universities and state game commissions will also share the expense. It is expected that the new courses will follow, in general, the lines of the forestry courses now found in many institutions; they will consider not only the teaching of modern game management methods but also original research work in wildlife subjects.

"This is the best thing so far as our non-migratory wildlife is concerned that has happened in years," Mr. Darling says. "It will mean the salvation of our upland game species. It means also that we shall at last be able to coördinate our research and experimental work." It will do away with the duplication of effort that has existed in the past when uncoördinated, scattered agencies often studied identical phases of wildlife subjects; and, further, provides the long-desired means, hitherto lacking, of disseminating the information that was gathered on these subjects.

"Ding," as Mr. Darling is better known to millions who have seen his widely used, dynamic cartoons, has devoted his efforts for years to the cause of American wildlife. He accepted his present position solely because of this one great interest of his; he felt that this would give him the opportunity to achieve the end for which he has so long fought. It is no mere coincidence, therefore, that an important stride forward has been made. Game will benefit, game commissions and conservationists will begin to see fulfillment of their dreams, and many thousands of people will profit by the work that Mr. Darling has so ably furthered. He is to be congratulated for his success so far. Let us hope he will be able, during his tenure of office, to expand greatly the number of institutions with courses on wildlife.

## How Bright Is a Newspaper Columnist?

IN the July number of this magazine there was an article entitled, "How Bright is a Lightning Bug?", in which a professor of physics told how he measured the illumination of the common fire fly. He found it to be one fifteen-hundredth of a candle-power.

A columnist connected with an Oklahoma newspaper appears to have run across this article and half read it, and found the wheels of his imagination set spinning by an aspect of it which we confess that we, as the editors who included it in this magazine, have entirely missed. We have before us a clipping from that Oklahoma newspaper, in which the experiment is mentioned and commented upon as follows: "Imagine a guy going to all that trouble just to find out about that."

Ourselves lacking a sense of humor, we should rear up instantly in wrath to defend sacred science. But no. The poor overworked devil who wrote that line was probably hard put to it that day for something to comment about, in order to fulfill his daily stint of copy before his chief descended on his luckless neck—just as the present writer, a brother scribe, is at this moment racing against a printer's deadline and trying to forestall a similar fate. Had the same poor devil, however, had the energy in the sapping climate of Tulsa to read on, he would have found his answer in the very same article. "How the fire fly can radiate 'cold light,'" the article stated, "is a problem which has baffled science for many years, *and its solution will revolutionize our lighting industry*."

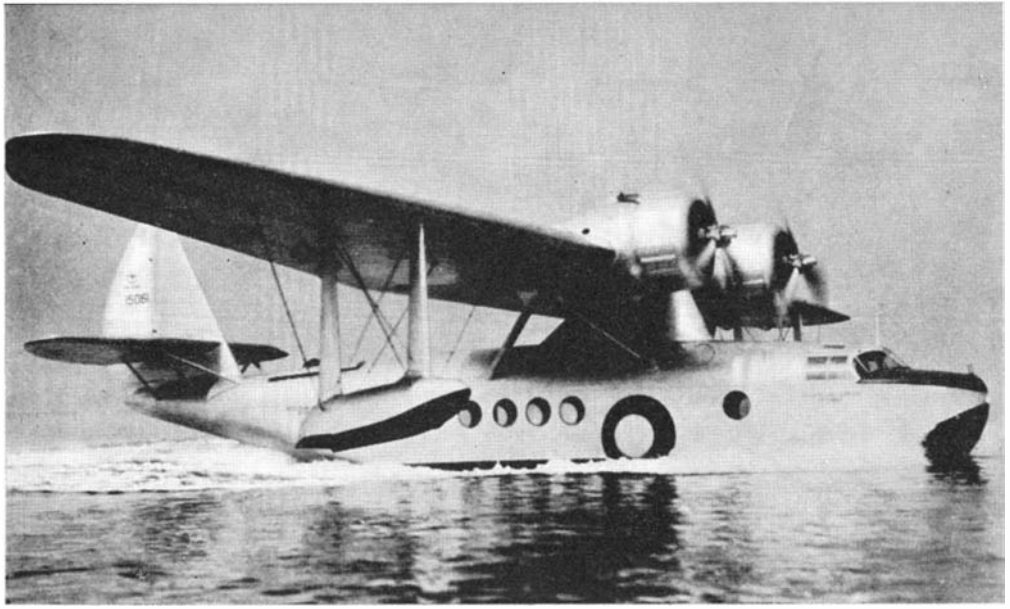
Perhaps science will not learn the solution of this economic advance by courting the fire fly's confidences; but again, perhaps it will. Anyway, scientists don't make fun of the fire fly; she does her best as a lamp and that means far better than man's own very best. Instead, they observe her as minutely as possible. Perhaps that was Professor Parlin's reason for measuring the fire fly's candle-power; or perhaps the same "guy" did it, in this instance, just because it was fun.

We can better agree with our facetious friend from Oklahoma in at least a part of another comment which he appends. He says, "That's what's the matter with this country. All our ignoramuses go to Congress and all our educated men run around with butterfly nets." Here he equals, or even surpasses, the full candle-power of one fire fly. But not all of our ignoramuses go to Congress.

## Competition

OUR unbounded faith in the ability of American industries to take care of themselves in any fair competition makes our ire all the greater when goods from foreign sources are dumped upon our open markets with no distinction whatsoever as to their origin. A case in point is brought to light in a recent stipulation of the Federal Trade Commission wherein electric light bulbs were the bone of contention. According to the Commission's report, an American manufacturing concern was selling Christmas tree lighting outfits equipped with imported lamps, without marking the containers with appropriate words clearly stating the fact that the lamps were imported. This company used the same style of container, packings, and markings for sets equipped with American-made lamps as it did for other sets containing lamps marked "Made in Japan." These lamps were so marked, however, that the words indicating their origin could not be read after the lighting outfits were assembled for sale.

Since in this particular case an American manufacturing concern was a party to the petty deception, the warning to the American public is all the stronger. It has been definitely proved beyond a shadow of doubt that the large majority of American-made goods is far superior in quality to competitive goods imported from foreign sources. While we have no desire to wave the flag of biased, blind nationalism, it is our opinion that the American buyer will be protecting himself as well as American industries if he will purchase American-made goods of standard quality rather than allow himself to be misled into a "bargain" in shoddy goods of foreign manufacture. It is only ordinary horse sense to expect and demand the most for your money and usually *the most* can be obtained when you buy American-made goods.



Sikorsky *S-43*

# WHY

## Record Flights Point the Way to Scheduled Operation . . . Prove Correctness of Designs . . . Test Equipment . . . Provide an Index of Performance

By REGINALD M. CLEVELAND

IT was chronicled in the American press a few months ago, with no little jubilation, that the score in world aviation records, in the official categories recognized by the Federation Aeronautique Internationale stood as follows: France, 40; United States, 39; Italy, 21; Germany, 8; Poland 1; and Austria, 1.

This was a gain for the United States of eight new world's records, six of which were broken and two of which were set when Lieutenant-Commander D. W. (Tommy) Tomlinson set down the wheels of his heavily loaded Douglas transport at Floyd Bennett Field. With co-pilot Joseph Bartels and a third pilot—the inanimate but highly efficient Sperry gyropilot at the controls for 90 percent of the time—the former Navy "Sea Hawk" had smashed mark after mark for loaded land planes up to distances of 5000 kilometers in TWA's flying laboratory.

General satisfaction at this important accomplishment was justified, however, not alone because the United States had gained on the tally sheet as against France—which it may have surpassed by the time this article is in its readers' hands, by reason of attacks on altitude records with load by Tomlinson in the same ship, and others on amphibian speed records by the new Sikorsky *S-43*—but because such records as these reflect the true advancement of American design as exemplified in practical transport airplanes.

An air race across-country or around pylons can be one of the most thrilling spectacles that man has been privileged to watch. An effort to set a speed record over the official three kilometer course can hold one spellbound, even though the challenger of that record flies a straight line and alone. There is little thrill in making records by a long, closed-course grind of 1000 kilometers —621 miles—2000 kilometers—1243 miles—or 5000 kilometers—3105 miles, but these are the records that are of special value to everyday aviation, to the growingly important medium of air transport.

LAST Summer, with Colonel Charles A. Lindbergh, Chief Pilot Edwin C. Musick, and Sikorsky's famous test pilot, Captain Boris Sergievsky, in the cockpit, the Sikorsky *S-42*, later to be christened *Brazilian Clipper* by Pan American Airways, swung around a 311 mile course which ran from Stratford Lighthouse to Staten Island, Fire Island, Point Judith and return, to fly 2000 kilometers at an average speed of 157.5 miles an hour, and to add eight world's records for seaplanes with load to the two altitude records in this class which she had already made. It was a wonderful start on the campaign of regaining air records which, fostered by the National Aeronautic Association, is now so energetically being pressed.

But it was much more than this. It proved that the designs of Igor I. Sikorsky, the great airplane builder whose achievements were honored last June by the honorary degree of Master of Sciences from Yale University, and his staff, and the ideas of the technical committee of Pan American for efficient transport aircraft for its exacting service, were correct. The further proof of this pudding has come of late in the Pacific arena where a sister ship, the Pan American *Clipper*, has been flying with the regularity of clockwork between the Pacific Coast and the territory of Hawaii, and between Hawaii and Midway Island, and those other dots in the wide ocean which mark the stations of the pioneer service from the United States to the Orient.

Upon the basis of the record-making performance of the first ship of this type, this great flying boat has erected an operating schedule, performed at a cruising speed which is almost exactly the speed which brought the records home. She has shown that record making is much more than a stunt, that it is the index of actual performance under service conditions, leading to new expansions in the realm of transportation by air.

COMMANDER TOMLINSON'S series of world and American marks for loaded land planes have a similar significance. When he sent the Cyclone-powered Douglas, carrying 2000 kilograms (4410 pounds) over the long triangle which ran from Floyd Bennett Field to Bolling Field to Willoughby Spit, near Norfolk, and back to New York, at speeds which averaged 190.906 miles an hour for 2000 kilometers, and reached 254 miles an hour between the Rapahannock and Hampton Roads on one lap, he was not merely performing a stunt. He was demonstrating in an unquestionable way that the Douglas was capable of carrying more than its normal payload for more than its normal non-stop range; both important factors of safety and performance for everyday airline operation.

These records showed even more. They were made with the airliner which is familiar on the routes of the "Lindbergh Line" across the continent, on many of those of American Airlines, and on the runs of Eastern Air linking New York and Chicago with New Orleans and Miami. This is a 14-passenger monoplane, powered with two 715-horsepower Wright Cyclones. Its successor nears the service stage. This will be a 30-place monoplane, also powered with two Wright Cyclones of a total horsepower only about 300 in ex-

# SEEK AIR RECORDS?

cess of the twin engines now used. But, by the evidence of the wind tunnel, test flights, and the Tomlinson records, there is every indication that it will fly as fast and as efficiently, with its greater size and load, as its prototype.

At this writing, preparations are under way for an attack on a group of amphibian records by Mr. Sikorsky's latest creation, the *S-43*. This largest amphibian in the world showed its mettle beyond question the very first time it left the water.

With Captain Sergievsky at the controls, it started its take-off run on the waters of Long Island Sound off Stratford Lighthouse. Spectators on shore, watching through glasses, held their breath as they realized that the right engine was idling. But the plane surged up on the step, took the air, and climbed to 200 feet on the power of one engine; the first time a water-going aircraft has ever accomplished this feat from its natural element. Fuel pressure had failed on the right-hand line and it was not until a wobble pump restored the flow of gas that the second engine caught hold, and the rest of the first flight was made on full power.

THIS 16-passenger, clean-cut monoplane amphibian unquestionably has a top speed of around 200 miles an hour, and will cruise around 180 for 750 miles non-stop with full load. The records that are sure to fall in its lap will not mean merely another feather in America's cap. They will indicate that an aircraft has been put into service which may well change in important respects the whole airline map of the United States and its possessions, because an amphibian with performance equal to fast land planes of the modern type will be available.

Translated into scheduled operation, this may easily mean the development in key cities of the United States of seaplane landing facilities like the new Thirty-first Street ramp in the East River, New York City, which has demonstrated its ability to handle water-going planes ranging from a little Fleet up to a Martin bomber on floats. With these facilities it would be altogether possible to operate from the heart of one city to the heart of another without the lag now entailed by the trip from center to airport by ground transportation.

The saving which this would bring about in point of time can be realized by the example of service between New York and Chicago. Between these major cities the time in the air, averaged in both directions, is now a little less than five hours, but the time from hotel to hotel is very close to seven hours, and involves a change of vehicles and of baggage.

ONE takes a taxi from his hotel or place of business to the airline's city terminal, then a bus or limousine to the airport, and this process is reversed upon arrival. If, however, the East River ramp and one like it on the Chicago lake front were used, one 15-minute taxicab ride should suffice at each end and, roughly, an hour and a half would be knocked off a seven hour journey.

There is little question that good results for American aviation could come out of efforts to regain certain absolute records — without load requirements, now held abroad — notably the altitude record of 47,352 feet by Commander Renato Donati, now held by Italy, and the world's speed record of 440.681 miles an hour, made by Francesco Agello and also to Italy's credit. From the first might easily come valuable lessons, especially in regard to engine supercharging applicable to military operation as well as to the substratosphere flying which is peeking around the corner.

The absolute speed record is an expensive achievement. The Schneider Cup Races cost England each year that she competed about $1,000,000, but from them unquestionably stemmed some of the more efficient of the Rolls Royce military aircraft engines and the Hawker Fury and Super-Fury, neither showing quite the performance claimed by enthusiastic Anglophiles, but both among the swiftest combat airplanes.

There is reason to believe that the world's land plane speed record, held by Raymond Delmotte of France at 314.319 miles an hour, may fall to America this year. Here is another prize worth gunning for, not alone from the sporting angle, but because of its implications in plane and engine design.

But whatever the value of the records which do not involve carrying a load, there can be no question that those involving speed and altitude with load have an importance for practical air transport which transcends the satisfaction involved in their winning.

**A Douglas airliner over the Continental Divide**

Photographed for TWA by Margaret Bourke-White

# In Defense of Insects

## Only 300 Species Out of 500,000 Are Man's Enemies . . . No Insects—No Silk Stockings, No Fruit . . . Even the Hated Housefly Now Useful

By ALBERT DICKMAN, Ph.D.

**If you were given the power of a genii to destroy forever all the insects, entirely ridding the world of them—likewise all the bacteria—would you give the command? Few of the bacteria, relatively speaking, do us any harm and the same is true of the insects. Most of them are either harmless or actually helpful to us.**

**Will the next age of the world be the Age of Insects? Alarmists urge the danger of insect domination. Suppose, however, we look at the same question from the insects' point of view. Here is an animal that was on earth millions of years before man's most remote ancestors appeared. It is the insects, rather, which have cause to worry about the end of the Age of Insects and the beginning of the Age of Man. "Scare-you-all" articles which envision man's defeat by the insects are perhaps a bit sensational.—*The Editor.***

ACCORDING to some of our foremost entomologists, man is fighting a losing battle with insects for supremacy of the world. We are besieged on many fronts. Our crops are devoured, our homes undermined, our health and our very lives are placed in jeopardy. The cost of insect destruction to food crops, in North Dakota alone, amounted to the sum of 10,000,000 dollars in 1933, while chinch bugs in the same year caused an estimated damage in Iowa of at least 25,000,000 dollars. Termites by their destruction of wooden structures cost American home owners more than 30,000,000 dollars a year.

The yearly losses caused by the destruction of food crops in the United States is greater than the cost of our entire educational system, and nearly twice the cost of the maintenance of our army and navy.

Moths and beetles attack our clothing, furniture, and stored foods. Maggots of bot flies develop in the bodies of our living domestic animals, causing fatal diseases in some, and perforating the hides of others. Mosquitoes were responsible for 100,000 deaths in the United States—deaths from yellow fever alone—from 1793 to 1900; they alone are responsible for the transmission of malaria. Houseflies may be responsible for the transmission of typhoid fever, dysentery, cholera, and tuberculosis; lice transmit typhus and relapsing fever; tsetse flies transmit African sleeping sickness, and according to recent reports the caddis fly with its 2000 or more shedding hairlike scales is responsible for numerous cases of asthma.

From the above it might be hastily concluded that insects are the earth's deadliest wild animals, and that a relentless battle should be fought for their complete extermination.

This denunciation of insects, fortunately, cannot be extended indefinitely, for to our astonishment we soon realize that our list is disappointingly short and that, after investigation, man's convicted enemies in the insect world amount to only about 300 species. When we realize, too, that at the present time over 500,000 species of insects have been classified, and that thousands of unclassified specimens are accumulating in museums, universities, and in the pockets of entomologists, we find we cannot justly condemn a whole class because of an extremely small number of disreputable members. Suppose insects do destroy 10 percent of our crops? What of it? What a small fee they exact, when we consider that without the aid of insect pollination we would have practically no crops at all!

Courtesy *Journal of Bone and Joint Surgery*

**How maggots are applied to an infection of the skull, where they soon clean up the dead tissue**

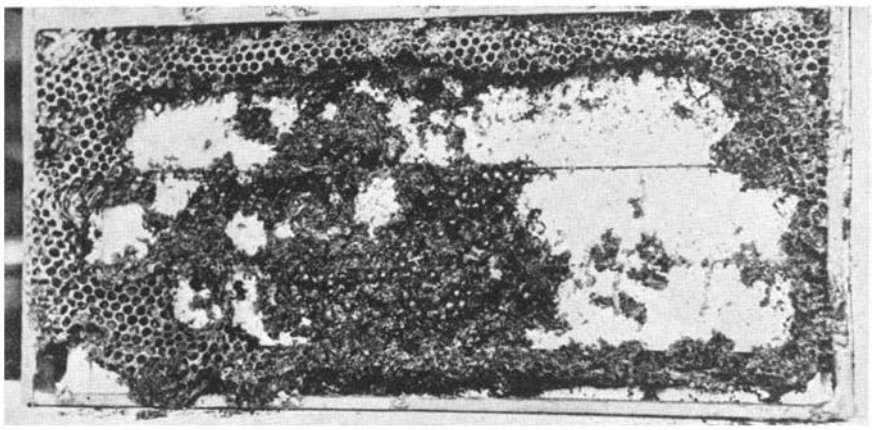
COMPARED with the 500,000 species of insects we find that there are only 30,000 known species of vertebrates. But in this last group we find all of the animals with which we are most familiar; those usually represented in zoos and aquaria, all of the birds, the reptiles, the fishes, the frogs and toads, the hair and fur-bearing animals. Among these, one species of snake, the cobra, kills about 20,000 natives in India yearly. According to our own government reports, wolves, coyotes, mountain lions, and other predacious animals in one year destroy over 20,000,000 dollars of our wealth. From incomplete statistics we are told by a reliable authority that, in Germany, rats alone destroy 50,000,000 dollars worth of property, while in England they destroy 400,000,000 dollars worth. Another authority states that the annual economic loss due to the destruction by rats in the United States is higher than one dollar per rodent. On one cane plantation in Puerto Rico where there were less than five hundred people, 25,000 rats were killed in six months!

Plague, better known to us as the black death, and primarily a disease of rats, at one time erased 50 percent of the

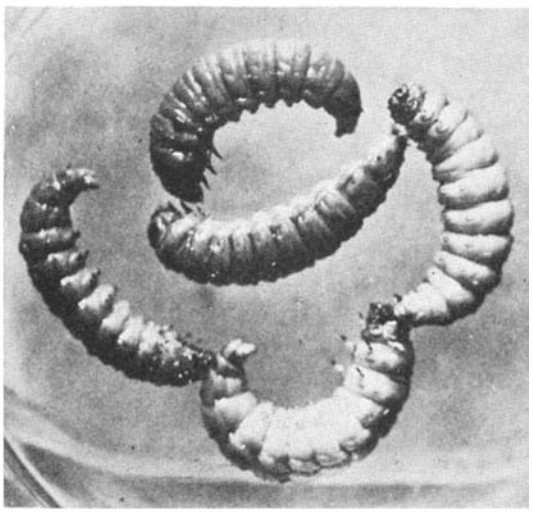
total population of the Roman Empire, and during the 14th Century in Europe killed about 25,000,000 people.

Insects, the little creatures, are not so bad. It is very likely that man, in the future as in the past, will continue to keep in abeyance those of them which are injurious to his health and well-being, and at the same time divert the activities of others to the common good.

How many times will the value of our silk commodities offset the destruction of the Japanese beetle? We are too prone to forget the beneficial aspects of insects, and the millions of dollars of wealth produced in the form of fruits, silk, honey, beeswax, dyes, and lac by them.



***Below:*** **Larvae of the waxmoth.** ***Above:*** **Destruction to waxcomb by larvae of the waxmoth, or beemoth. The moths lay their eggs in the hive; these hatch and eat**



Locusts, which lay waste great areas, are not only in many cases welcomed by natives as delicious items of food, but by their destruction they clear the lands of useless perennials and grasses and encourage the growth of new grasses and young plants, thereby affording future food supplies for wild cattle and game.

WE must be thankful to the insects for the destruction of dead and decaying animal and plant bodies which otherwise would in a short time litter the face of the earth. It has been stated that three flies, due to their rapid multiplication and activity, will devour a dead horse as quickly as would a lion, and were it not for the activity of drilling insects, a century would elapse before the elements alone would remove from the face of the earth the ruins of one of the hardwood tropical trees.

Numerous species of insects have been used since biblical times as a source of dyes. One particular species was used for dying cloth blood-red or crimson. The crimson dye of the Greeks and Romans, and the imperishable reds of the Brussels and other Flemish tapestries, were produced from the bodies of these insects. It was universally used before the discovery of the New World and the introduction of cochineal from America by the Spaniards.

The dried bodies of the female cochineal insects were being used by the native Mexicans when the Spaniards under Cortez arrived in Mexico in 1518. Although supplanted to a great extent by the cheaper but inferior coal-tar colors, cochineal is still produced commercially in many parts of the world. Before the use of the cheaper substitutes, 800,000 pounds of cochineal, valued at 9,600,000 dollars, was annually imported into Europe.

Thank the insects for lac, which is the excretion of a certain minute species. Twenty-five thousand tons, valued at a million and a quarter dollars, are produced annually in the central provinces of India. From it we obtain our finest grades of sealing wax, and shellac which is the chief ingredient of most wood polishes and of the coating on the fine lacquer ware used so much in China and India.

For evidence of the insect's martyrdom to man's progress in medical sciences, visit any one of our institutions erected and endowed for the study of cancer, and you will see numerous species of insects among such unusual experimental organisms as salamanders, crayfishes, and onions. Cancer is primarily a problem of cell growth and cell multiplication. Tear off a few legs from an insect, explain the sudden rapid growth of tissues and multiplication of cells to regenerate these lost parts, and you have fundamental information with which to help explain similar spontaneous growth of cells in the cancers of human beings.

The females of insects commonly grouped as gall insects, deposit their eggs in the tissues and stems of plants. The adults, having performed their primary function in life, perish, and the young begin their solitary struggle for survival in the stems of the plants. But there is a dearth of food in the small stems. The insect larvae in some remarkable manner stimulate the plant cells which surround them to multiply prolifically, and thereby furnish an abundant and constant supply of food material. What is this stimulus? How will the discovery of this mechanism ultimately affect our procedures in cancer research?

APINIZATION is one of the newer treatments for rheumatism. A long series of cases recently reported by two French physicians gives evidence of the efficacy of this treatment. The equipment is astonishingly simple, inexpensive, and occupies little space. It is merely a number of living, freshly caught worker honey-bees and a pair of tweezers. The treatment consists, essentially, of holding the bee by means of the tweezers against the ailing spot. The bee does the rest. Since the bee poison which displays these beneficial properties also manifests the properties of cobra venom and such alkaloids as strychnine and belladonna, treatment must be carried out under the observation of a qualified physician. In a number of stubborn cases which could not be relieved by conventional treatments, remarkable results followed a series of stingings. To remove the risk of infection from the stings, sterile extracts of the bee poison were made, with the added advantage that bee poison was made available at all times of the year.

In addition to the yearly production of millions of dollars worth of honey and wax, you may now credit the honey bee with having relieved human suffering—and it is very possible that in the near future they will take places in our laboratories beside horses, calves, and guinea pigs, as sources of materials in our fight against disease.

During the World War a keen and imaginative American surgeon was stationed at a base hospital in France. Ambulances returned periodically from the battlefields with wounded, frequent-

Photo by the Philadelphia Commercial Museum

**Honey bees have been experimented with in the treatment of "rheumatism," but this is not a general recommendation that rheumatics try the treatment**

ly with men who after a few hours on the battlefield possessed seriously contaminated wounds and general systemic infections. In such cases the mortality rate was extremely high. On a number of occasions, when the barrage was exceptionally severe and when the shelling and machine-gun fire continued uninterrupted, it was impossible to recover the wounded for periods of several days. On such occasions it was noticed by this surgeon that certain soldiers who had lain upon the battlefields for as long as seven days without food, water, or medical care, and suffering from severe wounds, showed upon examination no fever or general infection. Upon carefully removing the tattered clothing from the wounds he was astonished to see them infested with numerous squirming fly maggots, and the tissues around the wound in a miraculously healthy and healing condition. The minute fragments of bone and dead tissue had been entirely removed by the maggots, and the usual pus condition was missing.

SOME years after his return to the United States, and with these observations in his mind, he began experimentation upon laboratory animals, using clean, living maggots in the treatment of infected wounds. His results were so uniformly successful that he began their use in the treatment of similar human ailments. As a monument to his keen observation you can find on hand in numerous hospitals a supply of sterile maggots; or if you are interested you may obtain the name and address of a source which supplies them on a moment's notice, for the treatment of certain bone infections and similar diseases.

Very recently two physicians experimenting with the use of maggots in the treatment of diseases, and realizing that the maggots not only neatly remove the dead tissue of a wound but also produce some substance which prevents the growth of harmful bacteria in wounds, ground up maggots, producing an extract which, upon injection into individuals suffering from these bone diseases, has produced remarkable results. With internal infections, such as sinus and mastoid infections, where whole living maggots cannot be employed, injection of this extract is producing interesting results. Who will estimate the value of these insects in the short time of their use, in the alleviation of human suffering and the preservation of life?

Have you ever heard of the beemoth? From the time of Aristotle it has been denounced as a serious pest. It is the brazen little rascal which will creep into a beehive at night and whose offspring will in a very short time reduce the hive to a mass of debris. It is warred upon by beekeepers in all the civilized countries of the world. But visit a number of scientific institutions and you will find this pest carefully protected and fed, and kept comfortably warm in special incubators.

In a celebrated French institution of medical research this insect has offered very convincing evidence in favor of a long ridiculed biological belief. At present it is generally accepted that acquired characteristics are not passed on by parents to the next generation. But these little insects, after being injected for a successive number of generations with certain germs, have been shown to acquire an immunity for those germs, which they are then able to pass on to future generations.

Man's defense against the attacks of invading bacteria consists, among other things, of the destruction of these germs by the white corpuscles of the blood and of the production of chemical substances which disable and destroy these minute enemies. In the case of numerous diseases, however, the body may be entirely overcome by the rapidly multiplying invading hosts before the white corpuscles can rally to the attack and before the chemical factories of the body can be set in operation on an efficient and effective basis.

If the body, in such circumstances, can be immediately fortified by the injection of the ready-made chemical substances or antibodies into the blood stream, the invading bacteria may be destroyed or at least held in check until the patient is able to get his own factories in operation.

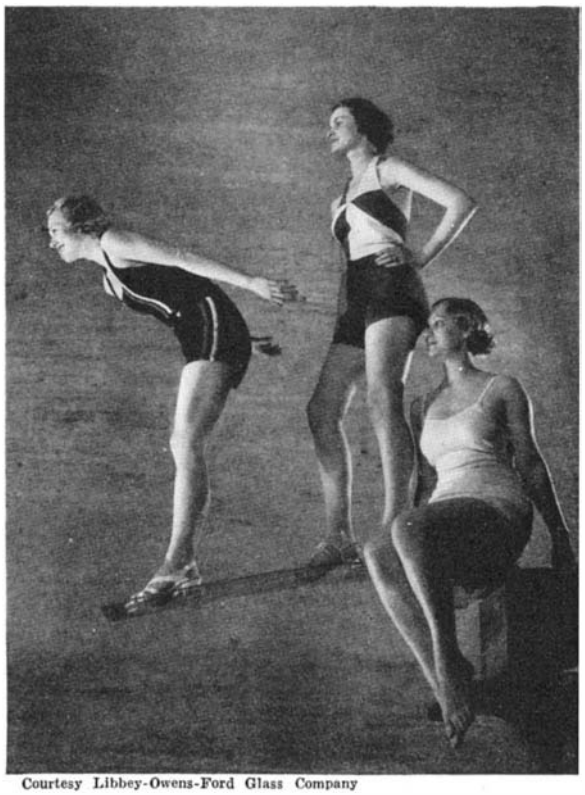
WHERE are these chemical bullets obtained in such emergencies? They are of such complex chemical nature that none of them can be made in our chemical laboratories. And each germ is vulnerable to its own particular bullet. In a number of cases, laboratory animals such as horses, rabbits, and guinea pigs are transformed into living factories for the production of these protective substances on a commercial basis. When certain germs are administered in proper and safe form, the animals begin the production of these antibodies which accumulate in the blood.

Attempts up to the present time to produce a serum for the treatment of tuberculosis, one of the greatest scourges of the human race, have been unsuccessful. No living factory has been found capable of becoming immunized and an effective producer of antibodies for this deadly germ. But there is a little creature which for many years has kept from man the secret of its own superiority over man, in the display of a complete immunity towards the tubercle bacillus—that same waxmoth or beemoth, the little pest of beekeepers, is immune to the tuberculosis organism! Inject into one of these insects enough tubercle bacilli to kill a whole laboratory of guinea pigs and the germs are immediately destroyed in its body. In the body of the waxmoth is a substance which stimulates the prompt and complete destruction of the tubercle bacillus, a substance rare or absent in human beings.

There are some few insects which, to be sure, are among our enemies. But let us hope that no one discovers a means of eradicating all insects overnight.

# TEMPERED GLASS

## Resists Temperature Changes . . . Can Be Twisted or Bent . . . Stronger Than Ordinary Glass . . . Clear or Colored

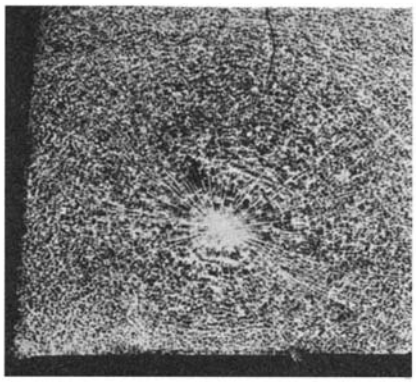


Courtesy Libbey-Owens-Ford Glass Company

**A sheet of the new tempered glass served as a diving board in a recent test. The young lady's weight has bent the strip far beyond the breaking point of ordinary glass**

SPRINGBOARDS and swing seats made of plate glass serve to illustrate dramatically certain qualities of tempered glass, but only hint at the industrial applications that are sure to follow the introduction of this product to the American market. Tempered glass has five distinct advantages over ordinary glass: It is approximately five times stronger; will bend far beyond the breaking point of other glass; can be twisted to a remarkable degree; is impervious to sudden changes in extreme temperatures; and if broken under severe strain it crumbles into innumerable pieces without sharp edges.

Briefly, tempered glass is produced in a manner similar to the "tough glass" described on page 330 of our June 1935 number, made for optical purposes. Ordinary plate glass is heated until it is almost plastic and then is suddenly air cooled. Thus strains are created, developing high compression on the outer surface of the glass, while the interior is under tension or pressure.

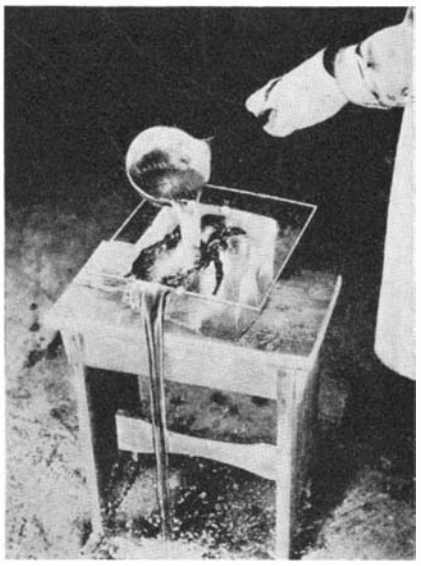


***Above:*** **A heavy weight was dropped on this pane of tempered glass. Instead of shattering into long slivers with jagged edges, as would ordinary glass, it crumbled into tiny fragments with blunt edges**

Tempered glass can be provided only on special order, since after it has been made it cannot be cut to size. When the surface is penetrated sufficiently deep with a cutting tool, it will crumble immediately. It has not yet reached the stage of development where it can seriously be considered as a safety glass for motor cars.

Possible applications of the glass, which may be either clear or colored, are: Port holes in furnaces; guards for thermal instruments; shelving carrying heavy loads; windows in deep-sea diving bells; illuminated signs; and in many other uses where transparency is desired but where the short-comings of ordinary glass rule it out.

***Left:*** **Three girls on a swing seat of glass, yet under their combined weight the seat only bends; it is tempered glass**



***Right:*** **When hot water is poured on cold glass—look out! But when molten lead is poured on a sheet of tempered glass that has been cooling off on ice—nothing happens**

# TUMBLING CAISSONS

## Caissons Constructed Upside Down on Ways . . . Launched . . . Built Up . . . Turned Over . . . Sunk in Clay . . . Workmen Inside Excavate Water Bed

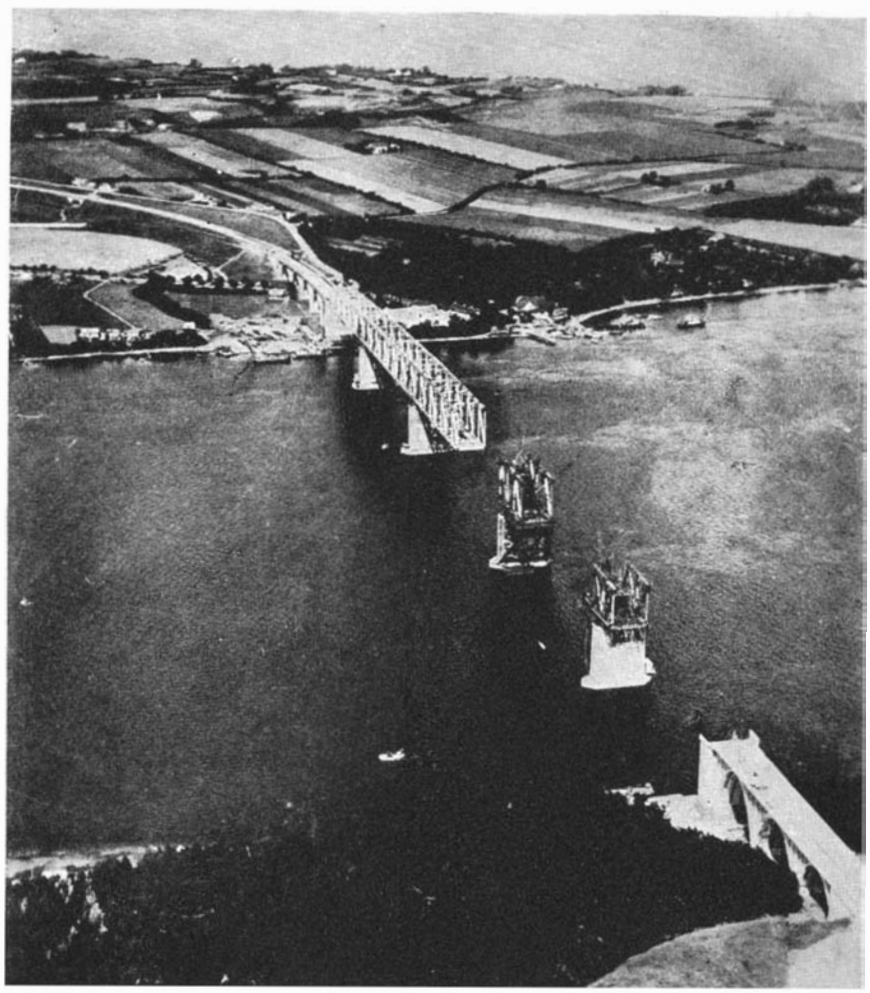
By R. G. SKERRETT

THE Danish State Railways system has recently completed and opened to traffic a combined highway and railway bridge that spans what is known as the Little Belt—a deep and rapidly flowing link with the sea that separates the peninsula of Jutland from the large Island of Fünen. The building of this up-to-date steel structure called for the mastering of a number of physical problems, which the responsible engineers accomplished in unusual ways.

The Little Belt Bridge is a concession to the modern demand for speed in transportation, dispensing with a ferry service that has been continuously active since 1872. The vessels that have been employed on the run in latter years are of ample size to carry on each trip about 30 freight cars and passenger coaches. With favorable weather the ferries have made the run in about 15 minutes; but fog, snow, and ice at times have seriously upset train schedules and caused delays.

The crossing of the Little Belt is a link in the much used railway route between Esbjerg on the North Sea coast and Copenhagen, the capital city; and the Little Belt is threaded by a very considerable volume of international water traffic. It was, therefore, necessary that the over-water sections of the bridge should be held high enough to afford clearance under all tidal conditions to the tallest masts of vessels navigating the Little Belt; it was equally vital that the several piers supporting the steelwork should be securely anchored in the bed of the stream where the channel is deep and the currents strong and swift.

With the single exception of the dominating peninsula of Jutland, which is part of the mainland of western Europe, Denmark is otherwise an aggregation of islands, great and small, that number approximately 500. A glance at any large-scale map of the kingdom will reveal how often waterways have to be spanned either by bridges or ferries in maintaining train services between the outstanding cities of this industrious and picturesque nation.



An arm of steel on high piers reaches across the Little Belt, a 2700-foot water gap between the Peninsula of Jutland and the Island of Fünen, Denmark

THE Danish Parliament authorized the bridging of the Little Belt in 1927. Construction was started the year following, the work being entrusted to an associated group of four experienced engineering and construction firms. The plans called for a water crossing made up of five steel spans, having a combined length of 2706.68 feet, and on each shore an arched concrete approach of exceptionally graceful lines—the entire structure to be a trifle more than 3864 feet long. The central span, which bridges the main channel of the Little Belt, is 721.78 feet long between the centers of the two supporting piers, and the underlying waterway has a maximum depth of something more than 131 feet at mean low water. The water bed at three of the four offshore pier sites lies between 101.7 feet and 99.4 feet below the surface of the stream, and the tidal sweep attains a velocity in excess of seven miles an hour.

These two circumstances made it clear that great care would have to be exercised in locating and sinking deeply the caissons forming the foundations for the piers for the steel spans. The first problem was how best to do the work; the second, that of keeping the cost as low as possible while still assuring rigidity and strength. Success in any case would be contingent upon knowl-


Courtesy *Engineering News-Record*

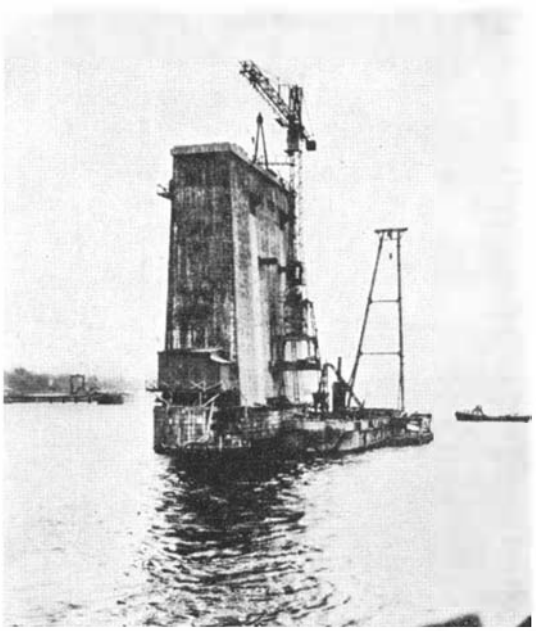
**Location of Little Belt and another bridge being built in Denmark**

edge of the water bed into which the caissons would have to sink. Exploratory drilling indicated that the underlying formation is mainly composed, to a depth of hundreds of feet, of clay that is so compact that it is impervious to water when penetrated less than 15 feet below the channel bed. The surface of the water bed, however, is extremely uneven; and that fact influenced the modeling of the caisson for each pier site.

The depth of the water in which some of the piers would have to be set, and the added depth to which the caissons would have to be sunk into the channel bed, precluded the employment of sand hogs and the use of caissons having working chambers of the conventional types—those filled with compressed air to hold the outlying water at bay while excavating the earth underlying the caissons. The Danish engineers developed caissons that could be sunk into the clay bed by dredging operations carried on by workmen in a working chamber in the caisson and on the surface of the Little Belt. The cutting edge of one of the caissons rests at a depth of 132 feet below the surface of the stream, and the surmounting pier rises virtually 105 feet above the water.

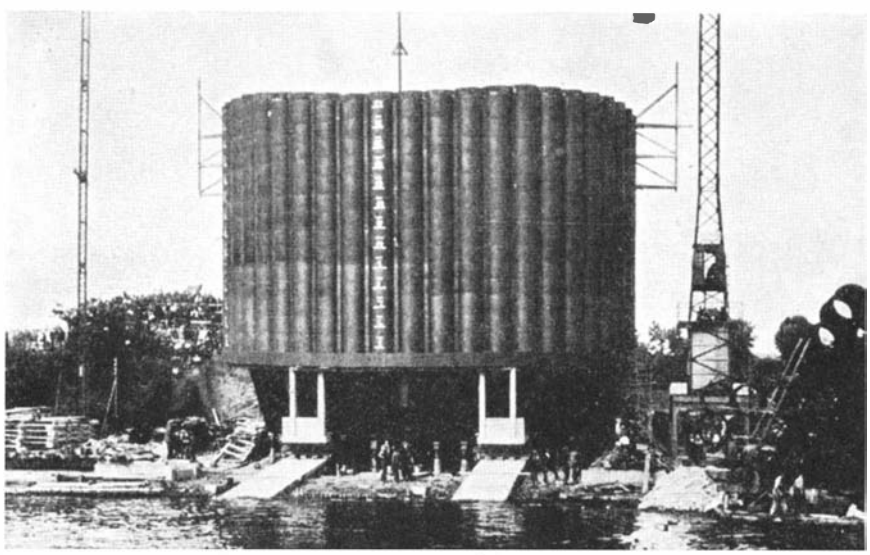
Because the cutting edge of each caisson was modeled to conform to the surface of the water bed, and was therefore irregular, the caissons were constructed upside down on shore, the flat deck above the ceiling of the working chamber resting on the building blocks from which each caisson was successively launched when ready. After being floated, the caisson was ingeniously made to turn turtle so that the flat bottom would become the top of the structure on which to erect progressively the concrete and the masonry superposed sections of the bridge pier. Each caisson at the time of launching had a dead weight of fully 7000 tons. To cause it to turn over and to control that motion at the proper time entailed the making of exact calculations and the exercise of nice regulation of so great a mass.

Viewed from above while building, the two parallel sides and the two semicircular ends of each caisson were composed of a continuous line of reinforced-concrete tubes, 76 in number, with a uniform internal diameter of nearly four feet. Immediately within the strange looking structure and strengthening the outer wall of the interconnected vertical tubes, were 22 similar tubes arranged symmetrically. All these tubes were later used to excavate the clay underlying them when a caisson was landed on the water bed at its given location. Thus, as the excavating proceeded, uniform sinking of the caisson was affected and the structure kept upright.



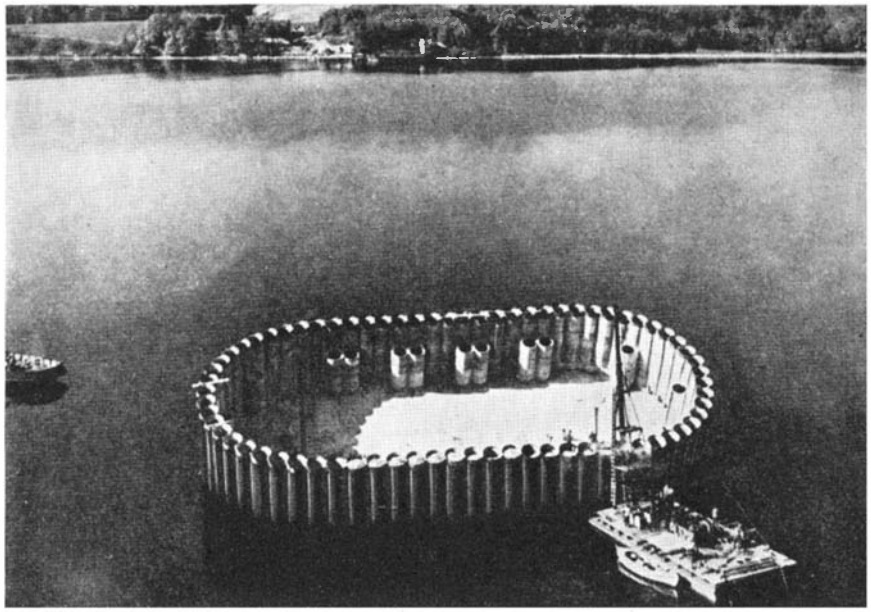
**One of the four sturdy piers of the new bridge which rise to a height of 105 feet above water**

The enveloping tubes were joined to the massive concrete ceiling of the working chamber and also to the reinforced concrete walls supporting a second deck — the latter forming the bottom of the caisson while on the building blocks. The interior between the working chamber ceiling and the succeeding deck was divided into a number of separate compartments by lengthwise and crosswise heavy walls of concrete. These subdivisions were used to hold water ballast for upsetting a caisson, and to regulate its stability and dead weight while it was being towed to the pier site and landed on the bottom of the Little Belt. Admission and expulsion of the water ballast could be regulated as occasion required. At the time of launching, the highest point of the tubular walls of some of these caissons was as much as 60 feet above the under-most part of the structure. The uniform length was about 146 feet, and the maximum width was 75 feet — a large and heavy body to launch and then to control during the subsequent operation of capsizing.



**On the ways, completed and ready for launching: A caisson built upside down, the ceiling of the working chamber within being at the bottom of the structure**

THE method employed in turning a caisson through an arc of half a circle was both ingenious and simple. Several hundred tons of water ballast were admitted to one of the side compartments. The further necessary tipping weight was in the form of sand poured into the upturned openings of several of the perpendicular tubes on the same side of the structure. The admission of a little more water ballast was all that



**A caisson, first towed into deep water, being made ready for the job of overturning. After it is capsized, the rims of the cellular walls became cutting edges**

was necessary to heel the caisson over until water could pour into the great central cavity over the depressed lip of the cutting edge. As soon as the former bottom of the caisson swung up to the surface, all the sand ballast automatically dropped out of the down-turned tubes. The caisson was then brought to a level by allowing the water ballast to flow partly into a neighboring chamber, on the opposite side, and thus bring about a balanced distribution. The caisson was then towed to a point where the water was of suitable depth, and anchored where a floating concrete plant furnished the material for adding to the upper part of the caisson. This operation was continued two more times, the caisson being shifted successively to deeper water, and then moved to its final position at the given pier site. By that time, the superstructure was high enough to be above the surface of the Little Belt at high tide, with the cutting edge resting on the water bed at all points.

THE bottom material under the approximately elliptical cutting edge was next removed, step by step, by means of a novel boring and excavating tool which was lowered into each of the wall tubes to cut away and remove the clay encountered at the open lower end of each of these wall units. The boring tool was made up of a large cylinder of steel with its lower edge formed into a series of saw-like teeth. Within the cylinder, near the bottom, were radial arms, also toothed, that broke up the bottom material. Powerful jets of water promoted further disintegration, and a continuous discharge of high-pressure air formed an emulsion and helped to lift the excavated material to the surface. The rotating shaft of the drill was hollow to provide a passageway for the upward flow. In this manner, the cutting edge was worked deeper into the compacted clay of the water bed, and at the same time the unexcavated area of the water bed rose correspondingly higher into the working chamber of the caisson. This material had next to be removed to permit the caisson to settle to its designated depth.

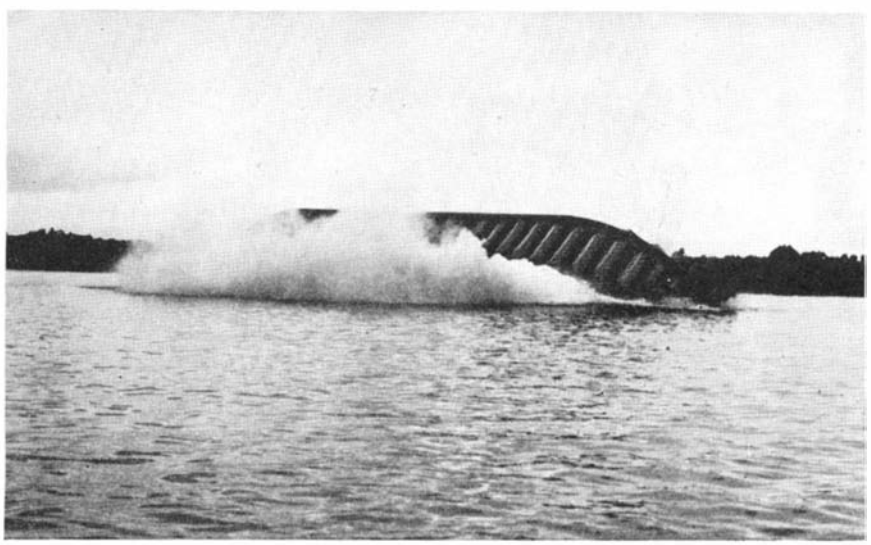
Because of the favoring firmness of the clay, no water could enter the working chamber from beneath the caisson when the cutting edge was something like 12 feet below the surface of the bed of the channel, and workmen could descend into the chamber through certain of the inner tubes that had their lower ends some distance above the cutting edge. These men worked under atmospheric pressure and "in the dry," as it is termed, and loaded buckets that were hoisted to the surface and dumped overboard. In this manner, the bottom material projecting into the working chamber was gradually removed and leveled to the desired depth so that the ceiling of the working chamber could come to rest there when the caisson had settled to the proper depth in the clay bed.

With all four caissons in place and their surmounting piers of concrete and masonry carried to their crests, 105 feet above the water, the steel workers started the erection and gradual extension of the five cantilever spans that reach from shore to shore of the Little Belt and link the peninsula of Jutland on the west with the Island of Fünen on the east.

THE bridge, which has a width of nearly 60 feet, carries two railway tracks, a vehicular roadway wide enough for two lines of traffic and a sidewalk about eight feet broad. The reinforced-concrete approaches have been skilfully designed to harmonize with the weblike steel spans, and the longest of the arches has a spread of nearly 150 feet, which is notable.

The building of the Little Belt Bridge has aroused much interest in European engineering circles because of the resourceful way in which all difficulties have been mastered. The Danish people and the many thousands of visitors annually from abroad will benefit by the year-'round time-saving now assured them by this bridge.

The caissons and piers for the Little Belt Bridge were designed and built by Messrs. Monberg and Thorsen, of Copenhagen and the Grün and Bilfinger Company, of Mannheim, Germany; while the steel for the bridge and the erection of the spans were covered by contracts with Friedrich Krupp A.-G. and the firm of Louis Eilers, both of Germany.



**The splash made by a caisson in turning over through a half circle. This delicate job entailed careful calculation and the use of water and sand ballast**

# THE COSMIC RAY PUZZLE

## Once Believed to Be Light of Extremely High Frequency, Cosmic Rays Are Now Thought to be Mainly, or Largely, Charged Particles . . . But the Final Answer Still Remains a Mystery

By JEAN HARRINGTON

THE long dispute over the nature of cosmic rays is perhaps at last coming to a conclusion. The study of this penetrating radiation from outer space has for years been a battlefield on which two opposing schools of thought struggled for supremacy. Dr. Robert A. Millikan of the California Institute of Technology is the leader of the older school, which maintained that the rays were made up of photons or light quanta. The exponents of the newer theory, led by Dr. Arthur Holly Compton of the University of Chicago, are diametrically opposed to this view. They believe that the rays are streams of electrically charged particles, including positive and negative electrons, with possibly some protons and alpha particles.

During the 1920's, when quantitative evidence was still scarce, the opposing forces were too nearly equal to concede victory to either theory. Within the last few years, however, a flood of new data has indicated that at least a large part of the cosmic radiation consists of charged particles. One by one the supporters of the photon theory have deserted the ranks to join Dr. Compton and his particle theory. Dr. Millikan was left to defend the photon practically singlehanded. Now it appears that he, too, is partly changing his mind.

BOTH scientists are Nobel prize winners, and stand today in the foremost ranks of atomic physicists. Their vigorous disagreement over cosmic rays has made the study of the phenomenon one of the most dramatic developments of modern science.

The radiation was discovered early in the century and, because of its extreme penetrating power, it was at first identified with the gamma rays which emanate from radioactive elements. In 1910, however, the Swiss scientist Gockel and the Austrian, Hess, carried instruments far above the earth in several balloon flights, and discovered that the intensity of the rays increased with altitude. They could not, therefore, come from any elements on the earth, but must originate far outside the atmosphere.

Cosmic rays are distinguished from the many other kinds of radiation known today by their extremely high energy. They can penetrate a sheet of lead with as little blocking effect as a ray of sunlight encounters in coming through a window pane. Regener, sinking a sensitive electrometer in the waters of a mountain lake, detected their presence at a depth of 700 feet. The lake was presumably free from radioactive contamination, and no other known rays could possibly have traversed such a thickness of water.

Since at that time, particles of such great penetrating power were unknown, scientists naturally assumed that cosmic radiation must be of the same nature as light. The energy of light depends directly upon its frequency or rate of vibration. In order to account for the tremendous energies of the cosmic rays, it was necessary to associate an extremely high frequency with them. The higher the frequency of an oscillating motion, the shorter its wavelength; but in the case of cosmic rays the theoretical wavelength was far too short to be measured by even the most sensitive experimental means. Thus there could be no direct test of the soundness of the photon theory.

Nevertheless, scientists accepted it for many years as a matter of course. It was not until the late 1920's, when new evidence was brought forth, that any serious doubts arose to threaten the old ideas. In 1927 the Dutch physicist, Professor Clay, discovered that the intensity of cosmic rays was less in some parts of the world than in others. His finding stimulated a number of similar investigations. In 1932 and 1933, Dr. Compton undertook a series of very careful and widespread measurements. Observations were taken at 81 stations all over the world, and the records confirmed quantitatively the results which had been obtained by Dr. Clay. They showed clearly that the intensity of the radiation increased steadily from the equator to the poles. Dr. Compton explained this effect by the hypothesis that the rays were made up of small, electrically charged "bullets," shooting through space with tremendous velocities.

When any electrical charge is in motion, it creates about itself a magnetic field. If it happens to pass through another magnetic field, the interaction of the two fields tends to deflect the charged particle from its straight-line course. An electrically neutral particle, such as a photon, undergoes no such deflection. Now the earth itself acts as a great spherical magnet, with its north and south magnetic poles near the geographic poles. If the cosmic rays do consist of charged particles, those encountering the earth's magnetic field would tend to be driven away from the equator and toward the poles. Only the particles of extremely high velocity would be able to pass through the field and reach the region of the equator without appreciable deflection. The fact that more cosmic rays actually do reach the surface of the earth in higher latitudes than in equatorial regions is a powerful weapon to combat the photon theory.

DR. MILLIKAN, skeptical of the results of others, undertook a world-wide expedition of his own. He confirmed Compton's measurements of the variation of intensity with latitude and, unfortunately for his own theory, uncovered another bit of evidence in favor of cosmic ray particles. This is the variation of intensity with longitude. The earth's magnetic field is not symmetrical with respect to its axis of rotation, but is slightly off center. The strength of the field is therefore not constant all around a given parallel of latitude. Since the intensity of the cosmic rays varies inversely as the strength of the magnetic field, measurements taken in the same latitude but in different parts of the world do not agree. This effect can be explained on no other grounds than that the rays are charged particles, and it is a stumbling block which Dr. Millikan cannot leap. He admitted at a recent meeting of the National Academy of Sciences that if this evidence is fully substantiated, he may be forced to revise his opinions.

He did not make this concession without reservations, however. He maintains that these streams of electrons may not be the cosmic rays themselves, but are an effect caused by them. When the un-

charged photons, traveling with the speed of light, collide with molecules of gas in the atmosphere, they expel electrons, both positive and negative, from the atomic nuclei. These may be the particles, he says, which are influenced by the earth's magnetic field.

This is still a source of contention between the supporters of the two theories. In order to decide whether the electrons are secondary or not, it is necessary to determine their energy very accurately. This can be done with fair precision by the Wilson cloud chamber method. This instrument is an ingenious device which enables scientists to photograph the tracks of particles far too small to be seen. As a charged particle shoots through the chamber, it knocks electrons from the orbits of any gas molecules which happen to get in its way. Then, if the gas is suddenly cooled by expansion, moisture condenses on the ionized molecules, and a photograph shows these tiny drops forming a thin white line along the path of the particle. If the instrument is placed in a magnetic field, the paths will be curved, just as they are in the earth's field. The strength of the field and the mass and charge of the particle are known; the curvature of its path can be measured on the photographic plate, and from these data, its velocity and hence its energy can be calculated.

THE values of the energy are generally expressed in electron-volts, which are more convenient units than ergs or joules. When an electron is placed between two charged plates, it is attracted to the positive one, and its velocity depends upon the difference of potential between them. The number of volts which would have to be applied between two plates to give the electron a certain velocity may be used as a measure of its energy, and this is the significance of the electron-volt unit. Dr. Compton believes he has measured cosmic energies as high as 600 billion electron-volts. Dr. Millikan concedes values only as high as 10 billion electron-volts.

As the cosmic rays come through the air, they are absorbed, and so are less intense at the surface of the earth than they are near the top of the atmosphere. The stratosphere balloon ascensions of the Piccards and the free balloon experiments of Regener in recent years have been made in an attempt to discover just how much absorption really does take place. Compton and Millikan dispute this point as well, Compton saying that the amount of absorption can be satisfactorily accounted for if the rays are electrons, and Millikan insisting that an adequate explanation can be made only if the rays are photons.

The investigation of cosmic ray phenomena has by no means ceased. The exact laws of atmospheric absorption are still uncertain, and further stratosphere flights are being planned and carried out in an effort to clear up the difficulty. Dr. Compton himself is at the present time working on free balloons at the University of Chicago, with which he hopes to make cosmic ray intensity measurements in the near future. Both the balloon and the instruments it carries will be controlled by radio signals from the earth, and it is expected that data will be obtained from even higher altitudes than have been reached before.

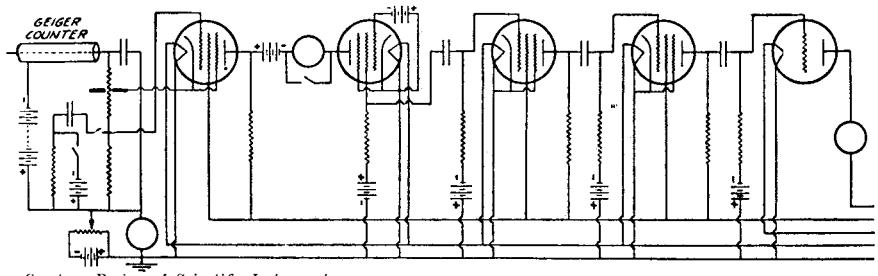
The Byrd expedition was equipped with apparatus to measure cosmic ray intensities in Little America, while ships and airplanes alike frequently carry automatic measuring devices. The instrument most often used for this purpose is the Geiger double counter, which determines not only the intensity but the direction of the incoming rays. It consists of two glass tubes placed in a line with each other (see figure on opposite page) evacuated so that only a few atoms of gas are left inside. When a cosmic ray enters the instrument, it ionizes these atoms, freeing some of the electrons from their orbits. A charged wire runs through both tubes, which attracts the free electrons. A small current therefore results whenever a cosmic ray passes through the instrument, and this can be made to operate a key or the shutter of a lens. Thus the number may be counted or recorded automatically.

ALMOST every new addition to the knowledge about cosmic rays throws its weight into the balance in favor of the charged particle theory. Scientists now generally believe that at least part of the radiation consists of particles, but they disagree as to how large that part is. Dr. Millikan estimates it as 15 or 20 percent of the total radiation; Dr. Compton classifies all but a fraction of one percent as particles, while Dr. W. F. G. Swann of the Bartol Research Foundation sets an intermediate value of about one third. They all agree, however, that it is very difficult to determine which are the original rays from outer space and which are secondary rays, created when the primaries collide with atoms and molecules in the atmosphere.

The question of the ultimate nature of cosmic rays is by no means decided. Much more research must be carried out before either theory can be accepted with confidence. Until the constitution of the rays is known, their origin can be only a matter for conjecture. Some hypotheses have been advanced, however, which are interesting to examine. Dr. Millikan's atom-building theory attracted a great deal of attention a few years ago. Hydrogen atoms, which are scattered throughout interstellar space, he said, might occasionally fall together to form atoms of the heavier, more complex elements. It has been found experimentally that when such a fusion does take place, energy in the form of photons is radiated. Dr. Millikan's first measurements of cosmic ray energies seemed to check closely with the values he computed, from his hypothesis, but later investigations proved that, in general, cosmic ray energies are higher than can be accounted for in this way. He still believes, however, that if the primary rays are photons, they result from the partial or complete annihilation of atomic mass in space, and the transformation of this mass into energy.

Others have proposed that the explosion of clouds of charged particles from the atmosphere of novae or rapidly expanding stars may account for cosmic rays. Still others look to some cataclysmic disaster in by-gone ages as the explanation. Whether any of these ideas approximates the truth, or whether theorists must search for some solution as yet undreamed of, no one can say.

But cosmic rays may not remain a mystery for long. Science is busy, finding and fitting together the pieces of the puzzle, making clear, bit by bit, its intricate design, and approaching gradually the completion of the picture.




Courtesy *Review of Scientific Instruments*

***Figure 1:*** **An ordinary Geiger counter, such as is used for general research in laboratories, for counting ions, consists of a hollow metal cylinder, indicated schematically at the upper left-hand corner, with a fine wire (dotted line) running through it. If connected with an amplifier much like those used in radio sets, the current output may be used to close keys, operate shutters and so on. Such an apparatus as this would count the ions caused by cosmic rays, but it would not indicate the direction from which the rays came. Next, note the double Geiger counter shown on the opposite page, arranged for directional use**

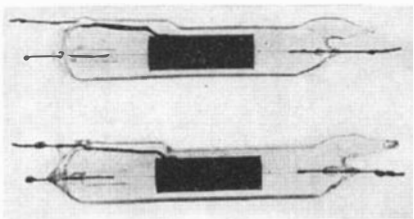
# COSMIC RAYS*

By ARTHUR H. COMPTON
Professor of Physics at the University of Chicago

WHENCE come the cosmic rays? One of the most significant aspects of the latitude effect [See preceding article.—*Ed.*] is its implication that the cosmic rays originate far beyond the earth's atmosphere. The earth's magnetic field is not strong enough to bend appreciably any radiation produced within the atmosphere before it is stopped by collisions with molecules. Furthermore, the cosmic ray intensity is found to depend upon the average magnetic effect of the whole earth, and to be almost unaffected by "local" magnetic idiosyncrasies which may extend even over a whole continent. This must mean that they feel the effect of the earth's magnetism when yet thousands of miles from the earth's surface.

EXCEPT for deflection by the earth's magnetic field, however, the cosmic rays are found to approach the earth nearly uniformly from all directions. Outside the earth's atmosphere, we fail to find any isotropic distribution of matter within our galaxy where such rays might originate. The extra-galactic nebulæ or space itself would, on the other hand, satisfy the condition of spherical symmetry. Calculations by both Eddington and Lemaître have shown that the probable absorption of a cosmic ray traversing the matter in interstellar space with about the speed of light for $10^{10}$ years would be wholly negligible. If, however, these rays are subject to the same red shift as that which occurs in the light from the distant nebulæ, the rays originating at distances as great as $10^{10}$ light-years would arrive at the earth with only a small fraction of their initial energy. If the rays are being continuously produced, therefore, their isotropic distribution suggests that most of them originate in the remote galaxies or in remote space, at an effective distance of between $10^{9}$ and $10^{10}$ light-years. An alternative would be to suppose with Lemaître that they were formed at the beginning of the expansion of the universe, and have ever since been coursing through space.

Some positive support for this view of the remote origin of cosmic rays is given by the fact that there appears to be an effect on their intensity due to the rotation of the galaxy. According to Stromberg and Hubble, this rotation carries us toward declination 47° N. and right ascension 20 hr. 55 min., at a speed of about 300 kilometers per second—one thousandth the speed of light. If the source of the cosmic rays is outside our galaxy and at rest relative to its center of gravity, calculation shows that at our latitude this motion should cause a diurnal variation, following sidereal time, through a range of the order of 0.1 percent. The best available records of cosmic ray intensity show a variation with sidereal time of about the predicted magnitude, and with its maximum at precisely the predicted time. Though further experiments are necessary before other possible interpretations of this sidereal time variation are ruled out, the complete agreement with the predictions may justify the presumption that it is really due to the rotation of the galaxy. This would necessarily imply that an important part of the rays originates outside the galaxy.



Courtesy the National Geographic Society

**What a double Geiger counter looks like. There are two cylinders, each about eight inches long, each with the wire mentioned under Figure 1 on the opposite page, and exhausted of air. Arrangements are made such that no record will be made unless the incoming cosmic ray penetrates both cylinders simultaneously. In this way the double unit becomes directional, and this is the principle of the cosmic ray "telescope" (which is not really a telescope). Units like the simple one shown above, but in larger groups, were taken aloft in the National Geographic Society-U. S. Army Corps stratosphere flight in South Dakota**

How are the rays produced? Of the many hypotheses regarding the origin of cosmic rays, none has received sufficient experimental support to gain general acceptance. Those which assume the primary cosmic rays to be photons appear to be in definite conflict with the observed latitude effect. Also those which would ascribe their origin to transformations of atomic nuclei with resulting loss of mass are unable to account for the huge energies of from $10^{9}$ to almost $10^{12}$ electron-volts which the more recent studies seem to require for the individual rays. Local or interstellar electric fields have been suggested; but the maintenance of such fields in highly ionized stellar atmospheres seems an insurmountable difficulty. There remain, however, a number of theories which cannot thus be excluded. Prominent among these are Lemaître's hypothesis of "super-radioactive particles" emitted at the initial explosion of his expanding universe, Swann's theory of the acceleration of electrical particles by electromagnetic induction from the changing magnetic fields of "sunspots" on giant stars, and Milne's view that the particles owe their energy to the gravitational attraction of the universe.

ONE of the most fruitful lines of cosmic ray research has been the study of their effects on passing through matter. Especially valuable have been the experiments with Wilson chambers in strong magnetic fields, and the use of Geiger-Müller counting tubes. These and other methods have shown that a complex mixture of secondary rays is excited by the primary cosmic particles.

A prominent feature of the secondary radiation associated with cosmic rays is the occurrence of "showers" of 2 to 20 or more high-speed particles emanating apparently from the same point. These particles are about equally divided between positive and negative electrons. Furthermore, these showers themselves frequently occur in groups, all excited by some "shower producing radiation." This "shower producing radiation," according to studies by Rossi, Blackett, Anderson and others, seems to consist of photons, similar to X rays, produced at the collisions of the primary cosmic ray particles with atomic nuclei.

Our analysis of the composition of cosmic rays is well under way, and from present indications should soon give conclusive results. The "cosmic" origin of the rays, though perhaps not established, appears now more probable than ever. How they originate is still obscure; but increased knowledge of their characteristics has helped to limit the type of hypotheses that are admissible. Of immediate value is the use of these rays as a tool. They have made possible the discovery of the positron, and now afford a means of extending our studies of the properties of matter to energies a thousandfold greater than are available from any other known source.

*Courtesy of *Nature* (London)

# For Better Houses

## Scientific Materials . . . For Insulation . . . Durability, Permanence . . . Easier Application . . . Slow Growth Explained . . . What The Future Holds

By PHILIP H. SMITH

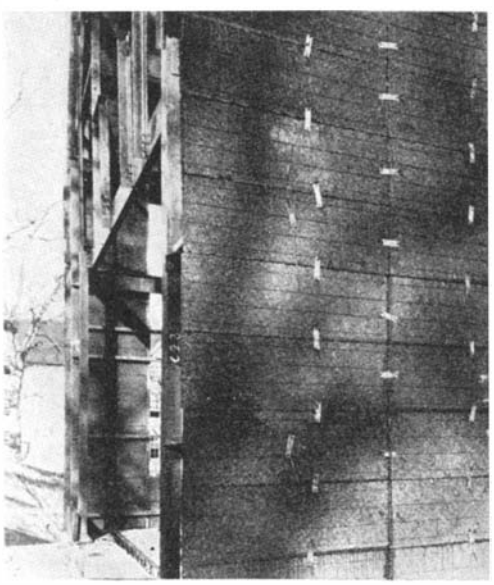
THE building materials incubator has been hatching new products at such a tremendous speed of late as to leave the casual observer, not to speak of the prospective builder, engulfed, bewildered, and often skeptical of the much touted progress. What materials are substituting and why? Are new products really superior to older ones or are they produced simply to catch the unwary? Why are they coming upon the market in such volume when building is at ebb?

There are several ways to get answers to these questions. Examining objectives will reveal quickly the significance of building materials development. Products usually are not made simply to sell, though there are exceptions; they are made for specific purposes, and delving into these purposes organizes the heterogeneous lot so they can be reviewed and appraised. Once materials are properly lined up, evaluation can proceed.

There are four main purposes which will serve as pegs. They are, to obtain: Better insulation; Greater durability and permanence; Easier application; Elimination of repetitive and overlapping treatment—and hence higher costs.

There are, of course, many lesser objectives which promptly come to mind, but every product on the market or on the verge of commercial introduction ties to one or more of these four points. As a matter of fact the aim is to incorporate as many good points as possible in any single material, and commercial success now hinges on such inclusion.

HEAT insulation is listed first among objectives because it has been given most serious attention, because it has received the most striking treatment, and because it symbolizes perhaps better than anything else the direction of materials research. Dwellings have always been inadequate in the matter of insulation and the progress of building through the centuries has been marked by the slow overcoming of this deficiency. Latterly the concept has been spread that a structure is outmoded if it approximates a heat sieve. Household economy can no longer tolerate heat waste. And air conditioning comes along to provide the final stimulus, since its proper, economical functioning depends upon adequate insulation.



**Panels of pressed cork used with steel framing in the construction of house walls**

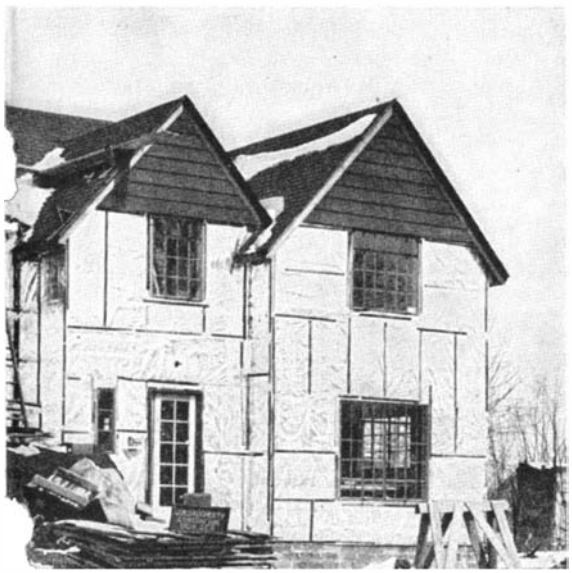
Two schools have grown up in the insulation field. While both aim to keep temperatures constant, one seeks to prevent the conduction of heat through wall structures by using dead air spaces, and the other seeks to reflect heat by providing a baffle. Proponents of the first method provide fiber and cork boards, felts, and insulating wools of the rock, mineral, and glass type; the second group employs aluminum foils.

Great strides have been made toward perfecting insulating boards, although presumably the ultimate is far from being reached. All manner of raw materials are being put to use; practically anything having a fibrous or cellular structure will provide dead air spaces. Products on the market make available a great variety, some having finished surfaces, others surfaces to take plaster or color treatment. More recently efforts have gone to create a board which will serve as a complete wall, to have—in addition to insulating value—ease of installation, reduction of labor operations, and durability. An example of this type is a board comprising an insulating material sandwiched between slabs of asbestos-cement.

CORK board, comprising granular cork pressed into a solid mass without the use of a binder, is being used in conjunction with steel framing to give a solid insulating wall, lacking only a surface finish. This really carries over the principle of the household refrigerator. Rock and mineral wools, hailed as revolutionary only a few years ago, have come into general use as accredited insulating materials. Progress has been made in evolving wools from the waste products of mines in order to obtain a high grade product at low cost. The better grades are made water-repellent as they should be if maximum insulating value is to be obtained. Glass, too, finds a use here, for spun glass—long hair-like filaments massed in batt form—provides a structure with countless stagnant air spaces.

Known in Europe and there put to practical use before adoption in the United States, aluminum foil has quite recently come forward as an insulating material. Commercial application to homes has followed upon early use in

**One of the methods of applying aluminum to walls for insulating purposes: The thin, shimmery sheets are applied to all wall surfaces immediately beneath outer surfacing material to check heat radiation**



American naval construction and later industrial uses such as for refrigerator cars, household refrigerators, and steamships. Foil insulation works in two ways—it reflects radiant heat back toward its source and checks the emission of heat from its polished surface. It does for a house much what the vacuum bottle does for its contents. It differs radically from orthodox insulating materials in that it does not store heat, hence a foil-insulated room warms up more quickly when heat is turned on and, conversely, cools off more rapidly when heat is shut off. Whereas fibrous and cellular insulators reduce heat conduction, foils check heat radiation.

One can ponder this distinction between insulators and wonder how foil can be utilized since metal is a good conductor of heat. The manner of installation provides the answer. Foil is applied in several ways but in every case there should be an air space in front of the reflecting surface. One type of application calls for hanging the metal in sheets with intervening air spaces between the inner and outer wall of a structure. Another type employs crumpled foil so that where sheets touch, there will be a minimum contacting area through which heat might be conducted. Still another form uses foil affixed to sheets of heavy kraft paper, to a metal fabric acting as a plaster base, or to gypsum board.

Homes can be efficiently insulated today, for suitable, reliable materials are available. Need has brought them into existence, for home owners are coming to realize that enormous heat losses are unnecessary and that although initial construction costs are higher when insulation is used, in time fuel savings will more than offset the original outlay. B.t.u. heat losses can be reduced from 25 to 40 percent with properly installed insulation, the extent of the saving depending upon the type, size, age, and condition of a house. And aside from cost savings there is the gain of increased comfort for the occupants and longer life for the interior construction —equable temperatures reduce the stresses and strains induced by volume changes of materials.

Maximum insulation means adequate insulation, properly applied; and that involves more than walls and roofs. Plenty of heat escapes through windows and this has led glass manufacturers to make the valuable contribution of double glazing. Storm windows, so-called, have been used for generations but double glazing goes several steps further in accomplishment. This new development comprises two panes of glass set in a single sash with a sealed air space between panes. It takes into account the fact that insulating value varies with the width of the space between panes and provides the proper spacing; it seals this space to make it an effective barrier and dehydrates the air so that moisture and frost formation will be checked or prevented.

INSULATION, while holding the front seat at the building materials arena, by no means monopolizes all the advances. Here we must depart from the classification of purpose since the materials to be reviewed are chosen because they represent the most recent fruit of the laboratory of a significant type.

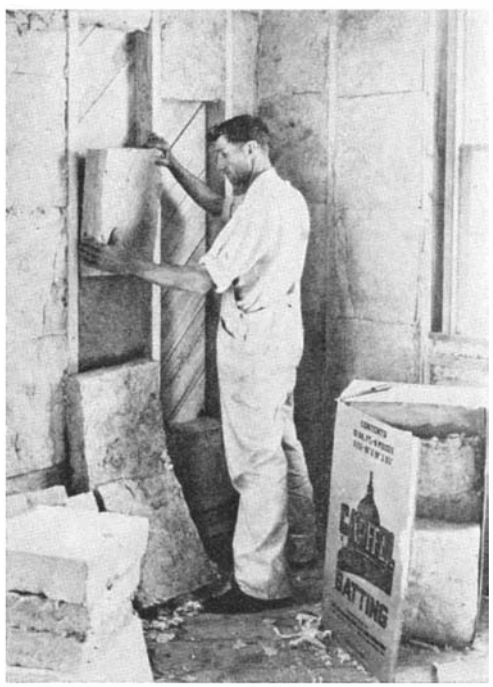
One can hardly think of a material more basic than cement unless it be wood, and cement has marched along with the procession. The goal of research has been to achieve a control which would give a more uniform product and attention now centers upon finding out what happens in the manufacture of cement, what physical and chemical changes take place in the various stages of production to establish this control. Out of this work the researcher hopes to find a way to make a more durable product and one with a more constant volume, rather than a stronger one. It was established several years ago that the water-cement ratio was of paramount importance in the mixing of concrete and as this fact has been disseminated structures have become increasingly satisfactory. Here the layman has run up against a tangible improvement and, aside from this, the introduction of pre-cast joists constitutes about the only other advancement which has come to his immediate attention.

Improvement in the technique of precasting permits production of joists in quantity, in stock sizes, adequately strong, fire-proof, and, of course, easy to install. Coupled with the use of precast slabs, entire floors can be made of concrete and methods have been devised which obviate the use of forms. All this means lower costs and widens the range of cement use. Such simplification in the handling of cement points the path of development, for it is in this wise that costs will be lowered, rather than in lower material costs since the emphasis is on improving quality.

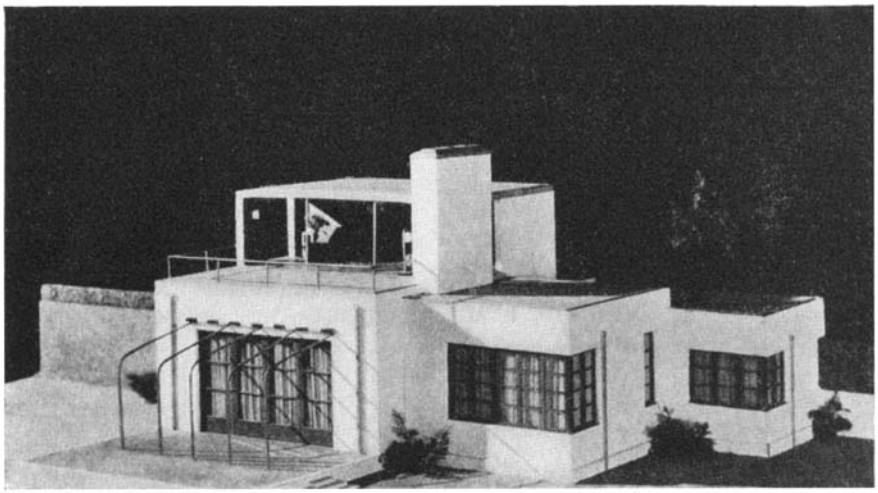
ALLIED to concrete in character is artificial or synthetic stone of which several types are on the market. One such synthetic stone is made from naturally occurring alumino-silicates like shales and slates, made to react with an alkaline earth base in the presence of low pressure steam. The principal advantage of the synthetic stone lies in control of size under factory methods. And if waste materials can be used, the advantages are substantially increased. One such waste product stone is now being made from fly ash to show what can be done to produce durable building materials at low cost.

Fly ash results from the combustion of powdered coal and since it is a light


**Section of window pane showing double glazing with sealed air space**



**Rock Wool batts, in convenient sizes that are easily cut, are placed between studs**



**Model of a house built mainly of a pressed board which, in turn, is composed of processed wood scraps. It makes a livable house in the true "modern manner"**

material, formerly having no value, its disposal has always been a power house problem. It is collected from the combustion gases either through electrostatic precipitation or by wet scrubbing, and collection is necessary to prevent it from covering the countryside. Using the reaction between this fly ash and an alkaline earth base, a stone has been produced which is made up of 90 percent fly ash. As yet the stone is in the introductory stage and has been used in the form of brick and hollow back-up units for load-bearing walls. Since this product seems to lend itself well to factory treatment, proponents suggest that the power plant of the future will have a floor directly underneath the electrostatic separators where the fly ash can be fabricated into building materials. This would mean production close to the place of consumption.

Even as concrete and synthetic stone come in for experimentation to impart qualities lacking, so brick undergoes development to better it and make it suitable for a wider variety of uses. Brick, or we might better say ceramics, reached a high stage of commercial use without the benefit of science, so science now looks back to determine physical and chemical structure with the idea of establishing a control permitting the manufacture of more uniform products. Clays are being studied, so is the firing process, and the net result will be ceramic materials designed for specific purposes. The result of such studies is already manifest in the arrival of lighter weight brick having good insulating properties. The method of manufacture is one of mixing the basic materials with some organic material which burns out in the firing process to leave a multitude of voids[1]. Cork is used, but experimental work considers other substances, and research men are endeavoring to find ways of making the voids, or cellular structure, more uniform.

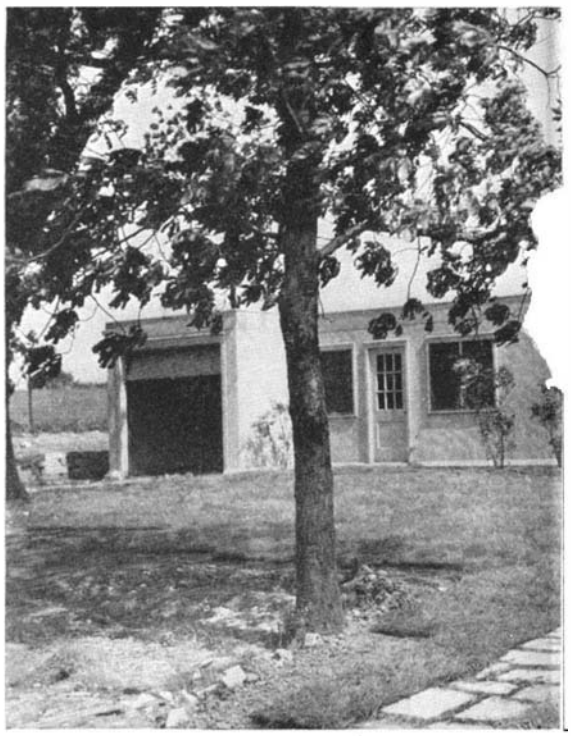
IT is not hard to visualize some very significant results from work with ceramics in the light of present research. It is conceivable that, with the establishment of better control, materials will be developed which will lend themselves to fabrication into wall panels combining more qualities than are to be found in any existing material. Being a ceramic base, such a panel would be fireproof and termite-proof, it could be light in weight and be treated to be water-proof. It would also have high insulating value. This is the sort of material research seeks.

If the goal is not achieved with ceramics it will be reached with some other material, for a great volume of work is being carried on to improve and perfect factory-made panels for wall surfaces. Most of us are familiar with the boards now on the market; those made from wood pulp, wood fiber, cane fiber, plaster, gypsum, and the like. Still newer are the plastics made from synthetic resins[2]. And from this comes resin treatment of woods to make them more durable. Synthetic resins have provided a binder for laminating woods to make the laminations inseparable and the product mold-proof. Waste products come in strongly in the panel board field and the end is not in sight. New compositions are undergoing experimentation which will bring into use such materials as latex, sawdust, and shavings.

Control of volume changes has recently taxed the attention of board producers, having already tackled such problems as finishes, textures, insulating properties, application and durability.

No survey of new materials would be complete without some reference to

[1] April 1935 *Scientific American*, page 201.



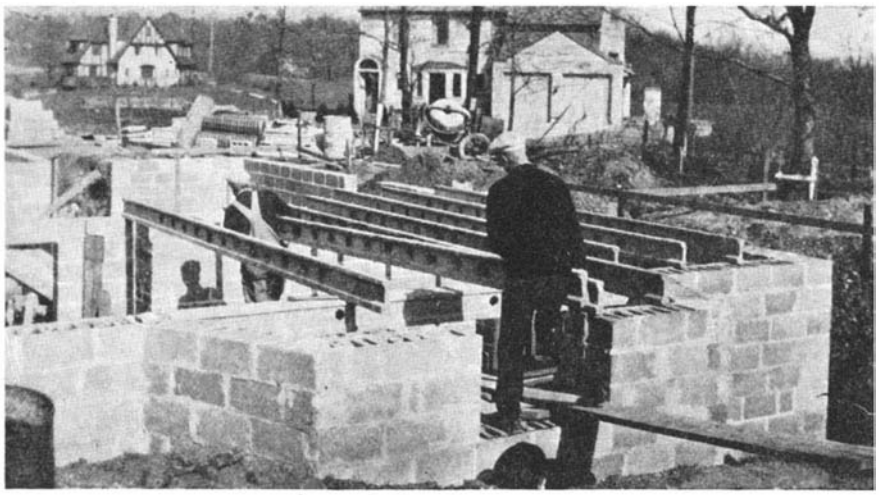
**A completed house of steel construction, attractive, Its cost was surprisingly low, amounting to only 4500**

**Laying the gypsum section of one type of "package" home. Long used as a heat insulator in steam plants, gypsum may find wide use in house construction**

[2] January 1935 *Scientific American*, page 5.

metals, but the mention must needs be short for extended comment has been made in previous articles[3]. In home construction, the metals have played a minor part. Stainless steel, admirable from the standpoint of corrosion resistance, and aluminum which boasts the advantage of light weight, both make their major contribution in commercial building. What we do find is a slow but steady growth in the use of steel for framing and for floor joists, and some use of steel sheets for exterior walls of houses.

But let us halt at this point, having sensed somewhat the direction of building materials development and its ultimate objectives. Let us consider another step which is going to be taken very promptly. This step is the elimination of repetitive and overlapping treatments which are so much a part of building operations and so wasteful.



**Pre-cast concrete joists are of comparatively light weight and are easily installed. Properly made, they should never shrink. They are fully termite-proof**

**comfortable, and up-to-the-minute in every respect. dollars, including a winter air-conditioning system**

The elimination of wasteful operations is very largely a problem of material design, but it also involves integration of materials and labor operations. What many far-seeing producers of materials appreciate is the possibility of so manufacturing items that overlapping is greatly minimized. This calls for more prefinished materials and development of installation technique to eliminate the mess which normally accompanies construction. It means, for example, fasteners which eliminate the puttying of nail holes; it means floors which do not have to be refinished once they are laid, just because of the tramping they get while the rest of the house goes up. It would mean that when a particular craft had made its contribution there would be no returning to the job to repair the troubles created by another craft operation. Such progress is conceivable and is, indeed, approached as materials become standardized yet flexible in use.

IT is valid to say that more progress will be made toward solution of the above problem as the researcher and the chemist come out of their laboratories to view the building field as a whole, and as they become more conversant with its practical problems. This they must do if the products of their labor are to make their way in an increasingly competitive market. No building material stands wholly alone; it must fit and function with many others and to the degree that it does so, it comes to your attention and my attention as prospect and critic and so into ultimate use.

With many more thousands of minds trained upon the building industry than ever before, advancements are bound to come to light more quickly, but in the last analysis it will be the creator of the new who will be most responsible for their quick acceptance and utilization.

The architect is sometimes criticized for his delay in adopting new materials. But the criticism is hardly justified. As custodian of the consumer's bank roll it is not his function to experiment. The responsibility for prompt placing of advancements before the consuming public goes back to the chemist and those surrounding him. Tests must properly take place in the laboratory or under controlled conditions and then the translation work begins. Good translation means quick consumer benefit.

Because the chemist and the producer are accepting this responsibility more and more, you will see in the next few years much more rapid progress in this enormous field which has existed ever since man sought shelter from the elements.

Illustrations courtesy: American Houses, Inc.; The Corkanstele Company; The Masonite Corp.; Portland Cement Assoc.; The Standard Lime and Stone Co.; The Thermopane Co.; International Vermiculite Co.

**Erection view, from above, of a house having cellular steel walls, in the spaces of which can here be seen Vermiculite for insulation against heat conduction**

[3] *Scientific American*, July 1935, page 20, and August 1935, page 66.

# CUT THE OVERHEAD!

## When Hard Times Come It Is the Logical Time to Increase, Not Cut, the Funds for Research . . . Research Millions Are the Seeds of Billions

By T. SWANN HARDING

A FEW years ago, when I worked in industry, things got pretty unpleasant when an economic depression appeared and business got bad. The bosses began to work six hours a day instead of playing golf eight and working two. They spent a great deal of their time creeping up on laboratory research men, such as I was, yelling "Boo!" and then remarking that there were nine fellows downstairs who would love to have my job at half the salary. They then departed, singing a sort of song-chorus which ran over and over again, monotonously, "Cut the overhead!"

So, a little while back when the Federal Government began to accumulate a deficit, the same sort of people began to cry "Cut the overhead! Fire the scientists! Discontinue all research by the Government, for it has only gotten us into trouble. Cut the overhead!" Yet the cost of all the research carried on by the Federal Government never reached above 20 millions a year, and has usually been less, while conservative estimates hold that it has paid from 250 to 500 percent dividends.

What is 20,000,000 dollars? Two thirds the cost of building the *Queen Mary*, and less than that of a first class battleship! In 1930 ten companies in the United States could afford to spend more than two millions each for magazine advertising alone. This is no adverse criticism of advertising or of the expenditure but it does seem that the same country as a whole could afford to spend 15 or 20 millions a year for Federal Government research.

The business man's answer is "But look what it got us! The Department of Agriculture spends most of that money on research, and look at the mess it got the farmer into, showing him how to increase production. Now it has to go around and tell him to produce less, just because of research." Yet when you consider research which lessened plant diseases, for example, the result of plant improvement has been, over long periods of years, rather to prevent ruinously low yields in occasional years than to raise the general level of production.

SUCH crop improvement tends to stabilize production. This permits more definite, scientific agricultural planning. Take stem rust, caused by a fungus, and which has long taken an enormous toll from the nation's wheat crop. The disease, like whooping cough in humans, is not of equal severity in all years. Some years it is negligible, some years so devastating that it wipes out the wheat crop of entire sections. But agricultural scientists can breed wheat varieties resistant to stem rust. These reduce losses almost to the point of elimination, in some cases.

With susceptible wheats it is impossible to plan a wheat production program intelligently, because you never know when rust may wipe out your crop; but with Ceres, Thatcher, or other resistant wheats available you can plan sensibly. The same thing is true of wheat that is resistant to hazards like winter-killing and smut injury. The same is also true of oats and their losses to such diseases as crown rust, stem rust, and loose and covered smuts. Breed resistant varieties and you stabilize production. Whether the wheat or oat quota is high or low it is obviously ridiculous for farmers to raise these crops for disease to annihilate.

**Fertilized and unfertilized cotton. Note plants in the farmer's hands**

Rust and smut not only decrease the yield but also the quality of oats and wheat. Gains in quality or resistant varieties are often as important as increased production. A few years ago practically all the wheat from some shipping points in the Pacific Northwest was very smutty; the consequences were heavy dockage and low price. But with the use of smut-resistant varieties like Ridit, Albit, and Oro, most of the wheat from these same regions is smut-free and unpenalized.

The newer strawberry varieties produced by research are of finer quality than those already existing. Alfalfa wilt not only causes losses of the crop but it shortens the life of established alfalfa fields. Dozens of new varieties of fruits and vegetables have been developed which are simply of better quality than those replaced.

Other altogether new crops have been introduced, like Korean lespedeza. This plant was introduced only a few years ago. Now we grow 15,000,000 acres of it because it can withstand such unfavorable conditions as the heat and drought of 1934 far better than our already common legumes. It can provide grazing when other crops fail. Again the factor of stabilizing agricultural production is important.

THEN there is the question of maintaining an agricultural industry in a section where plant diseases menace the very existence of the crop. In 1922 the lettuce-growing industry of the Imperial Valley of California was menaced by mildew and brown blight. The Department of Agriculture and the California Experiment Station got together and produced strains of lettuce resistant to both diseases. They then transferred this double resistance to a number of lettuce varieties with other good characteristics, and now 90 percent of the commercial lettuce grown in the southwest is of strains produced by this research.

There is another oddity about lettuce. Lettuce seed have to have a period of dormancy before they will germinate. Seed produced in the regular lettuce-seed sections of Northern California is harvested in August and cannot be used the same fall in the Imperial Valley.

But it has just been found that if this seed is soaked in water and then exposed for a few minutes to daylight it will germinate immediately. When this work is completed the commercial lettuce growers will have their problem still further simplified by a type of research which does not directly make for increased production.

Again it is found that the removal from the tree of a part of the apple, peach, or orange crop early in the season results in much greater size and higher quality of fruits left unharvested. Or it is found that Kieffer pears ripened at a temperature of from 60 to 65 degrees will attain a quality not usually associated with this hard, gritty-textured, poor-flavored variety. Or it is discovered that, by proper precooling of refrigerator cars used in shipping Bartlett pears from the Pacific Northwest, the cost of refrigeration in transit may be reduced nearly one third, and one third fewer cars are required—as a result of which the Northwest fruit growers will save half a million dollars annually.

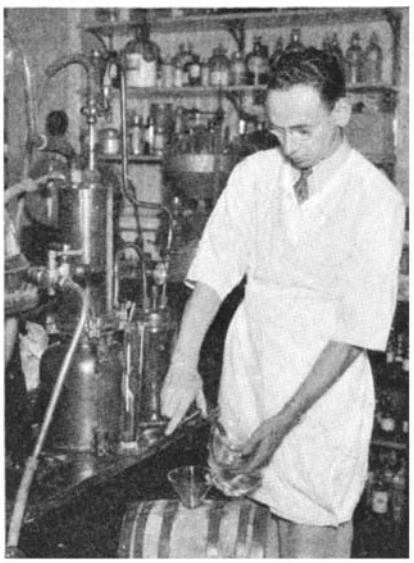
INSECTS cause losses to American agriculture estimated at two billion dollars a year. Why raise that much produce for the bugs to enjoy? If the discovery of the insecticidal value of rotenone by government scientists will decrease that loss, what is so wrong about that—if anything? Losses to the food industry as a result of decay, fermentation, rancidity, growing stale, discoloration and other deteriorative changes amount to several million dollars annually. Research by Government scientists is showing how to prevent these losses. Why isn't that a good investment even in hard times?

A study of methods for preventing such food losses which are due to microorganisms, enzymes, oxidation, heat, light and such causes, is an important project of the Department of Agriculture. This research does nothing to step up production. It simply saves the produce already fabricated. Methods have already been discovered of preventing the destructive action of sunlight by the use of proper colored wrappers, and of preventing the objectionable darkening of sliced fruits and vegetables by the use of materials less harmful potentially than sulfur dioxide.

Furthermore, farmers all produce culls and waste that can, by research, be turned into profitable by-products. The cost of production on these materials has already been incurred. Yet useful products can be made from straw, cornstalks, corncobs, hulls, and so forth—illuminating gases, chemicals, adhesives, wallboards, and the like. Research to establish such by-product production on a commercial basis well repays the initial cost and is justifiable under any agricultural program.

Research also widens markets, as when a new fire-proofing process is applied to cotton cloth and the use of this fiber is extended to the making of awnings in cities where fire regulations formerly forbade their use.

Government research on fertilizers has been of simply stupendous financial benefit to a country which then wanted to kill these geese-scientists who layed such golden eggs. There has been a marked and consistent decrease in the price of fertilizing materials, year by year, due directly to research. As a result of this research a profitable domestic nitrogen industry has been established capable of meeting our requirements; a domestic potash industry now protects us against foreign monopolists. The improved production of phosphate and of mixed fertilizers already saves farmers 30 millions annually.



**U. S. Dept. of Agriculture chemist with samples of wine from citrus fruit made by a method developed by the Department chemists, from citrus fruits that were a waste**

The next thing farmers must learn is to use concentrated fertilizers. Agricultural scientists have shown that such fertilizers are quite practicable, whereas the elimination of the nonfertilizing filler from the ordinary commercial mixed fertilizers will save astonishing sums, both in manufacturing and in transportation costs. When this research is completed the agricultural industry can arrange to save many more millions annually.

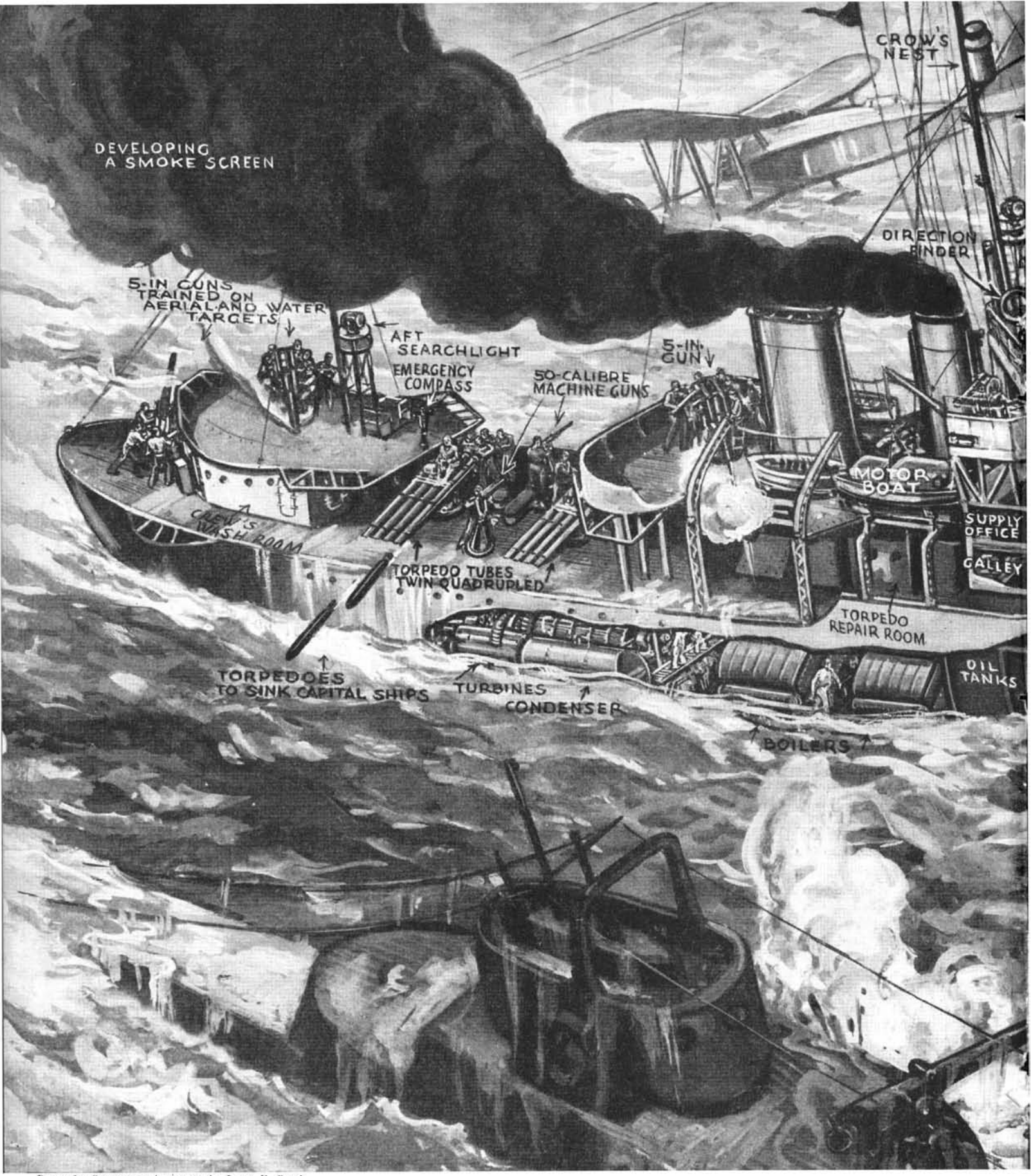
There are many other examples of such research, the results of which do not directly (or often even indirectly) increase production. Such research aims instead to enable workers to produce their allotments with less labor and expense. It also facilitates adjustment to new market and climatic conditions, and enables agriculturalists to follow the lead of manufacturers in catering to consumer preferences with quality goods. Research in other government agencies offers the same sort of aid to industry and manufacturing.

Yet the funds set aside for government research have been sharply curtailed. Dozens of projects have been abandoned or crippled; dozens of positions have not been filled as they were vacated by death, retirement, or resignation. Desperate bureaus in the Department of Agriculture had to call upon emergency funds in order to continue valuable scientific work in progress, and not to take the heavy loss its abandonment would mean. Secretary Wallace has throughout been alive to the necessity for the continuance of research, but he has fought against great odds.

A SPECIAL committee of distinguished scientists recently studied the Bureau of Standards and reported an actual reduction of 70 percent in the funds for the support of authorized work there. Appropriations for the Bureau had been reduced to 2,056,000 dollars, of which only 1,336,000 dollars could be spent (the remainder being impounded by the Treasury), in 1934. Since the Bureau has certain fixed functions to perform, this meant a 70 percent cut in research funds. Between 200 and 300 valuable scientists had to be dropped; the Bureau was found undermanned with younger men because no new appointments could be made.

It is absurd and ironical, as resolutions from numerous scientific societies urging increased appropriations for government research attest. One group of distinguished scientists, with the support of the National Research Council and members of various technical bodies, and headed by Dr. Karl T. Compton of Massachusetts Institute of Technology, drew up a recovery program of scientific progress. The program was presented to the Public Works Administrator. Scientific research, under the supervision of the National Research Council, was to be used as a rich creative and reconstructive force of unlimited potentialities—all on the small sum of 16,000,000 dollars to be spent over six years in the employment of idle technicians. But the National Industrial Recovery Act gave no authority for the expenditure of funds on research.

Something should be done. Mere reduction of government research funds can not solve the federal financial problem. It can do irremediable damage to agriculture, manufacturing, and the general public. It is specious doctrine to advise firing the scientists, for they do much more than make their keep and they do good rather than harm. Those who gave this fallacious advice were as misguided as my old bosses in industry.

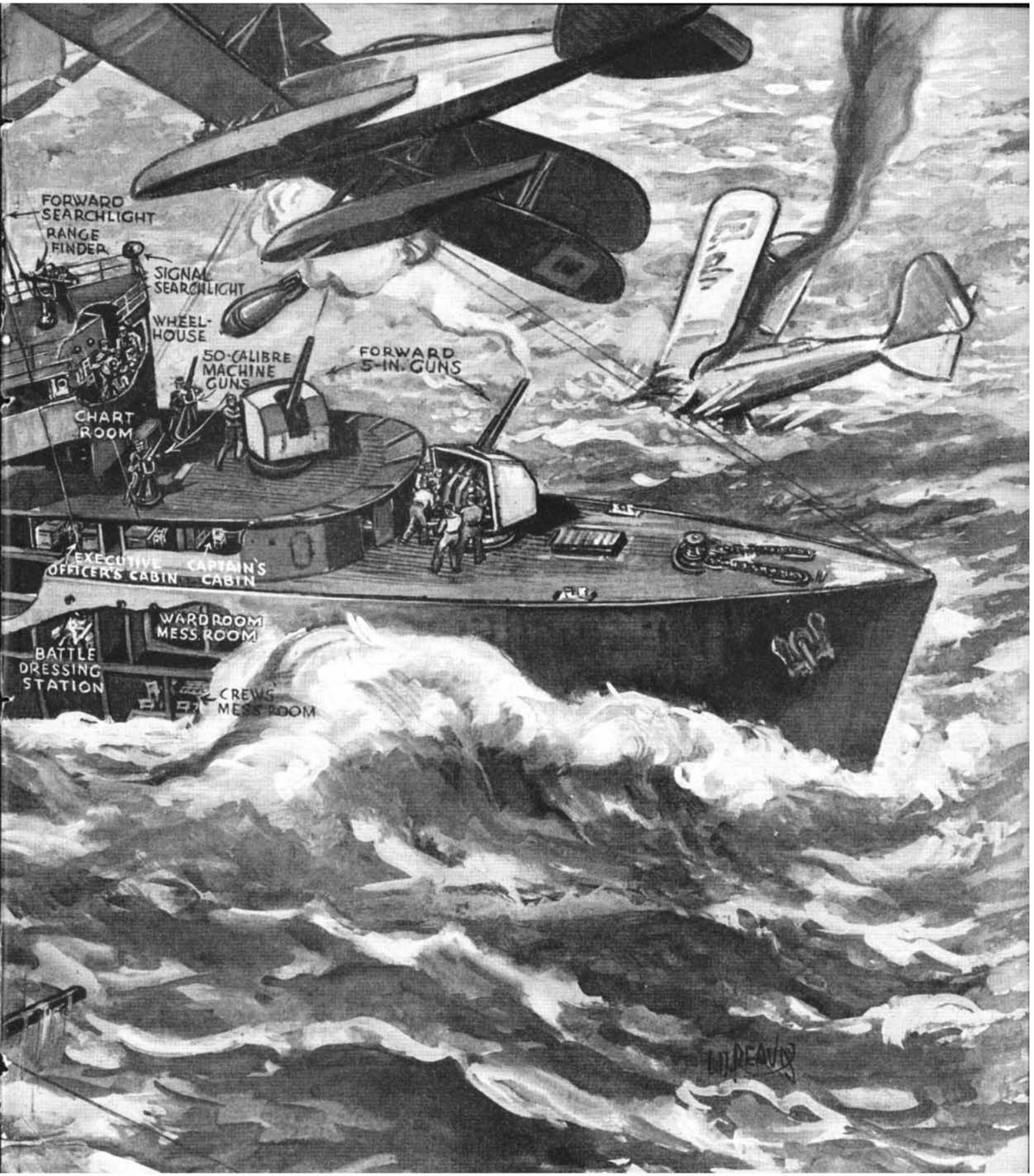



Drawn for SCIENTIFIC AMERICAN by Logan U. Reavis

# The Last Word in Amer

THE World War spawned a large number of hastily designed American destroyers to meet the submarine menace, but it has taken something like 19 years to obtain appropriations and construct the new *Dewey* type of destroyers, the essential features of which are shown in the drawing above. They were conceived originally in 1916 and only this year have we been able to put several in the water and several others on the ways under construction. They are the first destroyers built by us since 1920-21.

With a displacement of 1500 tons, they approach the British flotilla leader class—the 1540-ton *Codrington*, and the 1530-ton *Bruce*—each mounting five-inch guns. Published figures give the *Dewey* class a length of 341.6 feet—exceeding the old *Winslow* and later the *Mahan* types of destroyers—and a beam of 34.2 feet. For the first time in American destroyer design, airplanes are recognized as a serious menace: The five-inch dual-purpose guns are able to fire vertically as well as horizontally. These are the so-called "mystery" guns. This class possesses eight 21-inch torpedo tubes concentrated into two quadruple mounts. The four machine guns add to the defensive qualities of the vessel against airplanes or surface craft at close quarters. The *Dewey* class



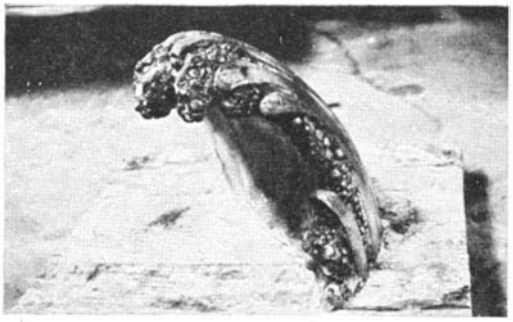

# ican Naval Construction

is said to be capable of 35 knots or better and is credited with a cruising range of 6000 miles, a fact of primary importance.

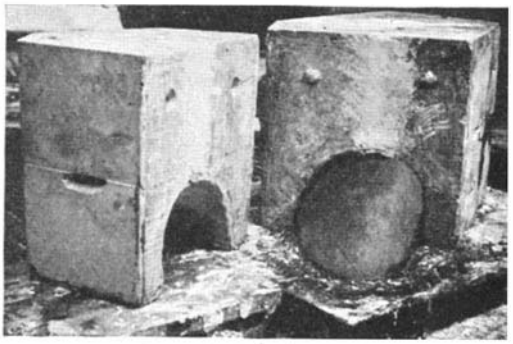
The Navy takes pride in the so-called mystery five-inch guns. Especially designed and constructed, these guns are reputed to have an extreme range in excess of older models. It will be noticed that blast shields, a feature to be found in several British and French destroyers, have been incorporated in this type. These shields project over the forward gun to protect its crew against the blast of the gun on the deck immediately above. A similar shield projects over the last gun in the stern.

In designing these vessels, special pains were taken to insure comfort for officers and crew, a notable example being in the separation of the crew's mess room from the sleeping quarters. In speed, armaments, and fighting qualities generally, these new destroyers have aptly been called "pocket cruisers." They are quite seaworthy, as was shown in the recent naval maneuvers in the Pacific; they shipped no water in rather heavy seas.

For purposes of illustration, the drawing brings a submarine and an attacking plane closer than advisable combat range—poetic license, so to speak.

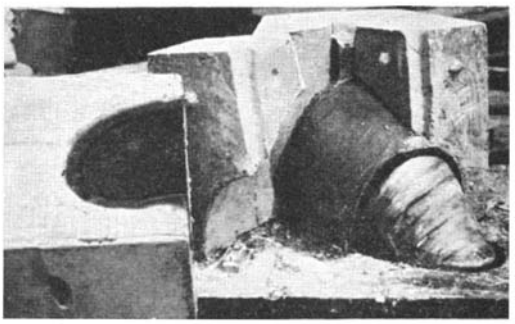


*First Step.* **Full-size plaster model**

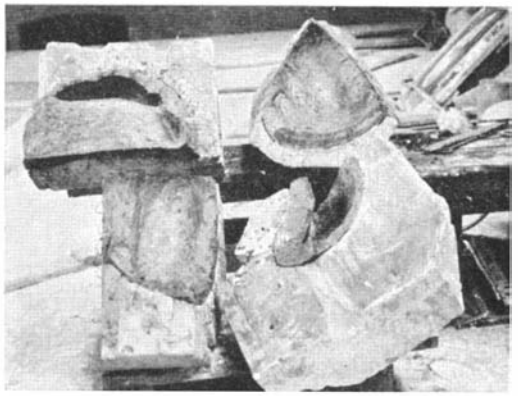


*Second Step.* **Plaster mold**

*Third Step.* **Stripping off the clay**



*Fourth Step.* **Mold, glue, and model**



*Fifth Step.* **Sections of glue-lined mold**

Courtesy Aluminum Company of America

**The Navy and Marine Memorial, largest aluminum monument in the world, in which many of the pieces were cast by the lost wax process**

# LOST WAX CASTING

## Used by Cellini and Before . . . Finest Work Possible . . . How It Is Done

IN casting the Navy and Marine Memorial, largest aluminum monument in the world, many of the pieces in the group were made by the "lost wax" casting process. While this process in general is old, its exact time of origin being unknown, it is still used with modern refinements for executing the most artistic and the most difficult types of sculpture, and by means of it the finest possible results may be obtained.

To Benvenuto Cellini, that roistering, swaggering, philandering spirit of the Renaissance, who was as much at home with the rapier as with the scalpel, art owes the revival of this ancient casting method. Many believed Cellini to be its originator, but a study of the earliest specimens of casting shows that it was actually in use long before even the art of making castings by the ordinary sand mold method was known.

In writing of Cellini's finest bronze, cast by the lost wax process, Royal Cortissoz says in an introduction to "The Life of Benvenuto Cellini": "It has something of a fascination, a *bravura* brilliancy, a sharpness of technical precision, which the work of . . . elder masters wants. Far above Gian Bologna's academical group of two naked men and a naked woman, above the blatant incapacity of Bandinelli and the dull pomposity of Ammanati, the Perseus soars into the region of authentic, if not pure and sublime, inspiration." This Perseus now stands in the Loggia de' Lanzi, fronting on the great piazza of Florence.

In the case of the Navy and Marine Memorial, the simpler parts of the monument were cast in plaster molds taken directly from the model. The more intricate pieces, however, and those which had undercuts too difficult to cast by ordinary methods, were made by the lost wax process. Very briefly described, the process is as follows: A gelatin mold of water-soluble glue is made from the original model. The surface of the glue is coated with a thin wax shell, which is backed up with a plaster core. Then a plaster of Paris mold is made of this wax-faced core. The mold and core are then baked slowly, at which time the wax melts and runs out of several gates at the bottom. This leaves a cavity into which the casting metal may be poured. The wax which flows out of the gates is "lost," from which the process gets the name by which it is known.

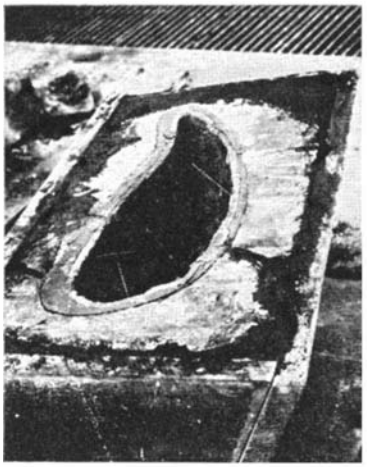
THE details of the actual commercial process can best be grasped by reference to the accompanying photographs and the following description. After a full-size plaster model of the final figure is made, the first step is to cover it

with clay to produce definite parting lines. Around this model is placed a mold form and a plaster mold is poured. In the second step the plaster mold is split and removed from the model. At this point the clay remains on the model surface and is carefully stripped off as the third general step in the procedure. In the fourth step the plaster mold is reassembled around the model and the cavity which was formed by the clay is filled with glue. Water-soluble glue is used because of its elasticity and its ability to follow all the intricacies of the model, thus making a perfect "negative" and producing an exact replica of the original in reverse.

The model and mold, in the fifth step, are again taken apart after the glue has set. To make doubly sure that nothing will go wrong, the sections of glue are held in place with small wire clamps. At this time the face of the glue is coated with fluid wax of sufficient thickness to correspond with the desired thickness of the metal in the finished casting. The sixth step consists of re-assembling the plaster mold with its glue and wax shells. As shown in the photograph of this step, rods are set in place to support the core, which is poured in completion of the seventh step. At this point the wax coating becomes transferred from the glue surface to the new core, and the form with its glue facing is removed from the core and discarded.

THE wax-coated core is now suspended in a suitable wooden form by means of wires which are later removed. Around the core is poured wet plaster, and suitable provisions are made for pouring sprues, gates, and risers, so that the poured metal may reach every point of the figure as soon as possible. This constitutes the eighth general step in the process, and completes the drag or lower section of the mold in which the metal will later be poured.

The whole mold is now ready for baking and drying, which is carried on at carefully regulated temperatures in the neighborhood of 500 degrees, Fahrenheit. At this temperature the wax melts and runs out through openings provided. A modern refinement in this process is the installation of thermocouples in the plaster in order to determine the exact temperatures at all times and thus remove the risk of cracking the plaster. The dried and baked upper and lower sections of the mold are shown in the photograph illustrating the ninth step.



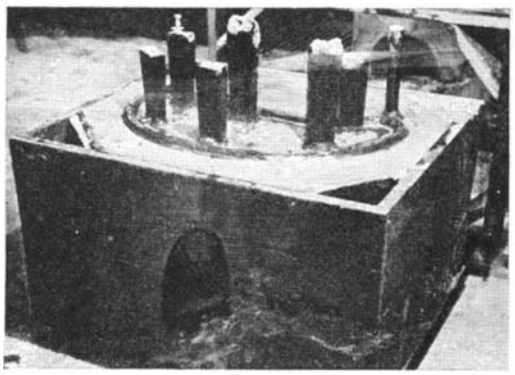
***Sixth Step.*** **Plaster mold with glue and wax shells re-assembled for making the plaster core**

The mold is now made ready for the molten metal, the tenth step in the process, by providing proper supports as shown. The metal, at exactly the proper temperature, is poured into the mold and forced into every crevice by gravity. After the metal is cast, it is allowed to cool, whereupon the mold is broken open and the finished casting removed. The casting as it comes from the mold is shown in the photograph of the eleventh step. Artists are now set to work chasing the surface, cutting away useless agglomerations of metal, pointing up flat surfaces, sharpening corners, and giving the whole piece a feeling of crispness.

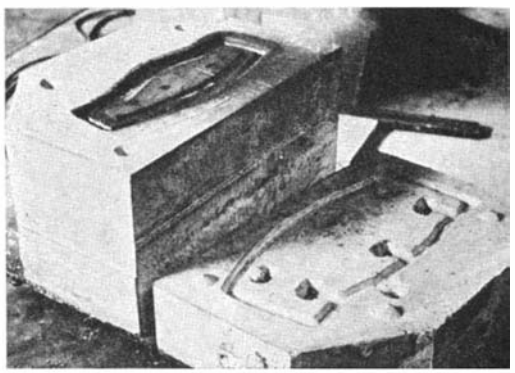
The surfaces of the finished aluminum castings for the Navy and Marine Memorial were finished by the Alumilite process to produce an oxide coating many times thicker and more resistant to weather than the natural oxide coating which is produced when aluminum comes in contact with the air. This oxide coating is impregnated with metallic pigments giving the statue the desired colors, ranging from varying shades of green in the waves of the Memorial to a golden yellow that approximates the color of sunlight.

IN producing the Alumilite finish, which can be obtained only on aluminum, the castings are subjected to various types of buffing, burnishing, polishing, and brushing, to lend character to the surface texture. Then the prepared metal is immersed in a special sulfuric acid bath and a current passed through the electrolyte. The piece to be coated is used as the anode, while the lead-lined tank containing the electrolyte acts as the cathode. The process is frequently referred to as the anodic oxide process.

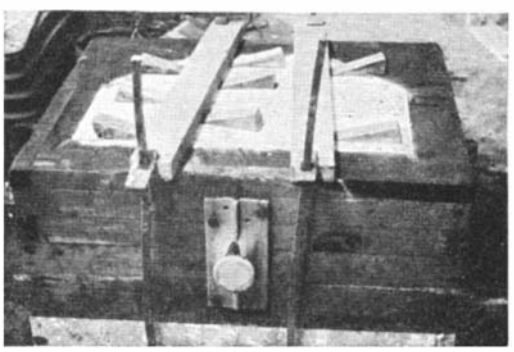
***Seventh Step.*** **Plaster core with wax facing**



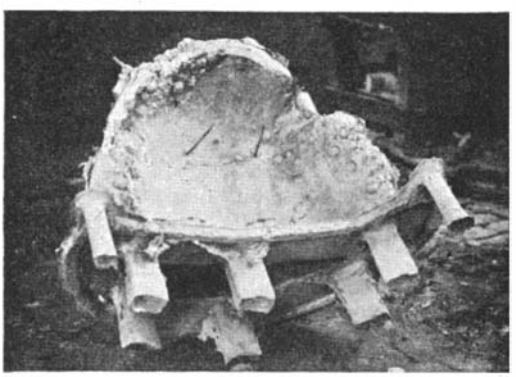
***Eighth Step.*** **The drag half of the mold**



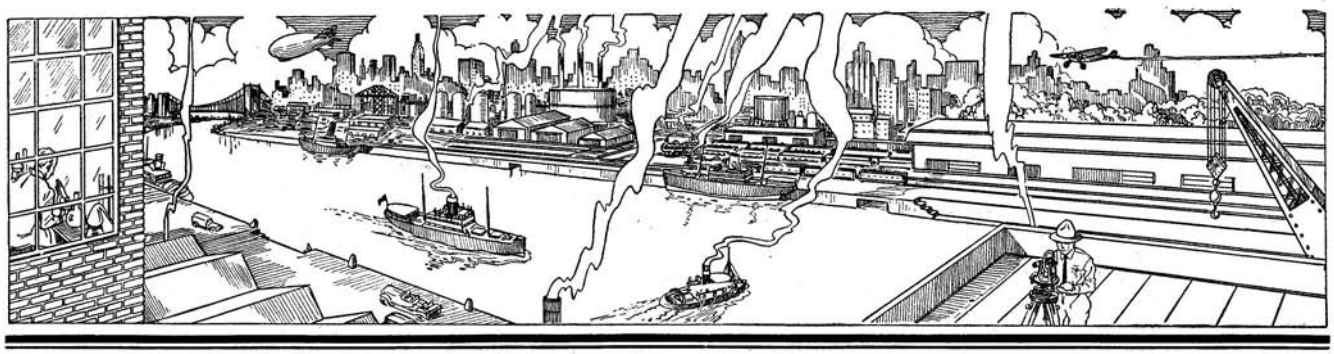
***Ninth Step.*** **Drying cope and drag sections**



***Tenth Step.*** **Mold ready for the metal**



***Eleventh Step.*** **Casting ready for finishing**



# THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH



## An Ancient Egyptian Sundial

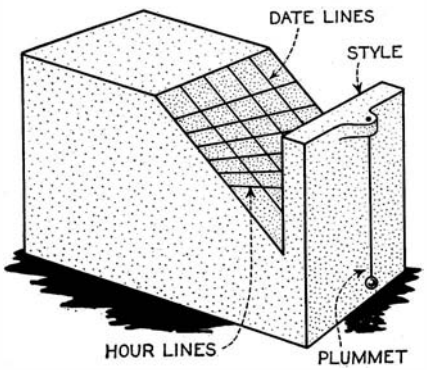
IN ancient Egypt the methods of telling the time were by klepsydras or water clocks—water running at a controlled rate out of a small opening—by instruments for observing the stars, and by sundials. Sundials were of three varieties, which measured respectively the height of the shadow, its length, and its direction. The fragment of a sundial shown in an accompanying photograph is in the Metropolitan Museum of

**Fragment of an Egyptian sundial**

Art, New York, and belongs to the second of these varieties. The sketch is made from one furnished by the Mayalls, authors of a recent series of articles on sundials, published in this magazine, from a written description in the *Bulletin of the Metropolitan Museum of Art*. The height of the fragment is $3\frac{11}{16}$ inches and it is made of marble.

"The gnomon was a perpendicular block rising at the foot of the sloping face, its height and width being the same as those of the latter," Nora E. Scott writes in the *Bulletin*. "On one side was an arrangement whereby a plummet could be hung so as to swing free of the base. The instrument was put down on a flat surface, and whenever it was to be used, was turned so that it faced the sun directly. The shadow of the gnomon then fell upon the face. The spaces marked off by the lines running from top to bottom of the face showed where the shadow was to be read during the different months of the year, starting with the summer solstice at one edge and turning back again with the winter solstice on the other. The oblique lines are for the hours. At six in the morning the shadow would strike the top of the dial; as the sun rose higher the shadow would decrease in length until at noon it touched the lowest line; it reached the top of the dial again at six in the evening.

"An inscription once ran completely around the base of our dial. With the exception of a probable pun (the word used for 'life' can also mean 'time') nothing is said of the dial itself. The text is a prayer




**Drawing showing how the Egyptian sundial appeared. Such a dial should be simple to construct**

that various gods should grant to the scribe Pa-si-Geb, son of Tehuty-kay, prosperity and health, a long life, and a good and beautiful old age."

## Water Softener

SODIUM hexametaphosphate has been found to possess properties that make it a useful adjunct to soap when washing with "hard" water. B. H. Gilmore, of the Mellon Institute of Industrial Research, has conducted an extended investigation of the rôle of this salt in sequestering calcium and magnesium ions as they affect detergent operations in which soap is used or formed. By removing these ions from solution without precipitation, the curdling effect of hard water upon soap is completely inhibited, and all of the soap used in washing operations is held in solution to exercise its full detergent effect. Sodium hexametaphosphate is recommended for use in laundering, in mechanical dishwashing, for cleaning the foliage of evergreen shrubbery, as a veterinary wash for the removal of medication, and for pet-washing in general.—*A. E. B.*

## Laboratory Tests for Rugs

IN the manufacture of rugs, modern science has contributed largely to the production of floor coverings that will give the best service under trying conditions. In no small measure has this been made possible by the application of laboratory tests to the materials and dyes used, as well as to the finished product. For example, in one rug factory, a constant check is kept on the colors of dyes used, and when a new shade is being sought, dyed

Courtesy Alexander Smith

**How long will a rug wear?**

samples of yarn are exposed to the action of ultra-violet light for varying lengths of time. Thus the "sun-fast" quality of the dye is determined.

For testing rugs for resistance to wear, the ingenious machine illustrated in these columns is used. A sample of the rug to be tested is placed on a rotating table and against its surface are pressed two large leather-surfaced wheels, turning in op-

posite directions. This action simulates conditions to which the rug will be subjected in use, but on a much more rapid scale. At intervals during the test, instruments measure the amount of wear that has been incurred. Comparison of records will show whether or not the materials used are up to the desired standard.

### PINE PAPER

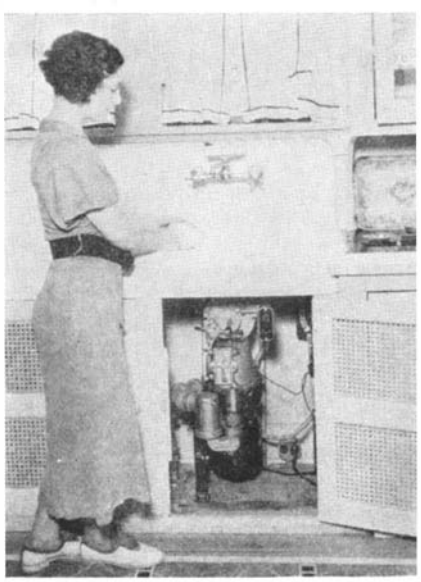
**SOMETHING like 70,000 cords of slash pine will be used yearly in a new 4,000,000-dollar paper plant in the South, which will make its paper by the process developed by Dr. Charles H. Herty, discussed in these pages last year. Its daily output will be about 120 tons of pulp for kraft paper and bags.**

## HOME GARBAGE GRINDER

LARGELY through the work of scientists and engineers, the time-honored ash can is being eliminated from American homes, and now the same combination has started a drive against the garbage can. An electrical device to be installed beneath the kitchen sink for the purpose of grinding the waste food and quickly disposing of it through the drain pipe into the sewer system has been developed by engineers of the General Electric Company.

Driven by a ¼-horsepower electric motor, which takes current from the ordinary 110-volt house circuit, the grinder will shred all types of waste food, including bones and other hard substances except bottles and cans. Reduced to a fine pulp, this is flushed by water into the sewer and carried away as part of the sewage stream.

The water used in the grinding and flushing process is almost negligible. It has been estimated by engineers of the General Electric Company that in any normal community the increase in the use of water because of this device will amount to but 1 percent. In the average family the grinder will operate not more than five minutes a day, and its average cost of operation per month will be about one half that required for operating an electric clock.



**The home garbage grinder in use**

Operation of the grinder is simple. Directly beneath the sink is a convenient projecting handle by which the hopper of the grinder is closed and the motor is started. It is sealed against leakage and the grinding knives are made of Carboloy, a metal next to a diamond in hardness. The unit weighs about 75 pounds and can be installed under any style of sink as a part of the outlet plumbing. When not in use the hopper inlet is covered by a perforated cap, leaving the sink bottom flush and in condition for ordinary use.

# PROGRESS In This Age Of Science

### As Told to SCIENTIFIC AMERICAN

**By WILLIAM S. SHIPLEY**
President, York Ice Machinery Corporation

**AIR CONDITIONING has been termed an "infant" industry, by reason of the fact, no doubt, that according to the calendar it can count its birthdays at not many more than 25. Within the past 10 years, however, the conditioning of air has progressed to the point where it must be recognized as an exact science. In the brief span of a single decade, air conditioning has revolutionized many industries. It is, in fact, an industry in itself today, which affects and benefits countless industries. The story of the development of air conditioning in its widespread industrial and commercial applications is a record of constant improvement, of continuous refinement in equipment, of constant striving toward the goal of perfection in equipment and reliability in operation. Today, the list of industries in which air conditioning finds new and profitable applications is steadily widening.**

**It was early in 1914 that certain far-sighted motion picture men realized that the true destiny of air conditioning lay not only in its far-reaching industrial achievements of that time, but more in the protection of human health and the assurance of human comfort. Others, quick to see the value of its application to human comfort, carried this new idea into other fields, with the result that today we find air conditioning on our railroads, in office buildings, homes, hotels, restaurants, hospitals, and even far down beneath the earth's surface, in gold mines. Railroads, theaters, and retail stores have found a new lease of life, with definite evidence of growth which can be traced directly to the benign influence of conditioned air. Wherever men and women work, play, eat, sleep, travel, or congregate, air conditioning plays a part in their comfort, and in the protection of their health. And in the rapidly increasing range of comfort applications many men are finding employment, not only in the building of air conditioning equipment, and the installation of that equipment, but in the field of scientific research, striving always toward the goal of a wider and more general application of this so-called "infant industry." In carrying out the feature of human comfort to its ultimate conclusion, the possibilities of air conditioning are tremendous.**

## FEVER TREATMENT FOR BLINDNESS

ARTIFICIAL fever treatment is proving to be a new weapon in the war on blindness and is expected to be a means of preventing one of the commonest forms of this affliction. Patients whose vision was restored by this treatment combined with drugs were reported by Drs. Arthur M. Culler and Walter M. Simpson of Miami Valley Hospital, Dayton, Ohio, to the American and Canadian medical associations.

The patients had become blind because of syphilitic infection. This disease causes from 10 to 15 percent of all blindness, Dr. Culler said. In some cases, improvement began after one or two treatments and the patients recovered useful vision. In cases in which atrophy or other permanent damage had occurred, the fever treatment did not appear to help any more than other forms of treatment. As most of the 58 patients had failed to respond to other forms of treatment the results were considered satisfactory.

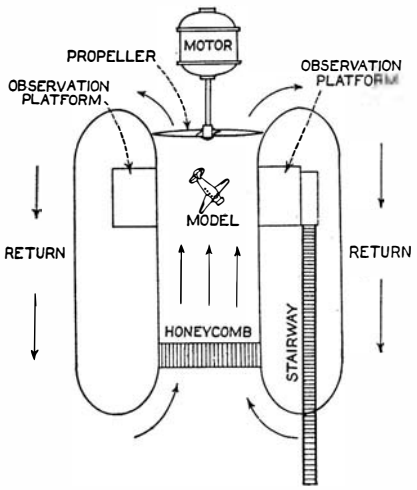
Importance of beginning fever treatment in the early stages of syphilis in order to prevent blindness was emphasized by Dr. Culler. The artificial fever treatment has already been found useful in the mental disease which results from syphilitic infection, it was pointed out.

The patients in the series reported were given 10 treatments of five hours each with temperatures above 105 degrees, Fahrenheit. Skill in the use of artificial fever has progressed to the point where most patients do not need to remain in the hospital. When the five-hour period of fever is over, streams

of cool air bring the temperature down within 30 or 40 minutes. By using new air-conditioned fever cabinets, temperature and humidity are so controlled that no serious effects are suffered.—*Science Service.*

## A Free Spinning Tunnel

VISITORS to the recent Langley Field conference were particularly impressed by the installation of a free spinning tunnel, patterned after a similar tunnel at Farnborough, England. As shown in our sketch, the tunnel is vertical and of the double return type. Its working portion is a cylinder 15 feet in diameter, and 27 feet high. The air, drawn upward by an electrically




**Vertical free spinning wind tunnel**

driven propeller, returns through a circular screen at the lower end of the cylinder, and its speed can be varied between 15 and 50 feet per second. At the top of the cylinder, an observation platform is built around the tube, to which approach is made by a staircase in the return section. Models are very carefully constructed of balsa wood, with a span of 2½ to 3 feet, and are ballasted to give the same moment of inertia distribution as in the full scale machine. These models are equipped with clockwork mechanisms which can be made to actuate the rudder or elevator or both through varying angular displacements, after varying periods of time, and with different rates of displacement.

The technique of experimentation is very simple. The model is pivoted at its center of gravity on a spindle attached at the end of a long pole, which is inserted into the tunnel, and is exposed to the upward air flow. Under the action of a displaced rudder, the model assumes a certain rate of spin. When the upward air speed has attained a sufficiently high value, the model rises from its spindle in a spinning attitude and remains hovering in the air flow, while the pole is withdrawn. The vertical velocity of the air now represents the rate of descent in a spinning nose dive. The model continues to spin about the axis of the vertical wind tunnel and does so with remarkable regularity. All the conditions of a spinning nose dive are thus accurately represented. When the rudder or elevator is displaced by the clockwork mechanism, the model, if it recovers from the spin, goes into an ordinary nose dive, its rate of vertical descent becomes higher and it drops instead of continuing to hover, and is caught in a netting below the experimental section.

For a designer this is a vital experiment. If his model recovers from the spin and drops into the netting, his painful efforts are successful at least as far as spinning characteristics go. If the movement of the rudder does not check the spin, he has to try again.

While the new method is more qualitative than quantitative, it will be of great value. It is far more logical to make an experiment in a free spinning tunnel than to ask a test pilot to spin the full size machine a number of times, and see if he can come out of the maneuver. Many a pilot has been killed when his machine refused to come out of a spin and his parachute did not function or became entangled under the difficult conditions presented to him. —*A. K.*

### AN AIRPLANE'S LIFE

**WE think of airplanes as ageing even more quickly than automobiles, yet the Bureau of Air Commerce, Department of Commerce, says that the useful life of an airplane frequently exceeds five years. As many as 169 civilian airplanes now in service in this country were built in 1926 or before.**

## Cost of Aviation Insurance

IT is generally believed that insurance is one of the reasons for the relatively high cost of private flying, and it is gratifying to learn from Jerome Lederer, Chief Engineer of Aero Insurance Underwriters, that aviation insurance rates have declined and that aviation insurance is far from being the most expensive protection which can be bought. The comparative figures that follow are convincing in this regard:

*Fire* on buildings of combustible materials, 4 to 5 percent. On airplanes the rate is only 3 to 3½ percent.

*Windstorm and theft.* On automobiles the rates range from 2½ to 6½ percent. On airplanes the average rate is 1 percent.

*Crash and Collision.* For automobiles rates range from 2 to 24 percent, depending on the city. For airplanes, rates throughout the country run from 10 to 18 percent.

*Liability and Property Damage.* For taxicabs, combined protection costs about 623 dollars. For airplanes, the two items are covered by about 377 dollars.

The aviation insurance rates were very much higher in 1926—in fact, prohibitively high. Since insurance rates are a reflection of the best opinion as to airplane safety, this decrease in costs and this favorable comparison with other forms of insurance are very satisfactory.—*A. K.*

## An Anti-Torque Propeller Drive

THERE are three difficulties inherent in the transmission of the engine torque or turning moment to the propeller. The torque has to be resisted by the airplane, so that the wing tips on one side must be given more incidence and lift than on the other; this means a delicate process of "rigging" the airplane. The difference in lift of the wing tips also means a difference in drag, and hence the vertical fin has to be offset to counteract the turning tendency thus introduced. If the fin is correctly offset to trim the ship with power on, then it is *not* correctly trimmed for power off—and it is evidently undesirable to have the ship at one time in trim, at another time out of trim. Finally the impulses of the motor are not uniform, and hence the torque of the engine transmitted to the airplane sets up vibration or flutter.

These difficulties are particularly serious where the airplane carries a very powerful engine in proportion to its size and weight. In the Schneider Cup Races, the only way to take up the engine torque was to place one float of the seaplane further away from the center than the other, and to put all the fuel in one float. On a land plane this is impossible, and with very fast racing planes it is hazardous to give full power on the ground because of the tendency of the plane to tip or roll.

Charles L. Brown, an oil jobber of Missouri, belongs to that typically American class of practical men, who, without lengthy technical studies, construct and experiment and invent by the aid of native ability.

He has devised an engine in which these difficulties are removed, has installed it in his own home-made airplane, and flown the combination successfully.

Mr. Brown employs an air-cooled engine of conventional design, in which the crankshaft drives a right-hand propeller in the usual fashion. But the engine itself is mounted in a hollow steel housing, which is mounted on two ball bearings and is free to

**How the engine and two propellers are arranged for anti-torque drive**

revolve. The engine rotates in the opposite direction to the front propeller, and with its casing two rear propeller blades, of opposite pitch, revolve in a contrary direction to the front airscrew.

The engine, the oppositely rotating propellers, and Mr. Brown's small plane are shown in our photograph. Difficulties of fuel supply and lubrication have been met —they were no more difficult than those offered by the rotary engines which were so widely employed before and in the early stages of the World War.

It can be readily seen that with this arrangement, the power of the engine is

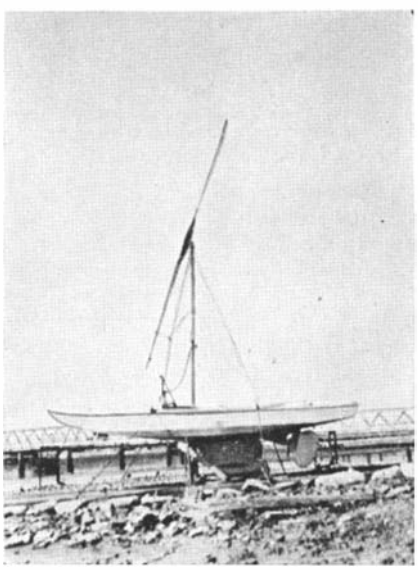
divided between the two propellers and the torque effects neutralize one another.

Some sacrifices have to be made, of course. Thus a four-bladed propeller or a combination of two two-bladed propellers is apt to be slightly less efficient than a straight two-bladed airscrew. Also, the rotating engine offers some mechanical difficulties of its own. But in addition to the advantages cited above the following has to be taken into account: The arrangement works as the equivalent of a gearing down of propeller speed, without the use of gears. Thus the engine may be firing 2000 times a minute, giving the equivalent of 4000 revolutions per minute in the conventional motor, yet the two airscrews will only be turning at 2000 revolutions per minute. The advantages of gearing down the propellers are, of course, well known to our readers. —*A. K.*

## The Gyroplane Sailboat

THE Wilford gyroplane boat, which has already been briefly described in our columns, has now given definite proof of splendid maneuverability, ease in handling, and real speed. The rotor is 20 feet in diameter and the chord of the two blades is 15 inches. The blades are constructed of heat treated steel spars with dural ribs and cloth covering, the construction being analogous to that of an airplane wing. The blades weigh about 15 pounds each; the rotor hub about 30; the mast and rigging approximately 80 pounds; making the total weight of rigging from 140 to 150 pounds. The ordinary sail rigging of the Star boat which has 280 clear feet of sail area is about ½ pound per square foot; therefore, the weight of the gyroplane rigging is substantially the same as that of the ordinary sail.

As can be seen from the photographs, the two-bladed gyroplane rotor is mounted at an inclination of about 17 degrees to the vertical mast. At the top of the mast and at the center of the rotor there is an axle about which the rotor is free to rotate. The axle is rigidly mounted to the top of the mast in a thrust bearing. The mast supporting the rotor is braced by wires attached to the thrust bearing in such fashion that the mast is free to rotate at the bottom.

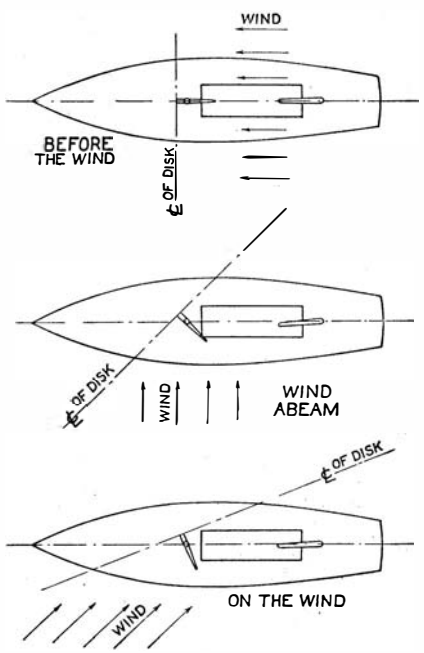


**The gyroplane sailboat under construction. Note rotor-blade angle**

**The mast of the gyroplane sailboat is rotated by a simple control**

The mast is also mounted on another thrust bearing at the deck level. This mast can be moved by a handle and fastened in steps provided at every six degrees of rotation.

The rotor, just like an airfoil or sail, has elements of lift and drag, the lift acting at right angles to the resultant wind which is composed of the forward motion of the boat and the direction and magnitude of the natural wind. The various positions of




**Angle of the gyroplane rotor is changed to meet wind conditions**

the rotor sailing at various angles to the wind are shown in the three sketches.

When coming to a dock the brake is put on and the boat slides in without flapping of sails or bouncing of booms which is customary to yachts worked with sails. Operation with the rotor is much easier than with sails because there is no need of pulling up ropes or of putting up and furling sails.

Tilting the rotor out at the bottom gives clearance for staying the mast in all directions, keeps the rotor disk far away from the cockpit, and eliminates the hazard of occupants being struck by the rotor.

We have often had occasion to explain the action of the Wilford gyroplane rotor, but it may not be out of place to reiterate very briefly the fundamentals of autorotation involved.

It must be assumed that a certain small velocity of air passes through the rotor disk, and that the blades are rotating with sufficient velocity so that the resultant angle of incidence is below the stalling angle of the blades. Under those conditions the lift acts at right angles to the resultant air and the drag with a good section is so small that the resultant air force lies slightly in advance of the axis of rotation. As long as this force lies in advance of the axis of rotation, the rotor will keep on autorotating and its autorotation speed will be limited by the reduction of the angle of incidence to a point where this resultant lies on top of the axis of rotation.—*A. K.*

## A Plea for Compression-Ignition Engines

IN a scholarly paper read before the Society of Automotive Engineers by Kenneth A. Browne, on the subject of compression-ignition engines, there is much food for thought on the future of these power plants.

It is sometimes stated that fuel economy in airline operation is unimportant. Reliable statistics for the year 1934 tell a different story:

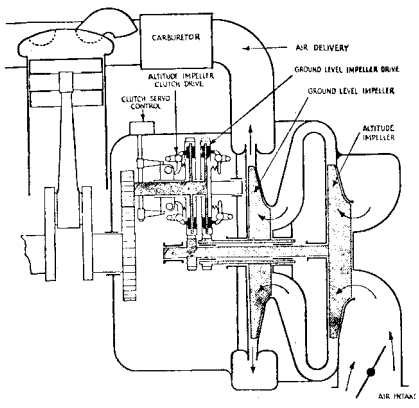
| | |
|---|---|
| Number of Passengers | 537,637 |
| Miles Flown | 42,622,619 |
| Gasoline Used, Gallons | 21,991,782 |

The average number of miles per gallon is thus 1.94. Passenger miles per gallon are given as 7.23. Figuring fuel costs at 11 cents per gallon means that fuel costs are 1.52 cents per passenger mile. The average airline fare in the United States is six cents a mile.

Thus the fuel cost is 25 percent of the passenger revenue. There is no doubt that increase in engine efficiency and the use of a cheaper fuel would help transport lines considerably.

In transatlantic operation, saving in fuel would be even more important. At present, non-stop operation of the large flying boats would be possible only with an insignificant pay load. There would be an immediate change in the situation if fuel consumption were cut down on the long over-water flights.

Now greater fuel economy than that of




**Diagrammatic view of the two-stage supercharger as used by Wiley Post**

the gasoline engine has already been obtained with the Junkers Aircraft Diesel engine, the Jumo, and with experimental examples (in the form of single-cylinder engines) of compression-ignition engines. In the compression-ignition engine only air is compressed in the cylinder, the fuel being injected just a little before the end of the compression stroke. The fuel mixture ignites itself, and the fuel injection equipment is simpler and at least as reliable as the combined ignition and carburetion equipment of the gasoline engine. Detonation or knock need not to be feared at much higher compression ratios than in the gasoline engine, and this makes for efficiency and eliminates the use of special high-octane rating, expensive gasolines.

Why, then, is the use of the compression-ignition engine lagging behind?

First, because reliable pumps for high-speed fuel injection have become available only quite recently. Second, because so much development work and investment have gone into the aircraft gasoline engine that there is a natural hesitation to switch to another type of prime mover. Third, because the compression-ignition engine requires much more excess air for efficient operation, and this means that for the same power the cylinders are larger and the over-all weight higher than for the gasoline engine. And the airplane designer seeks light weight above all things.

There is a way of making the compression-ignition engine lighter. Since this type aspirates and compresses air only, it lends itself admirably to the two-cycle principle —whereas in the gasoline-carbureter engine the two-cycle principle is accompanied with much waste of fuel. With compression-ignition, the fuel is injected *after* the scavenging is completed, and the waste of new gas is eliminated. With two-cycle operation, there is a power stroke every revolution, and hence more specific power for a given size and weight of the motor.

Mr. Browne is quite right, therefore, in advocating intensive development of the two-cycle, compression-ignition engine. Here is his list of specifications which many inventors, engineers, and operators will study with interest:

1. Two-cycle operation.
2. Adaptability of design up to 1500 horsepower. (For transatlantic work in particular there is a crying need for a large engine.)
3. Fuel consumption at cruising speed of only .35 pounds per horsepower-hour (as compared with .52 pounds for the usual type of aviation gasoline engine).
4. A weight of only 1.5 pounds per horsepower.
5. Air-cooling.
6. Geared-down propeller.
7. Starting to be accomplished without glow plugs.
8. Either individual cylinder injection pumps or dual unit pumps.
9. For major overhauls, an interval of 1000 hours.
10. Minimum engine life of 4000 hours.
11. Engine to be capable of operating on a good grade of bunker or heavy fuel oil.—*A. K.*

## A Two-Stage Supercharger

In describing Wiley Post's altitude flight some months ago, we mentioned that the engine supercharger was in two stages. One supercharger is insufficient for maintaining pressure at very high altitudes; the blade tips in a single stage supercharger would have to revolve so fast to produce the necessary pressure as to be moving at a speed higher than that of sound (750 miles an hour) in which case efficiency and effectiveness would both be lost.

Now, thanks to *Flight* (London), we are able to show a diagram of the jealously guarded design employed in the two-stage supercharger. Apparently this design is due to the French firm of Farman Brothers, and Wiley Post's apparatus was built under license from this firm. Farman Brothers have themselves built such a two-stage supercharger for the Soviet Republic, and it has undergone successful tests, with speeds changed 250 times without reducing the speed of the engine and without sign of wear.

The two blowers are driven through gearing from the rear of the engine, through friction clutches. Operation of the clutches is by means of remote hydraulic control which imposes very little effort on the pilot. The clutch servo controls are placed between the engine drive and the friction clutches. The first supercharger maintains atmospheric pressure and the power of the engine up to an altitude of 6500 feet; the second supercharger keeps up the good work to a height of 16,400 feet. The efficiency is so high—68 percent—that an inter-cooler is no longer necessary. When an altitude of about 13,000 feet is reached both impellers are made to work in series, and engine power is then fully maintained up to the extraordinary height of 29,500 feet. If stratosphere flying is to be attempted in real earnest, the two-stage supercharger will be an important element of success. —*A. K.*

## Airports for Private Flying

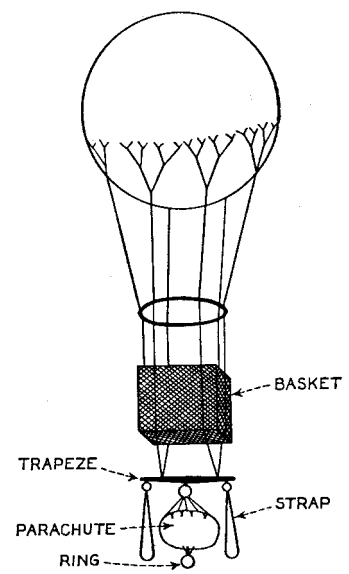
There are very definite reasons why private flying in the United States has progressed less rapidly than scheduled air transport. These are: doubts as to safety; the length of time and formalities required for flight instruction; the restricted number of flying fields; and last but not least, the cost. The Department of Commerce has made rather an ineffectual attempt to reduce cost of private airplanes by announcing a 700-dollar "flivver" airplane; in the matter of safety it has held a design competition and placed experimental orders for airplanes which it hopes will increase the safety and ease of operation.

Now the Department is attacking the airport situation by applying for 58,759,000 dollars from the Work Relief Funds, to be expended on airport improvements throughout the country. Part of this money is to be spent in "the preparation of airports for radio approach landings" in such cities as Newark, Pittsburgh, St. Louis, Kansas City, Indianapolis, Los Angeles, Seattle, and Washington. Other portions will be spent in the standardization and modernization of existing municipal airports, and in the construction of seaplane ramps in large centers.

From the point of view of the advancement of private flying, however, the most promising activity will be in the establishment of new airports in cities of 10,000 population or over, and in air marking on a national scale. The private flier needs more and more easily accessible landing fields, rather than the improvement of the great air transport terminals—however desirable this latter activity may be.—*A. K.*

## A Record for Low Parachute Jumps

The record low jump of 164 feet with a parachute is held by M. Réné Courtin, the French parachutist. M. Courtin uses a "flying trapeze" suspended below the basket




**The equipment used in setting new record for low parachute jumps**

of a balloon. He hangs on by two straps, with the parachute so arranged as to open almost instantaneously when he lets go. The diagram illustrates the method in schematic fashion.—*A. K.*

## Self-Heating Food

Canned food which heats itself when the can is opened is being used by Pan American Airways, according to *Food Industries*. Because of long-distance airplane flights, there has arisen a demand for food that can be eaten hot en route without operating a stove. This demand has been ingeniously met by the manufacture of self-heating canned food.

There is no magic about the heating

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process. The can of food is encased in a second can which has one compartment containing unslaked lime and another filled with water. To heat the food, the chef merely turns the package upside down and punches holes through the lime and water compartments so that the water runs into the lime. Chemical action does the rest. There apparently is some porous filler material in the lime to retard and distribute the reaction, because it takes about half an hour for the food to heat.—*A. E. B.*

## New Vitamin, Choline

A NEW vitamin which is essential for liver function, and which may play an important rôle in controlling diabetes, has been described by one of its discoverers, Dr. C. H. Best of Toronto, co-discoverer of insulin, the life-saving remedy for diabetes. The new vitamin has a real name, choline, instead of a letter as do most other members of the vitamin family. It is found in many foods, but the best sources are meat, egg yolk, and yeast.

Dr. M. Hershey and Miss M. E. Huntsman, of the University of Toronto, were responsible for many of the fundamental observations that led up to the discovery of the significance of choline.

Lack of this vitamin causes the serious condition of fatty liver, Dr. Best said. When the liver becomes fatty, it fails to make sugar or handle bile or do many of the things it should do, he explained.—*Science Service.*

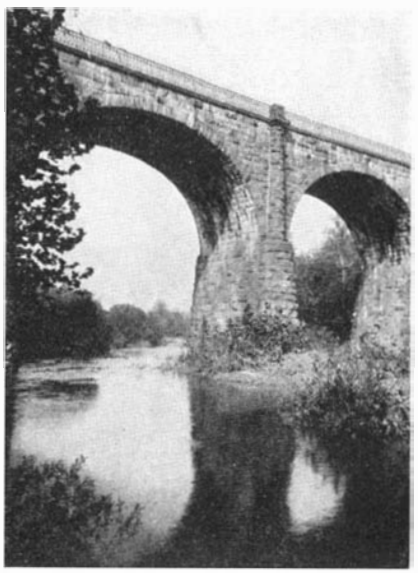
## Telephone Set for Outdoor Use

FOR outdoor telephone service, such as is required by police and fire departments, at taxicab stations, and by watchmen, a new Western Electric telephone set is available. This set can be adapted to either manual or dial systems.

The new set has a cast aluminum housing divided by an inner door into a rear and front compartment. The switchhook projects through the upper part of this inner door and carries the handset, and a dial or apparatus blank is mounted near the center of the door. A spring catch holds the outer door shut when the set is not being used. The outer door may be opened by pulling the handle at the right of the set.

**New outdoor phone in use**

Within the rear compartment is the talking and signaling apparatus, consisting of an induction coil, a condenser, and the ringer, and provision is made for the installation of a relay when auxiliary signals are required. The gongs of the ringer extend through an opening in the bottom of the housing, which is provided with a removable cover with screened louvers to secure maximum audibility and at the same time provide protection against storms. When loud ringing telephone bells are used, a switch may be provided below and to the left of the dial, as shown in the illustration, to cut them in or out of the circuit as desired.



**They builded better than they knew! One hundred years ago, engineers built the stone arch viaduct shown in these photographs. It was designed to carry the early six-ton engines of the Baltimore and Ohio Railroad, but is still giving satisfactory service with 350-ton engines**

## Model Planes Set New Records

A GASOLINE-powered model plane for outdoor flying stayed in the air for one hour, four minutes, and 12 seconds in the recent National Championship Model Airplane Meet held at St. Louis, Missouri, winning for Leo Weiss of New York City a subscription to Scientific American. This plane just missed setting a new record for its class by a few seconds, but new records were set by two other winners of subscriptions.

An indoor stick model rubber-powered plane, hand launched, flown by Carl Goldberg of Chicago, set an all-time record for indoor ships of any kind when it flew for 23 minutes, 29.3 seconds. An outdoor stick model rubber-powered plane, hand launched, by Richard Korda of Cleveland, flew for 24 minutes, 40.8 seconds to establish a new record for ships of its class.

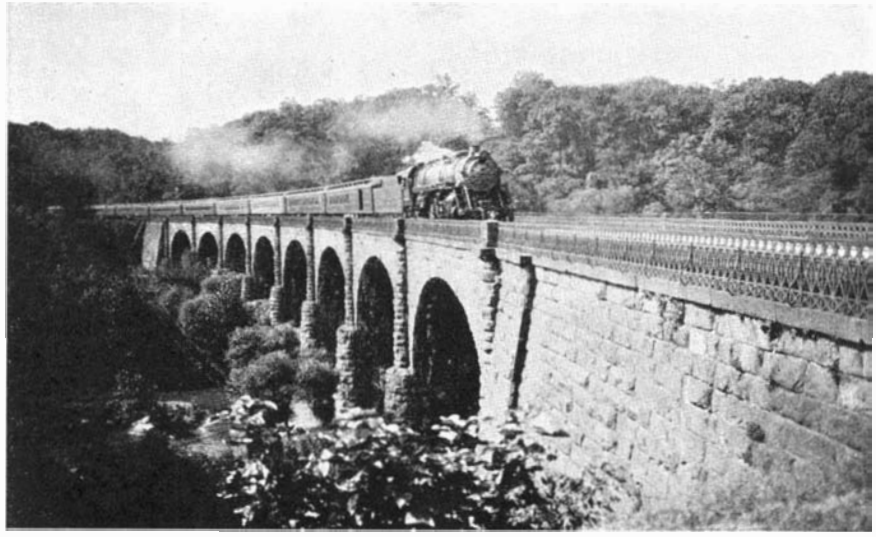
### SUN ENERGY

**A SCIENTIST has estimated that forest trees in the United States capture and store much more of the sun's radiation every year than is released by all the coal mined. Even at that there is a tremendous waste of the sun's energy, for the energy-utilizing process is wasteful in the extreme.**

## Patents on Activated Carbon Upheld

AT the height of the World War, a new weapon, poison gas, was suddenly unleashed on the Western Front. Immediately, every technical resource of the Allies was concentrated on the problem of devising some means of combating this new offensive weapon. It was Dr. N. K. Chaney, and his associates in the National Carbon Company, who discovered means of making activated carbon for use in gas masks, which provided effective defense against poison gas. Dr. Chaney was granted patents on his discoveries.

After the War, it was found that this highly activated carbon was equally efficient for a variety of peace-time uses. In 1919, the National Carbon Company began the manufacture of activated carbons by the Chaney process for industrial use. Other industrial concerns applied the same principles for the recovery of solvents by absorption in activated coconut carbon. So general was the peace-time application of Dr. Chaney's discovery that the National



Carbon Company finally brought suit for infringement of the Chaney patents against Richards and Company and the Zapon Company, of Stamford, Conn.

On May 13, in a decision rendered by the United States District Court for the District of Connecticut, the Chaney patents No. 1,497,543 and 1,497,544 were held valid and infringed. District Judge Hincks found the claims of the patents valid and rendered judgment in favor of the plaintiff for $24,410.65 on account of the infringement. —*A. E. B.*

## Europe's Share of Motor Vehicles

COMPARED with the United States, where unique economic and transportation conditions have led to an unusual development in automotive traffic, the degree of motorization in Germany is still quite low. In Germany there is an average of one automobile to every 75 people, while the motorization quota in the United States is one automobile for every five inhabitants. The millionth automobile in Germany will be in operation this year; in the United States the first million mark was reached in 1913 and the second million mark was passed in 1915. There will be considerable possibility for further automotive expansion in Germany even after the level of France and Great Britain has been reached, for Europe is still in a relatively early stage of automotive development compared with the United States. For this reason the depression affected motorization differently in America than in Europe.

The steady rise in the use of automobiles in the United States was checked in 1930. As the depression became more severe from 1931 to 1933, the number of cars declined by nearly three million. In Europe, however, the long-run upward movement continued in spite of all the difficulties. In the first depression year (1930) the number of cars in Europe increased by 640,000 and in 1931 by 300,000. In 1932 there was a slight decline of 90,000 automobiles. But in the following year the upward movement set in again at the previous speed. By the end of 1933 there were 550,000 more cars in operation than at the end of 1932, and in 1934 there was a further increase of 500,000. As a result of this development, Europe's share of the world's motor vehicles has increased from 13.3 percent to 18.8 percent since 1929, whereas the share of the United States declined from 82.1 percent to 76.1 percent.—*Institut für Konjunkturforschung, Berlin.*

## Leg Cramps

THE lame walk, through the workings of a glandular extract taken from the pancreas.

How this new medical miracle has been wrought on older persons, incapacitated by cramps of the leg muscles resulting from hardening of the arteries in the legs, was demonstrated by Drs. Irving S. Wright, A. W. Duryee, and co-workers of Bellevue and New York Postgraduate Hospitals, New York City, before the American and Canadian Medical Associations.

Men who could not attend their daily business because they were unable to walk as much as five city blocks without an attack of leg cramps were enabled by this treatment to walk as much as a mile and a

half. As a result they are able to keep on earning their livings.

The extract does not contain any of the insulin secreted by the pancreas. It does not cure the cramp condition, but relieves it. The injections are given three times a week and must be continued in order to keep up the relief.

Many persons who are going to chiropodists for treatment of cramps of the feet and legs are suffering from hardening of the arteries, although they do not realize that this condition is giving them the cramps.—*Science Service.*

## Refrigerated Flies

IN the *Industrial Bulletin* of Arthur D. Little, Inc., consulting chemists, is reported the following story to illustrate an outstanding achievement in a field that is particularly dear to the chemist—the utilization of by-products.

"Although our own record in converting wastes and nuisances to profit is one upon which we pride ourselves, we gladly take off our hats to an industrial engineering friend of ours for a superlative achievement in this field which has just come to our notice.

"A client of his raised mushrooms and fertilized his beds with manure. This practice resulted in the hatching out of vast numbers of flies which were extremely difficult to get rid of.

"The engineer recommended the installation of a suction fan which passed both air and flies over some refrigerating coils in such manner as to chill the flies and then drop them in a dormant state into large cans. The installation was made and the flies eliminated as a nuisance.

"The canned flies are now shipped to frog raisers. Upon receipt the cans are immersed in a brine solution, which chills the flies and again renders them dormant. In that condition they are fed to the frogs.

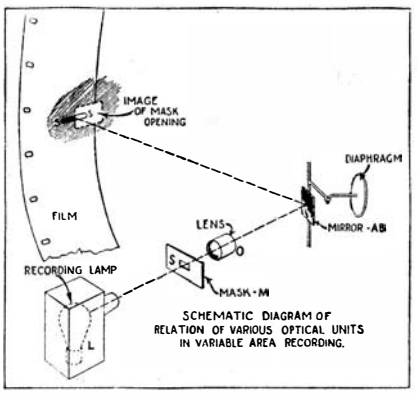
"The mushroom grower now realizes from the sale of flies nearly as much as from the sale of mushrooms."—*A. E. B.*

## Home "Talkies" With New Sound Camera

SOUND-on-film, which revolutionized motion pictures in the theater, promises to do the same in the amateur and home movie field with the introduction of the first amateur sound camera with which anyone may now make his own "talkies."

The new sound camera utilizes film 16 millimeters wide with sprocket holes on one side only and a narrow track on the other side for recording the sound. Sixteen-millimeter sound projection equipment has been on the market for some time, but the new development of the RCA Manufacturing Company is the first amateur sound camera. In appearance and size it differs only slightly from the silent amateur movie camera, and though it incorporates a complete sound recording system, it weighs only 8¾ pounds fully loaded, including the three small flashlight cells for the recording light.

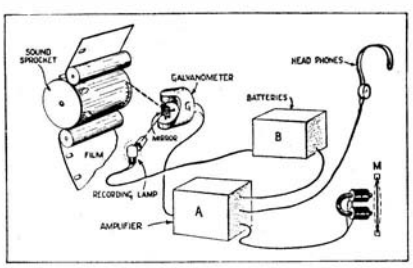
In operation, the photographer talks into a mouthpiece imbedded in the back of the camera as he focuses on the subject. Behind the mouthpiece a vibrating metal



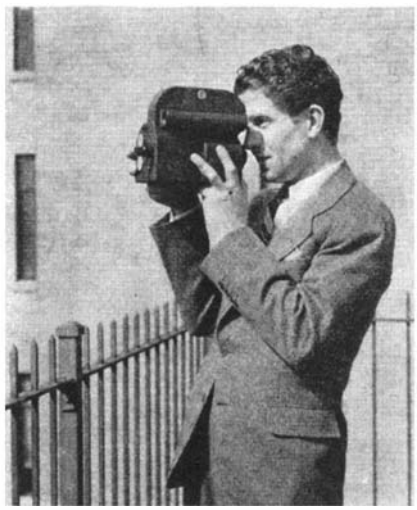

diaphragm coupled mechanically to a tiny mirror is set in motion by the voice. A light beam directed on the mirror is reflected, with its fluctuations, on to the sensitized edge of the film as it passes through the camera. For recording outside sound effects as well as the persons being photographed, a separate microphone attachment together with electrical amplifying and recording equipment is provided for convenient mounting on a tripod, on which the camera is also placed. The total overall weight for this equipment is 20 pounds.

Amateur theatrical productions, amateur voice and screen tests, and more effective visual education are some of the more obvious possibilities which the new development opens up.

The new sound camera is already finding an interesting application in the work of Dr. Kurt Lewin, Professor of Child Psychology at Cornell University. The recording microphone and camera are concealed behind familiar objects in a room so that the subjects do not know they are being observed, and a sound motion picture record is made of children's reactions to commands, suggestions, and other stimuli, to be studied later by interested psychologists.




***Left:*** **Equipment set up for taking home talkies. Note the microphone overhead.** ***Above:*** **Schematic diagram of sound recording equipment**



***Above:*** **The self-contained sound camera with mechanical microphone.** ***Left:*** **How the mechanical microphone records sound on film**

The Department of Interior is using one of the new cameras to make records of the soil erosion which is ruining so much pasture land in the West, with the investigator making his comments on the actual locations, permitting him to point out the preventative methods which may be applied.

In the United States Coast Guard Service too, tests have been carried on with the new camera. Sound picture records have been made of the scene where assistance was rendered to vessels at sea. Thus the observing officer was able to record a running account of the circumstances while they were actually taking place and being photographed, instead of relying entirely on memory to retain the essential data. Other possibilities of use are offered in crime detection where the testimony of prisoners and important witnesses may be taken on the scene of a crime.

### WALL CLEANER

**A FRENCH patent gives a composition of 455 parts of corn flour, 40 parts of copper sulfate, and 5 parts of alum, mixed with boiling water, for use in cleaning walls, paint, and so on.—*A. E. B.***

## Now You Can Eat Garlic!

YOUR best friend *can* now tell you! A lasting remedy for offensive breath odors seems at hand. Even the long-lingering odor of garlic yields to treatment devised by Drs. Howard W. Haggard and Leon H. Greenberg, of Yale's laboratory of applied physiology. Reporting in the *Journal of the American Medical Association*, the Yale physicians state: "The breath can be immediately and completely rid of the odor (garlic) by washing the teeth and tongue and rinsing the mouth with a solution of chloramine. The chlorine liberated in the mouth reacts chemically with the essential oils and deodorizes them. It is probable that many cases of foul breath from other causes would be amenable to the same method of treatment."

The solution of chloramine was made by

dissolving one 4.6-grain tablet in a small amount of water. Chloramine is a well-known chemical, available at drugstores, which is used in the treatment of wounds and for sterilizing drinking water.

In the Yale treatment particular attention was paid to the brushing of the tongue, for the papillae at the base of the tongue have long been under suspicion as the source of odor from retained food particles.

In their experiments Drs. Haggard and Greenberg first proved that the source of most obnoxious breath is not systematic but local. It arises, at least in the case of onions and garlic, solely from particles retained in and about the structures of the mouth. Air in the lungs does not taint the blood; the stomach is not at fault, nor is the saliva.

Having determined this, the physicians set about either to remove or deodorize the particles. They brushed the teeth and tongues of their subjects with soap and water and rinsed their mouths. Still the odor remained. Next they tried the proprietary mouth washes which rely on alcohol to sweeten the breath. These only masked the odor for from 15 to 20 minutes. Finally they hit upon the chloramine solution treatment, which brings lasting relief when used in connection with thorough brushing.—*Science Service.*

## Flowers "Heavenly" To Some, Objectionable To Others

ARE freesias fragrant? Before you select this flower as a sweet messenger to send to a lady, better find out what she thinks about it. Surprising differences in the smell of this flower to different individuals have been reported to the Eugenics Research Association.

At the recent flower show in New York, Dr. Albert F. Blakeslee, of the Carnegie Institution of Washington, secured 16,800 votes on the smell of different varieties of freesias. The same flower that one woman pronounced as "heavenly" was exclaimed over in anger by the man who followed her in the line. "Why, lady, they're terrible!" he said. Another flower that she had thought must have been doctored to remove the smell had a strong fragrance to the man.

Whether you find the odor of a flower lovely or not depends on several individual matters. For one reason or another, individuals may lose their sensitiveness to odors. A cold will sometimes be blamed, or sinus trouble. Some few seem to inherit a tendency to lose all sense of smell. Some are born with very dull smelling ability. And those who are keen to detect one odor may not notice another at all.—*Science Service.*

## New Plant Doubles Bromine Production

SOME months ago we reported, in these columns, the opening of a new plant at Wilmington, North Carolina, erected for the purpose of extracting bromine from sea water. It is interesting to observe the effect of this new venture on the country's total bromine production in 1934, as revealed by government statistics just released. United States production of bromine in 1934 amounted to 15,344,290 pounds valued at 3,227,425 dollars, an increase of

(*Please turn to page* 157)

# THE AMATEUR TELESCOPE MAKER

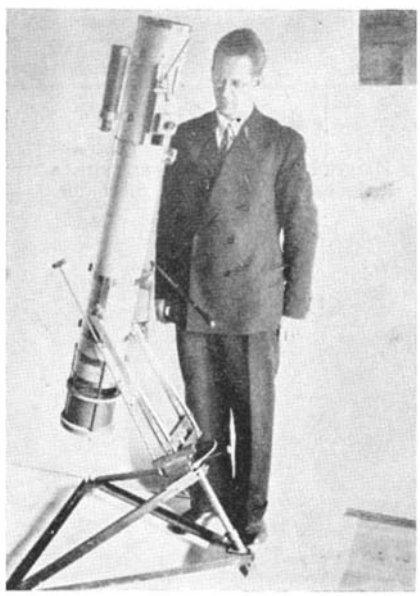
**Conducted by ALBERT G. INGALLS**

MAKING a telescope in a big city, where supplies and kindred spirits are to be found, is one thing; making one alone, in a small village or on a farm, may be another; but here is a letter from a man who made one in the very back of beyond, at Bambur, Nigeria. Ira E. McBride is the man. Read this: "One of the main requirements was patience. Return mail from America takes four months, so I waited that long for the book 'Amateur Telescope Making,' after sending to you for it. Then I waited four months more after sending for the mirror materials. Twice while silvering I had to send to the Coast, a thousand miles and a two months' wait. I claim," he asserts, and we second the motion, "that these waits are enough to try any amateur's enthusiasm. Well," he continues, "here's a picture to show that patience was at last rewarded. The natives called the telescope the '*gigabgipasina*,' that is, the thing-for-seeing-things-far-away. They had had many theories among them about the dark spots and light spots on the moon, but all was settled when they looked through the telescope: 'Mountains—just like ours.' And Saturn—'He wears a belt, just as we do.' (Popular styles in the Wurkum tribe demand at least a belt.)" And now McBride has visited home (Kansas) and gone back again to Nigeria (Bambur, via Jos and Lan, Nigeria, B. W. Africa) with the materials for making a 12-inch.

**McBride and the gigabgipasina**

"THE fork is weak, and I have learned what tremors are." This is G. O. Bjordal, Box 111, Askim, Ostfold, Norway, and he made his first telescope from the instructions in Krudy-Brunn's "*Das Moderne Spiegelteleskop in der Astronomie.*" This German instruction book lacks the typical German thoroughness, telling how to make a mirror but not telling how to use $r^2/R$. "I ask every new beginning amateur," Bjordal now urges, "to make the fork in the mounting so rigid that it can carry a big dog without any bending." Bjordal discovered that his first mirror was very much over-corrected, but on getting hold of a copy of "Amateur Telescope Making," made, not in Germany but in the U. S. A., he says he made a new and fine mirror. He uses his telescope throughout the long winter nights of Norway—15 to 20 hours.

IN contrast with the mounting whose weakness its owner points out, look at one by H. I. Linn, 2737 Humboldt Ave., Oakland, Calif., made for a 6″ mirror. "There is no machine work on it whatever," Linn writes, "except to drill and tap for a set-screw in the unions, to hold them in position. There are two types of unions—gasket and ground, and the ground joint should be used, as the other has side play." The stocky saddle of this mounting is a steam-pipe saddle. The pipe fittings are all standard 3½-inch: for declination axis, one cap, one long nip, one union, one T, one butt nip (inside), one pipe saddle; for polar axis, one union, one butt nip (inside), one 45° el; for post, one nip, one flange. (Add wedge under flange to correct for latitude.) Here is a mounting that will not shiver, for it has plenty of metal at the neck—that place on the declination-



**Bjordal of Norway**

axis shaft, between the tube and polar-axis shaft, where so many declination axes are thin swan's necks instead of bull necks. Linn's is one of the best—cleanest and steadiest—small mountings we have seen.

IN "A.T.M.," page 375, there is a photograph of a 6-inch, made by W. F. Sprengnether, Jr., and its "neat, finished workmanship" is mentioned in the legend beneath the picture. The same Sprengnether now sends us a photograph of another job he has done, and this again looks like professional instrument-maker's work. He doesn't say anything about it, but the picture speaks for itself.

HOGGING out the concavity on the average telescope mirror is too brief a job—only a few hours—to warrant setting up special equipment for short cuts, but on larger jobs, or on small mirrors having very deep curves, any practicable short cuts are worth looking into. It took Harold Lower of San Diego, plus a grinding machine, 98 hours, and used up all the Carbo west of the Rocky Mountains (25 pounds), to rough out the deep curve on his *f*/1 Schmidt mirror—the "Soup Bowl"—shown on page 295 of the June number. This curve is over an inch in depth. (Incidentally, Lower says such a curve involves literally *figuring* with Carbo—so closely must it be worked before polishing is even begun.)

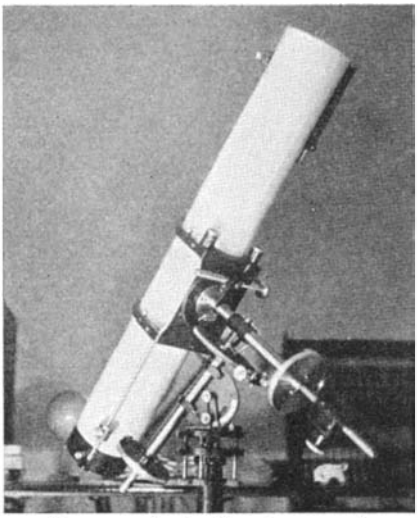
Just after Lower had done all that work, something new and better turned up—Borium. Here is the dope on Borium: The Stoody Company, it seems, located in Whittier, California, supplies Borium lathe tools, and with these you turn your curve in the glass just as you would turn a disk of metal. A piece of Borium ½″ x ⅝″ is used, and the glass is pitched to the face plate. Note picture on p. 156, sent by Dr. H. Page Bailey of Riverside, California. Concerning it he writes, "It is a revelation to see the glass scrape off—just like scraping ice with a steel tool. The tool I used on two 10″ Pyrex disks doesn't even show any wear, though it is slightly chipped." He roughed out two 10″ Pyrex mirrors to a deep curvature in eight hours—12 times the speed of Carbo work.

"In my opinion," Lower comments, "Borium is the greatest advance in the art since the invention of Carborundum." Bailey sent us a Borium point—heavy metal, said by someone else to be borium carbide. It proved easy to write on Pyrex with a sharp piece of it—sign all your mirrors. And the stuff is cheap, at that. Note the shaved "ice" in Bailey's photo, in a snowbank be-

**Linn and Gibraltar**

neath the tool. The metal is shattered in a vise, a selected point is brazed, welded or silver-soldered into a saw cut in the end of a drill rod, and dressed to a broad angle on a Carborundum stone.

HERE is another way of roughing out—a machine which J. H. Hindle of England invented and has been using on a 30-inch he is now making. The picture is



Sprengnether's No. 2—smooth

almost self-explanatory: rotating horizontal metal mandrel or "torpedo;" slowly rotating chuck for disk on vertical shaft, rope pulley, at bottom; capstan (note handles) for jacking it gradually upward.

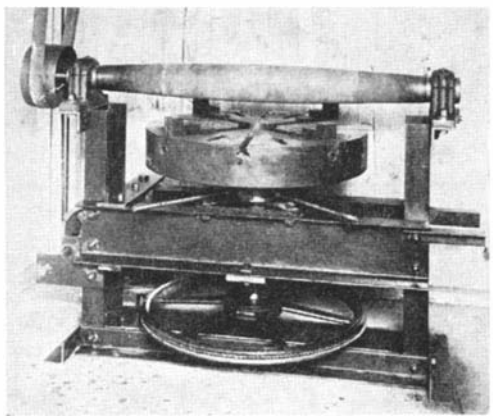
"I find this machine works excellently in practice," Hindle writes, "the concavity of the disk retains the water and grinding material, and a great advantage is that, if the disk is first ground on the back, this machine finishes it equal thickness all over. But do not," he continues, "run away with the idea that this machine will finish-grind it; the fine grinding has to be done in the ordinary way." Mr. Hindle, after making the 20-inch shown on page 453 of "A.T.M.," has now tackled a 30-inch job. Fine grinding is being done on another machine of his invention (to be shown later) and figuring is done face up with small hand tools, while the mirror is resting on the 18-point flotation system for the telescope.

HERE is an idea for those who like to organize organizations: Let's get up a sort of female relief auxiliary to this hobby, not for the purpose of encouraging "female" telescopes, but to assist us noble male telescope makers. For example, the ladies could spoon feed us while we grind, as Caroline Herschel did her brother, sing to us, even kiss us, and make lots of other noble sacrifices to science. Mrs. Scribe was the first to be invited to join this inspired, humanitarian movement, but ungratefully countered with the proposal to organize, instead, and on a militant suffrage basis at that, "The American Association of Optics Widows." Plank No. 1 in the platform of her organization would be for these suffragettes to fill up all cellars with earth, so that husbands, coming up for air, could not get back to their subterranean optical shops.

"I thought," writes one TN, "that I was the only one who had any differences of opinion with his better half as to the

value of telescope building. Mine declares she is a 'telescope widow' and that I don't love her any more." Other wives seem to object unreasonably to finding rouge, not alone on shirts, but on table and bed linen, and pitch on the furniture and rugs.

Mrs. Scribe now threatens to organize all these uncoördinated rumblings into a vast feminist movement which will put all TNs back into the exact, rather than the approximate, buzzms of their families. This forces us to reveal our real, original, secret motive in starting this whole telescope making movement, nine years ago. It was not to aid science but to keep 10,000 of you fellows at home and far, far from the old Demon Rum and ultimate Hell-fire. This will give your scribe something to claim some day, when standing before St. Peter, to offset some other things that need offsetting. In the meantime, truly appreciative wives really should send him fudge, for at least keeping their husbands away from platinum blondes, even if they do dive down cellar for most of the night.



**Hindle's torpedo excavator**

IT gets hot in Atlanta. J. J. Stoy, 501 City Hall, Atlanta, Ga., says so, but since this question is not in itself an essential part of our argument, we simply refer it to the Atlanta Chamber of Commerce, with recommendations of mercy to Stoy, who surely meant well. The point is that Stoy has been using, and liking, a new kind of tropical (this gets worse) lap. He says, "The Barbour Asphalt Co., 30 Arch St., Philadelphia, Pa., processes a pure Trinidad bitumen, designated as 'G-O,' that works well in a hot climate when treated with a half teaspoonful of turps to the quarter inch thick lap for 6″ mirror and about 8 percent by volume (not weight) of beeswax. It comes in 5-pound pails. Even after use of 20 pounds weight for cold pressing for 24 hours, with temperatures ranging between 75° and 85°, no material slumping is visible. After 12 hours of polishing, the channels only require further deepening once, and it does not scratch, as would be expected. Figure shapes up beautifully and normally with 30 minutes' work, then 15 minutes' cold pressing with 25 pounds weight. Mirror *always* works smoothly. Variations of as much as 15° do not seem to bother the figure in any way."

Stoy's letter was sent to Harold Lower in San Diego, for an opinion from southern latitudes, and his reply was that it never gets that hot in San Diego, and that San Diego, by golly, is *not* in the tropics! Well —try it out, somebody.

STOY had another good idea: To forestall bubbles in pitch laps, melt the pitch in a pot having the emphasis on area and not on depth. Deep pots, and deep pitch in them, trap the bubbles. We tried this out and it worked fine. This subject introduces a letter from Edward P. Goodell, 5528 Wayne Ave., Germantown, Pa., who says that memories of old days when, as a boy, he dipped bayberry candles, came back to him, so he dips or dunks his laps. "Why not dip the tool?" he writes, and then goes on to say: "I spread a little turpentine over its face and, grasping it by its handle, carefully lower it into the pitch until the face is half the tool's thickness below the surface. I then raise it and, holding its face in a vertical position, slowly twist it back and forth for a few seconds to prevent dropping, and then lay it face up, on the table. If, after forming the surface with a soapy mirror, I find that the pitch coating is too thin, it is a simple matter to repeat the process to obtain the correct thickness. I use Pierce's method of making channels, pressing them into the surface by means of a soaped steel scale. The result is the smoothest lap I've ever laid eyes on, absolutely free from bubbles and from the chipped-out places which I so often got when trying to cut my channels. Incidentally, this method makes it an easy matter to form laps on tools without raising them far above room temperature, so that polishing may begin only half an hour after dipping."

Joseph A. McCarroll, 521 Palisade Ave., Teaneck, N. J., the coal-tar pitch man (who, by the way, will try to handle orders for coal-tar pitch with different, known melting points for controllable hardness) says he makes his channels thus: A thin stick is shaved to the shape of a crude knife, wetted, pressed in and tipped to either side. After a little practice with the tipping technique the facets made are not irregularly wrinkled but round up clear across, the bulge on one side meeting the bulge on the other, blending with it, and giving the lap an effect like a pan of round baking-powder biscuits just out of the oven. No need to press these down: just go to work on the apices of the biscuits and they will gradually come down as you work.

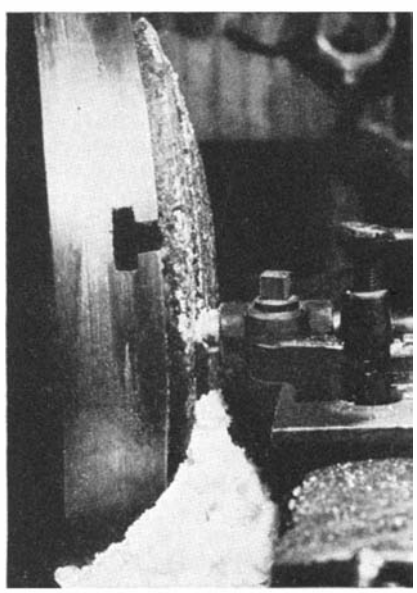
EVERY little while someone discovers independently that if the knife-edge in the shadow test is brought in from the other direction, the pinhole remaining as before, the shadows will be reversed—thus a paraboloidal shadow becomes an oblate. This idea was first reported to us by the late J. C. Critchett of Julian, Calif., in October, 1932, and its use may help in mentally delimiting the areas of light and shadow. Mr. Critchett used a double knife-edge, like a broad slit (really two opposed knife-edges), letting the rays come between the sides but using only one side at a time. This set-up facilitates quickly choosing either side, in order to get either reversal. With the reversal a turned-down edge becomes a turned-up edge, or vice versa. Hills become holes, and raised zones become depressed zones. It's fun.

FURTHER with regard to answering other amateurs' letters in pencil, informally, on the margins and backs, mentioned a month ago: Making it easy for the correspondent is not the only point in favor of this method, for it puts the answers opposite the questions asked, thus giving a closely tied-up record. It is not a job, but fun, to do it in that way—say when riding on a train or leisurely reclining on a soft sofa at home, but if the letter must be answered formally it is less likely to be answered so carefully, because it must then be re-read at the time the answer is dictated or written. The other way really amounts to an informal, natural conversation between friendly addicts of the same incurable habit.

Your scribe often starts reading a letter, sees it is from a telescope maker, says to himself, "That's too good to try to read in this busy place," and throws it down beside his hat, to be picked up and read at leisure on the long way home, where it can be enjoyed and studied in peace. The answers that then come to mind as it is read, and are jotted down in the margins, would not come again to mind so readily or spontaneously a couple of days afterward, if it were included in the regular grist of a million less interesting letters to be answered—less interesting because not about amateur optics. The informal, with-pencil-on-the-back style of answering fellow telescope makers' notes was set by Porter, years ago. If you get a reply of that sort, don't think you are being discriminated against: we'd answer Napoleon in the same way.

EVIDENTLY a lot of people have been making good mirrors, adding bad prisms and eyepieces to them, then wondering what can be the matter. A letter from H. E. Dall, of England, bears on this point: "Out of hundreds of prisms I have tested, only a small proportion are sufficiently good not to give a perceptible error on the final image. Some 1½″ (name of a noted maker.—*Ed.*) I have seen ruined the image of a good *f*/7 mirror. When three surfaces are concerned, it is obvious that first quality extra is wanted." If your mirror is good, use a good prism.

A certain amateur in California has been using his telescope to watch a doctor kissing his nurse, in a building 1.7 miles away. Readers, want the story? Shall we snitch on him?



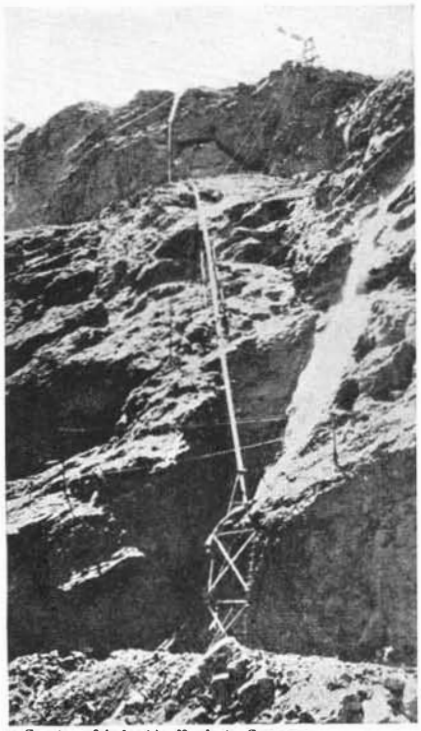
**Peeling off Pyrex on a lathe**

## THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 153)

51 percent in quantity and 58 percent in value over 1933. Bromine is used principally in the form of ethylene dibromide for the manufacture of anti-knock gasoline.

Imports of ethylene dibromide in 1934 amounted to 649,987 pounds valued at 143,164 dollars, compared with 290,410 pounds valued at 55,864 dollars imported in 1933. Imports of potassium bromide in 1934 amounted to 4410 pounds valued at 1047 dollars; in 1933, 9921 pounds valued at 1813 dollars. No raw bromine was imported in 1933 or 1934, and only small quantities of other salts.—*A. E. B.*



Courtesy Linde Air Products Company

**A welded pipe line solved a problem of transporting dry cement down a steep grade to the mixing plant of an engineering project. At one point there was a drop of over a thousand feet. The smooth welded joints made it possible for this gravity system to function properly**

## NEW SHIPS HAVE BOILERS ON DECK

BOILERS on deck, instead of in the conventional position in the hold, characterize two new Norwegian coal-burning freight ships recently put into service on an African route.

While the main idea was to gain more cargo space in the hold, several other advantages have developed. The "black crew" is delivered from the infernal heat of the ordinary stokehold in the tropics. Unloading ashes is no longer a problem: a slanting pipe simply discharges them into the sea as fast as they are raked out. Getting the boilers away from the bottom of the ship has done away with the rapid rusting of

the bottom plates, always a troublesome factor in steamship operation.

Finally, officers declare that the ships behave much better in a rough sea, even when running empty or only partly laden, than do ships of like tonnage with the boiler weight far down on the keel.—*Science Service.*

## TEN-MINUTE SOIL ANALYZER

ECONOMIES in time that will result in increased yields through proper fertilization of agricultural fields, are made possible through a new soil analysis device originated in Honolulu. By it laborious chemical tests that normally require weeks to complete are replaced by a method requiring but a few minutes. As a result, complete plotting of the required fertilization of every part of a field can be secured while time is still available to make use of the information for the benefit of the then growing crop. Spotted fields will be eliminated; average yields will be increased; and the whole will be accomplished at an infinitely decreased laboratory cost.

The apparatus for analyzing soils does in seven to ten minutes what formerly required five weeks. It is the development of chemists at the experiment station of the Hawaiian Sugar Planters' Association. Hamilton P. Agee, station director, has recently announced its successful tests.

This development, which may be described as revolutionizing methods of testing soils, is the fruit of two years of study and experimentation by personnel of the department headed by Francis E. Hance. Beginning with the crude soil-testing "kits" used by farmers elsewhere in the United States, experiment station chemists have worked out devices which combine the speed of those rudimentary indicators with the accuracy of a laboratory analysis.

The result is nothing less than a precision machine, which is now in use on all plantations in the territory which maintain agriculturists.

**Essential features of the 10-minute soil analyzing equipment. The illuminated window is in the lid**

The "analytical assembly," as it is called, or rather the assemblies, for there are nine of them for various analytical purposes, resembles, when closed, a box about 15 inches square and perhaps two feet high.

A small sample—one cubic centimeter, to be exact—of soil is agitated for half a minute with what chemists call "a weakly acidulous aqueous solution," that is, water containing a little acid. This is immediately filtered. The filtrate—the material that passes through the filter—contains the readily soluble soil materials. Portions of this filtrate are taken for individual analyses. Two reagents are added, and the mixture is placed for half a minute on the mechanical rotating device, which in addition to moving round and round, has a slight swaying motion suggestive of the hula. This produces "turbidity," a muddiness of the liquid, which is proportional to the amount of potash, for example, or other element for which the test is being made, in the soil. The amount of that turbidity is measured on an illuminated series of lines of different degrees of density and blackness. From the reading of these, the operator can refer to a previously prepared chart and determine the percentage or pounds per acre of the element for which the analysis is being made. All this is done in less than ten minutes.

**The rotating part of the soil analyzer is in a shelf directly below the cabinet containing the light source**

These assemblies are now in use almost universally on HSPA plantations, and the results are checked with the laboratory at the experiment station. In connection with other studies, results of which are correlated—as, for example, growing an "indicator" plant in the same soil—they enable the planter to practice more intelligent fertilization. They can be used for determining the content of certain chemical elements in cane juice as well as in soil.

There are assemblies for potash, phosphate, and phosphate fixation in soil; for potash and for phosphate in cane; for reaction—acid, neutral, or alkaline; for available nitrogen, and for the total amount of nitrogen in cane juice or other material.

## CHEMICAL RESEARCH PRODUCES BETTER GASOLINE

IMPROVEMENTS in the manufacture of gasoline during the past ten years have revolutionized automobile engine design. As the chemist has discovered what really constitutes good gasoline, he has been able to modify the procedure in refining crude oil so as to produce a motor fuel that is satisfactory in engines of much higher compression ratio than formerly. Whereas the average compression ratio in passenger cars ten years ago was about 4.4, in the 1935 cars it is about 6.0.

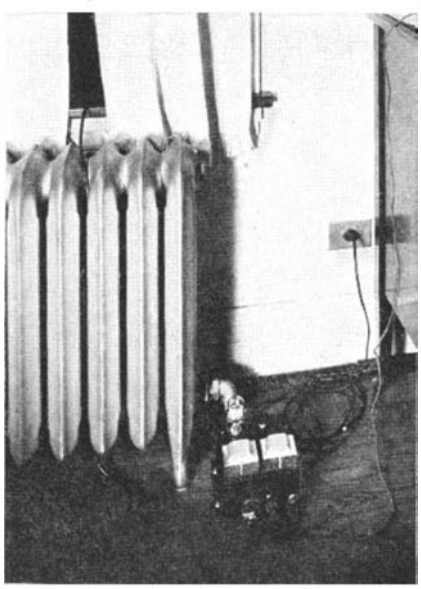
J. Bennett Hill of the Sun Oil Company explained how this improvement has been accomplished by petroleum chemists at a recent meeting of the American Chemical Society in New York City. The most important factors, said Mr. Hill, are (1) a control of cracking conditions in making the gasoline so as to give maximum octane rating and (2) the development of the tetra-ethyl lead which is added to gasoline to suppress knocking.

The question of proper gasoline volatility has been difficult, since inherently easy-starting characteristics and freedom from "vapor lock" are opposed to one another. Easy starting in cold weather requires a certain amount of easily vaporizable material in the gasoline; on the other hand, these volatile hydrocarbons tend to cause "vapor-lock"—that is, vaporization in the intake system of the car and consequent upsetting of the proper metering to the carbureter and irregular operation or stopping of the engine. This situation has been improved by sharply eliminating from gasoline the extremely volatile hydrocarbons, such as ethane and propane, since these compounds cause vapor-locking difficulty out of all proportion to their value in making starting easier. Even with an ideal gasoline it was impossible, however, some years ago to obtain in some cars easy starting on the cold days of a month and freedom from vapor lock on the warm days. This condition is subject to improvement by proper design of the automobile, and some automobile manufacturers have now taken steps in this direction.—*A.E.B.*

## Phantom Alarm Foils Intruders

WINDOWS in the private home may now be adequately protected from intruders by means of the phantom Faratron cell. It is not necessary for the intending intruder even to touch the window screen; his approach will start the Faratron in operation.

An advantage of this phantom cell is that it operates without light rays or other visible means of control. It is an adaptation of the radio oscillator and so can be built and installed by anyone familiar with these types of circuits.



**The phantom alarm, using an oscillator circuit, takes up little space**

In the photo-electric cell—as mysterious as is its action—there must be the beam of light, the breaking of which operates a relay switch, thus opening or closing the main electric circuit. In the phantom Faratron cell, however, merely the presence or the nearness of a person or object will do the same work.

This new electronic cell opens up as interesting a world of experiment for the electrical enthusiast as did the radio receiving set of ten years ago.

### UBIQUITOUS ALUMINUM

**ALUMINUM is one of the most ubiquitous of metals. It is used in electric ironers to conduct heat; aluminum foil is used in refrigerator installations to prevent the flow of heat.—*A. E. B.***

## Fuel for Coast-to-Coast Diesel Car=$7.63

AN Auburn car powered with a Cummins Diesel engine arrived in Los Angeles recently after covering the 3774 miles between New York and Los Angeles at a cost of $7.63 for fuel.

An average of 34.62 miles per gallon of fuel oil was made for the total trip.

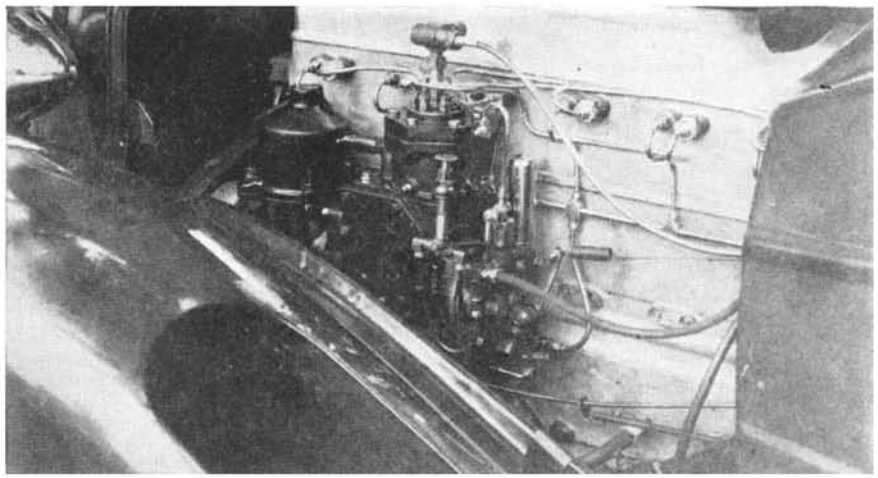
The $7.63 fuel cost was approximately one seventh of what the cost for gasoline would have been in an ordinary automobile, C. L. Cummins, president of the Cummins Engine Company, and owner of the car, said on his arrival.


**No changes were made in this car body in adapting it to a Diesel**

Mr. Cummins purchased a new car recently and replaced its regular gasoline engine with the automobile Diesel engine to make this test run. This Diesel engine is an experimental motor and is said to be the first passenger car Diesel engine ever placed in actual operation on the highway.

The engine manufacturer said that he had experienced no trouble in any way and that the car had performed in an excellent manner throughout the trip. No effort was made to take the shortest route or to set a speed record, the Diesel-powered car being held at an average speed of approximately 50 miles an hour. However, speeds of 75 miles an hour were often attained. Top speed of the car is 90 miles an hour.

The significance of this transcontinental economy trip is far reaching, because it demonstrates the flexibility, acceleration, light weight, freedom from smoke, and dependability of Diesel engines as applied to motor cars. It has a distinct bearing on the



**The cross-country Diesel engine installed in a standard automobile chassis**

marine, stationary, light truck, and general industrial fields. This power unit will be used in all of these fields and will be in regular production for other than automotive service during the next two to three months.

### 700 METEORITES

**STRANGE, you say, that so few meteorites seen to fall are afterwards found. In the Field Museum of Natural History, however, 52 percent of their collection of more than 700 meteorites were actually seen to fall.**

## Corrosion-Resisting Paint

THE binder used in "Acidseal," a new line of corrosion-resisting paints, is a rubber compound, hard and flexible, which gives the paint practically the same resistance as crude rubber. Acids and alkalies are said to have no effect, with the exception of those of an oxidizing character such as nitric acid or sodium hypochlorite. The paints are recommended wherever corrosive conditions exist but not for exposure to direct sunlight. They are handled much like lacquers by brushing, spraying, or dipping. They are said to adhere well to all surfaces and are available in a wide range of practical colors.—*A. E. B.*

## Acne-Sufferers Should Avoid Spinach, Pork, Potatoes

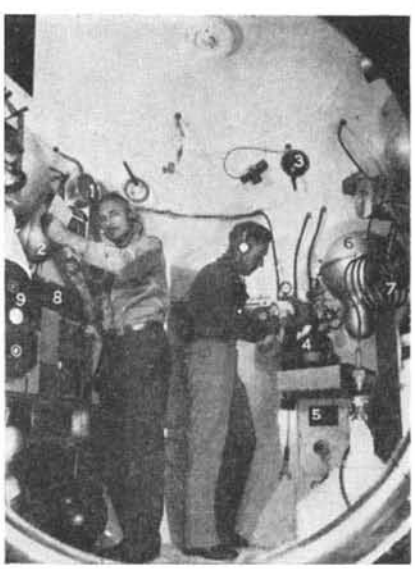
PERSONS suffering with acne would do well to avoid spinach, pork, potatoes, it appears from a report by Drs. T. D. Cunningham and J. C. Mendenhall, of Denver. These foods more than any others caused a reaction in acne sufferers who were tested for food sensitivity, the Denver physicians found from skin tests similar to those made on hay fever and asthma patients. The tests were made in the course of a search for the cause of acne.

This troublesome condition, one form of which is the familiar "breaking out" seen on the skins of adolescents, is apparently a state of sensitiveness to foods. Practically all acne sufferers are sensitive to proteins in foods, Drs. Cunningham and Mendenhall reported. Other factors such as drugs and glandular disturbances can and do produce acne in a small group of cases.

Diet has long been a method of treating acne, but the work of the Denver physicians shows that the diet can now be put on a more exact and scientific basis. Instead of avoiding certain general classes of foods, as formerly, the acne sufferer can now have the skin tests made to determine whether food is the cause of his condition and if so which foods in particular he should avoid. Half of the acne sufferers described said they had from 90 to 100 percent relief after following a diet selected in this way. The majority of the patients, 75 percent, received from 50 to 100 percent relief by avoiding the foods to which they were found sensitive.—*Science Service.*

## Inside the Stratosphere Balloon Gondola

THE gondola of the National Geographic Society-Army Air Corps balloon *Explorer II* is packed with scientific apparatus. Unfortunately, the fabric of the balloon ripped while being inflated for its scheduled flight in July from near Rapid City, South Dakota, but it is thought that the flight may still be made before the end of the year. In the accompanying illustration showing the interior of the gondola, which of



**In the stratosphere balloon gondola**

course, was unharmed, are Capt. Albert Stevens, right, and Capt. Orvil Anderson testing the compactly-arranged apparatus. Identifying numbers for the various instruments have been obtained by *Science Service* in co-operation with the National Geographic Society. They are:

1. Altimeter.
2. Lead-shielded electroscope for detecting cosmic rays.
3. Electrical firing device for releasing ballast from bags hung outside gondola.
4. Cylinders of compressed gas for operating balloon valves.
5. Cosmic ray instrument.
6. Container for stratosphere air.
7. Part of air-conditioning unit.
8. Battery of factograph cameras for recording readings of 19 instrument dials.
9. Aerial camera for photographing horizon.

## CURRENT BULLETIN BRIEFS

THIS THING CALLED AIR CONDITIONING. Exactly what air conditioning is, the six vital factors rendering air conditioning desirable, a brief description of different types of equipment, and how to proceed with the installation of such equipment—all these things are summarized within the 32 pages of this well printed brochure. Request this bulletin on your business letterhead. *Minneapolis-Honeywell Regulator Company, 2927 Fourth Avenue South, Minneapolis, Minn.*

CRAFT WITH "CELLOPHANE". A 32-page booklet packed with directions and illustrations detailing how to make 101 separate items from Cellophane, including belts, bracelets, lamp shades, book jackets, crocheted hats, and so on. *Write for Bulletin 935A to Scientific American, 24 West 40 Street, New York City.—10 cents.*

AN OPEN LETTER to E. J. Mehren, President, Portland Cement Association, from J. E. Pennybacker, Managing Director, The Asphalt Institute, is put out in pamphlet form in an attempt to clarify certain phases of the cost of road construction. *The Asphalt Institute, 601 Second Avenue, New York City.—Gratis.*

STAINLESS STEELS TREATED WITH COLUMBIUM is the title of a four-page pamphlet which shows how the addition of columbium to certain types of stainless steel results in the elimination of intergranular corrosion. Three tables give the results of a series of tests. *Write for Bulletin 935C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

QUAIL-FOOD PLANTS OF THE SOUTHEASTERN STATES, by Alec C. Martin, lists 46 food preferences of quail and gives splendid descriptions and comments regarding each one. Illustrations show many of the plants. Circular 348, United States Department of Agriculture. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

INDICATING AND RECORDING GAGES is a compilation of various types of gages used in industrial operations. A series of excellent illustrations and accompanying descriptions show how the gages work. They are particularly applicable to the indication, control, and recording of drafts in furnace and boiler installations and also to air filtration and refrigeration plants. *Write for Bulletin 935B to Scientific American, 24 West 40th Street, New York City. —3-cent stamp.*

WHAT THE MEDIA OWNER NEEDS AND THE ADVERTISING AGENCY DOES is a little heart to heart talk between an advertising agency and the executive in a business which requires the help of such an agency. It deals particularly with the relationship of publishers to advertising and the advertising agency. *American Association of Advertising Agencies, 420 Lexington Avenue, New York City.—Gratis.*

WHAT TO READ ABOUT MEXICO is a compact little 48-page booklet listing dozens of books dealing with Mexico—history, customs, people, politics and so on. Both English and Spanish books are listed. *Write for Bulletin 935D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

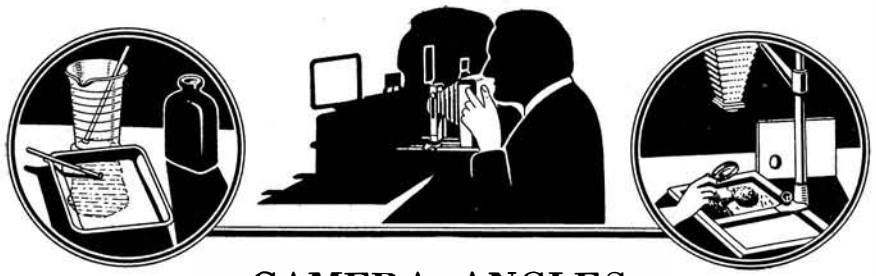
THE ELECTRIC EYE IN THEORY AND PRACTICE is a 32-page booklet setting forth the various industrial uses of photo-electric cells in a wide variety of work. Illustrated with 30 diagrams. This bulletin is sent gratis to electrical and industrial executives requesting it on company stationery. To all others it is priced at 50 cents. *Hugh H. Eby, Inc., 2066 Hunting Park Avenue, Philadelphia, Pa.*

TWELVE RULES FOR TIRE HEALTH, by K. D. Smith, is a four-page pamphlet listing in clear and concise form the various troubles to which automobile tires are subject, and how many of them can be avoided. *Write for Bulletin 935E to Scientific American, 24 West 40th Street, New York City. —3-cent stamp.*

SWIFT & COMPANY 50TH ANNIVERSARY YEAR BOOK is a beautiful piece of literature describing the progress of a large meat packing company over half a century and covering more specifically activities for the year 1934. Well illustrated, including four unusual color plates. *Swift & Company, Public Relations Department, Union Stock Yards, Chicago, Illinois.—Gratis.*

MATHEMATICS OF RADIO SERVICING, by M. N. Beitman, is a mimeographed booklet of value to men engaged in radio service work who have a slight working knowledge of arithmetic and elementary algebra, and who realize that this knowledge can be made a definite asset in their work. *Write for Bulletin 935F to Scientific American, 24 West 40th Street, New York City.—50 cents.*

WHITHER PUBLIC RELATIONS WORK? is a dispassionate survey of the art of publicity. It surveys the history of public relations and treats in some detail the present methods and trends. *Distributed gratis to specialists in industrial management and in professional, trade and public relations activities by Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.*



# CAMERA ANGLES

**Conducted by JACOB DESCHIN**

## PORTRAITS WITH PHOTOFLOODS

WITH two large lights and a smaller one for backlighting, an amateur equipped with the simplest of folding cameras can sometimes equal the work of an experienced professional, provided he is willing to follow some simple precautions, such as those put forth in the following paragraphs.

The most convenient and least expensive source of light for the non-professional is the Photoflood bulb. Used in reflectors, two of these bulbs will, with a balancing

**A well-lighted portrait**

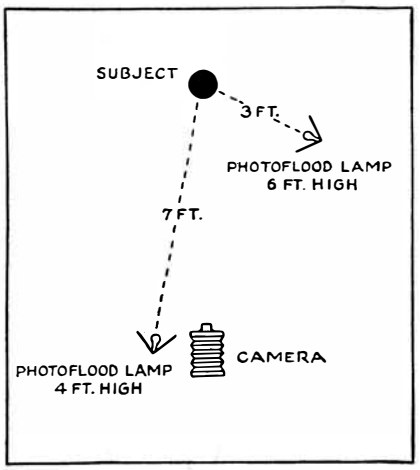
light unit for the highlight side of the face, permit snapshot exposures indoors or at night.

While the ideal camera for portraiture is one having a double or triple extension bellows, a ground glass for focusing and designed to take lenses of different focal lengths as desired, an amateur with a simple folding camera can get good close-ups by using a portrait attachment. If your camera does not have a lens of a focal length at least equal to the diagonal of the film used, do not attempt to get too near your subject in order to get a large "head and shoulders" portrait. Bad perspective and distortion will result. Seven or eight feet is the nearest you should get to your subject and if at this distance you feel you are including more than you want, the enlarging camera in the dark room will give you what your lens balked at.

Avoid darkroom heartbreaks by careful focusing on the ground glass or, in the case of a focusing-by-scale camera, by carefully measuring the distance from subject to camera and then setting the scale accordingly; by always mounting the camera on a steady tripod; and by using panchromatic films. This type of film, being sensitive to all colors, including red, almost eliminates freckles and other skin blemishes in the final printing of the negative. Panchromatic film, incidentally, should be developed in total darkness according to the manufacturer's directions.

It is proper lighting that makes the picture. A good portrait should have delicate halftones, transparency in the shadows, and details in the highlights. Modeling of the face is done with the highlighting unit, which should be raised to a height of six or seven feet and pointed down at the subject at a 45-degree angle. From this elevation the light gives depth to the eyes, highlights to the cheek bones, and prominence to the chin. You may check the correct placing of this light by making sure that the shadow cast by the nose falls upon the corner of the mouth.

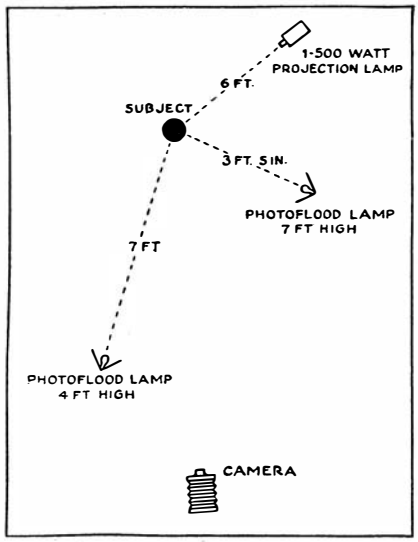
To provide general illumination so as to produce a well-balanced negative, place one




**Proper placement of Photofloods**

lighting unit at the side of the camera about four feet from the floor. If the lighting arrangements suggested in the accompanying diagram are followed, the effect of this light will be relatively weaker than that of the highlight unit. This is as it should be; otherwise, the modeling would be destroyed and a "chalky," characterless picture would be the result.

A spotlight, if used intelligently and merely as an accessory light, to give sparkle to the hair, to lighten up a particularly heavy shadow, or to add emphasis to some detail of face or dress, is very useful. It lends sparkle and distinction to what might




**A spotlight lends sparkle . . .**

otherwise be termed "just another picture."

Make your subject the dominant feature of the picture, to which everything else is subordinate; use a plain wall or gray cloth as a background and place the subject far enough away from the background to avoid casting a heavy shadow and to provide space for a small spotlight behind him, if desired. Above all, since naturalness in the final print should be the main objective, let your subject pose himself while you watch for the best moment. Then "shoot"—quickly. By the way, be sure none of the light strikes the lens directly.

Painstaking adherence to these tried-and-true pointers should result in a "bull's-eye" every time.

## New Leica Model

SPEEDS up to 1/1000th of a second are provided in the new Leica Model G, the other feature of this model being chromium-plating of all parts except the body of the camera, which remains black, as in the Model F.

## Universal Developing Tank

A UNIVERSAL developing tank, called the Perplex, for miniature negatives ranging in size from 35 mm. to 2½ by 4¼ inches, is made of bakelite and therefore is proof against acids. The tank is equipped with an adjustable grooved reel to take various sizes of miniature film, though in the case of 35 mm. it can accommodate only 12 exposures.

The film is loaded in the darkroom or a changing bag by feeding the film into the outer openings of the grooves after removing the paper backing from the film. After the lid is fastened, all the other operations may be carried on in bright light, from the pouring in of the developer in an opening at the top to final washing. An agitator is supplied with the tank.

## Distance Meter and Range Finder

OWNERS of cameras not equipped with range finders or the reflex principle will welcome the news that a reasonably priced distance meter has been placed on the market under the name of the Bee Bee Distance Meter and Range Finder. The first photographic range finder made in the United States, its price halves that of the cheapest hitherto obtainable. Its effectiveness ranges from 2 feet to infinity, and it can be either held in the hand or attached to the camera.

The meter uses semi-transparent, gilded, dividing mirrors showing two images of the subject when the instrument is not in focus. It is the work of a moment to turn the dial, superimpose the two images—thus bringing about accurate focus—and read off the distance on the dial. Its long optical base of four inches makes it twice as accurate as the two-inch type.

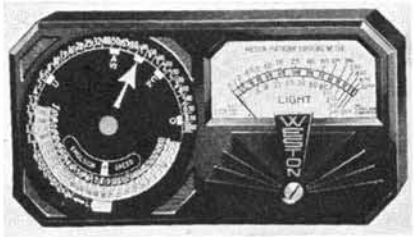
## Graflex Copygraph

SERIOUS advanced amateurs often have occasion to copy old photographs—or even their own new ones, for one reason and another—drawings, charts, or what not. A compact copying apparatus, complete with lights, is offered for this purpose to owners of Graflex cameras, the Speed Graphic, and other cameras equipped for ground-glass focusing. In conjunction with a microscope it can also be used in photomicrographic work, one of the most fascinating fields in photography.

Delightfully self-contained, the outfit consists of a case into which the apparatus is packed and which when open also serves as a base and copystand for the apparatus, an upright rod, a sliding arm to hold the camera, two reflectors with extension rods permitting the placing of the lamps in any position in relation to the subject, and a switch. When not in use the whole thing is packed away into the case, either for keeping in a small space or for carrying about. A complete copying studio offering ideal facilities for this type of work, it should open up possibilities for new work to many a camera enthusiast and be particularly helpful to students, scientific workers, and those looking for a chance to make a little extra money evenings by copying photographs.

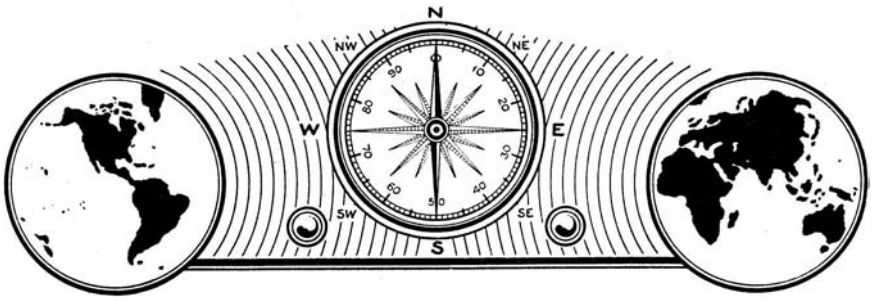
## New Meter For Critical Exposure Range

CORRECT camera settings in the range of low brightness levels where exposure problems are most critical may be obtained with a new photo-electric expo-




**A more sensitive exposure meter**

sure meter of increased light sensitivity. The meter is said to give exposure data for scenes less than one third as bright as that required to actuate earlier models, meeting the light conditions commonly encountered in photographing interiors, in home photography under artificial light, and in candid camera work.




# WORLD-WIDE RADIO

**Conducted by M. L. MUHLEMAN***

## SELECTING A RECEIVER

A GOOD all-wave receiver should have the following features: (1) At least one pre-amplifier or radio-frequency stage of the tuned type operating on all wave-bands. (2) Provisions for using a noise-reducing antenna of the doublet type. (3) Separate (not tapped) coils for each wave-band and each coil individually shielded. (4) Automatic volume control. (5) Two tuning-dial ratios, with the highest ratio not less than 50 to 1.

A good standard broadcast receiver should have the following features: (1) A pre-amplifier stage. (2) Diode detection. (3) Automatic volume control, preferably together with one of the many arrangements to eliminate noise when tuning from one station to another. (4) At least two power amplifier tubes in the output of the receiver, connected in push-pull. Preference should be given to receivers that employ power amplifier tubes of the triode type (such as the 45), or pentodes connected to operate as triodes (such as the 42). (5) A loudspeaker of the dynamic type with a diameter no less than eight inches. (6) Some form of compensated volume control, or bass compensation system, that actually reinforces low-frequency tones rather than simulating the effect of good bass response by eliminating or attenuating tones of high frequency. (7) A cabinet, preferably of the console type, providing sufficient baffle area for the loudspeaker. A large table model cabinet may be taken as the minimum. A cabinet of smaller dimensions will reduce the effective low-frequency response.

If one must be guided by price, it is well to give serious consideration to the class of service required before making a purchase. If the quality reception of local broadcast programs is all that is desired, do not place money in an all-wave or dual-wave receiver. The manufacturer places his pennies where they do the most good, but a multiplicity of services "built in" to a moderate-priced receiver calls for some compromise. A standard broadcast receiver, minus dual-wave or all-wave features, will have more of the manufacturer's pennies invested in tone quality.

If one is not guided by price, the full merits of distant short-wave broadcasting and the high-fidelity transmissions from local broadcasters may be enjoyed from one receiver. Most of the high-priced all-wave, high-fidelity sets have proved satisfactory from both standpoints.

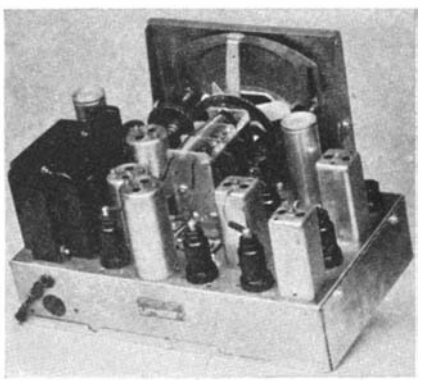
It is impossible to procure an automobile having all the worthwhile features of automotive design, unless the car is made to order. Much the same holds true with regard to radio receivers. Consequently the ultra-critical radio enthusiast can obtain the maximum in distance and high-quality reception only by resorting to a capable organization or engineer in a position to undertake the task of special design. Naturally, the cost is almost prohibitive.

## METAL TUBES

THE majority of radio manufacturers have introduced all-wave and standard broadcast receivers using the new metal tubes. A typical set is illustrated below.

So far there are but ten metal tube types, eight of which replace the glass type tubes most commonly used. However, the metal tubes are not interchangeable with those of the glass type and can be used only in receivers designed for them.

The metal tubes not comparable to any existing glass types, are the 6L7 pentagrid mixer amplifier and the 6H6 twin diode. The 6L7 mixer amplifier represents quite an advance in tube design. It supplants the type 6A7 mixer-oscillator glass tube, and uses what is referred to as "suppressor-grid



Courtesy Atwater Kent Mfg. Co.

**A modern radio receiving set employing nine of the new metal tubes**

injection." It prevents "lock-in" between oscillator and mixer and also provides almost uniform amplification on all wave-bands. Thus the use of this tube in the mixer-oscillator position in an all-wave receiver contributes greater sensitivity and improved stability.

The 6H6 twin diode is used for providing detection and automatic volume control. It is capable of handling much larger signal voltages than the diodes incorporated in the multi-purpose type of glass tube. This

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

greater signal handling power of the 6H6 eliminates distortion of programs due to overload and also offers certain advantages with respect to the automatic volume control system.

Generally speaking, the advantages of the metal tubes over those of the glass type are: slightly improved electrical characteristics; more rugged internal structures that serve to maintain proper tube characteristics; better shielding; less electrical circuit noise induced by mechanical vibration of the receiver; less breakage; easier insertion and removal from tube sockets.

## Stratosphere Radio

THE ill-fated National Geographic-Army balloon, *Explorer II*, was equipped for broadcasting from the metal gondola on both long and short waves. The signals were to be intercepted on short-

**Capt. O. A. Anderson in the gondola of *Explorer II*. Beside him are the radio receiver and transmitter**

wave receivers and re-broadcast over the NBC chain. The short-wave transmitting and receiving equipment designed for *Explorer II* is shown in the accompanying illustration. It is probable that, if the balloon's bag is repaired and the projected flight is made, the same radio equipment will be used.

## Western Union Radio Service

PHILCO has made arrangements with Western Union whereby any owner of a radio receiver may phone the nearest W. U. office and request radio service. The first thing you know—up pops a Philco Serviceman all set to take the kinks out of your receiver.

## New All-Wave Features

HIGH degrees of sensitivity and selectivity are not requirements for local reception. As a matter of fact, too much selectivity will affect the tone quality of broadcast programs. On the other hand, sensitivity and selectivity are essential to distance reception. Therefore, the design of an all-wave receiver, which must provide both services, is quite often a compromise.

One radio manufacturer has taken care of this problem in its more expensive receivers by incorporating dual amplification systems; one with low gain and moderate selectivity for high-fidelity reception of local programs, and the other with high gain and knife-edge selectivity for the reception of distant stations on all wavebands. The listener may use either amplifier at will by the mere flip of a switch.

Another scheme, which takes care of the same problem in a different manner, employs a manually-operated, continuously variable selectivity control. With this arrangement only one amplification system is used, but its selectivity may be increased or decreased at will to meet the reception conditions, by turning a knob which alters the distance between the transformer coupling coils in the amplifier.

## All-Wave Distance Reception

PEOPLE interested in distance or "DX" reception ought to have available a pair of headphones. A signal too weak to be heard from the loudspeaker will show up with considerable vigor in headphones.

Some receivers are provided with a jack so that headphones may be plugged in. With receivers not so equipped, a pair of headphones and an adaptor may be used. The adaptor looks much like a radio tube socket. Just remove the power tube in the receiver, insert the adaptor in place of the tube, and insert the tube which was removed into holes in top of the adaptor. A cord leads from the adaptor to a jack into which the headphones are plugged.

## Television

IS television just around the corner? If the newspapers continue in their attempt to force the issue, there is a possibility that one or more of the leading radio manufacturers will institute such a service sooner than they would wish to.

The situation between the American press and the radio manufacturer may be likened to a young man and an impatient young lady seated on a park bench, the young lady wishing to be off to the Amusement Park and the young man refusing to rise for fear she will see the rip in the seat of his pants.

## Short-Wave Converters

ANY standard broadcast receiver of the tuned radio frequency or superheterodyne type may be converted into an all-wave receiver by the addition of a short-wave converter. The effectiveness of such a combination will depend upon the merits of the broadcast receiver and the efficiency of the short-wave converter. If the broadcast receiver is satisfactory only for local reception, it will not function well as an all-wave receiver in conjunction with a converter, as the sensitivity of the receiver is the prime determining factor.

There are but two possible advantages to be gained in using a short-wave converter; a desire to retain the broadcast receiver, and the saving to be gained in purchasing a short-wave converter rather than a complete all-wave receiver.

# Books SELECTED BY THE EDITORS

## THE ART OF INVENTING AND WHAT TO INVENT

*By Raymond F. Yates*

WHILE it may be truthfully said that no list of needed inventions is necessary to the inventor, the author does devote four pages to a list of 77 articles that still remain to be invented. Everything which touches on our daily life can be improved and such improvements, in general, are inventions. Nevertheless, Mr. Yates has produced a book which we predict will have a wide sale and which undoubtedly will serve to put many embryo inventors on the right track. The author does not deal in platitudes but offers fundamentals which any would-be inventor can use to advantage. He deals with such things as what an inventor should know about mechanics, chemistry, electricity, sketching and drawing, and manufacturing methods. Patentable and unpatentable inventions are described in a few pages and the reader is put on the right path regarding applications for patents and his relations with patent attorneys. Three excellent chapters are those entitled "How Inventions Are Sold," "Pricing Inventions," and "Selling Unpatented Inventions." An appendix giving rules of practice in the United States Patent Office covers 63 pages and is well worth reading by anyone contemplating application for a patent.—$3.15 postpaid. —*A. P. P.*

## A FRESHMAN GUIDE TO WRITING

*By Prof. Bernard L. Jefferson and Prof. William D. Templeman*

WHILE this volume is intended as a text-book for students, it can be studied with much profit by thousands who are far past the freshman stage. We recommend it to those who have reports to write, particularly engineers and employees in industrial publicity departments.—$2.00 postpaid.—*F. D. M.*

## HEROES OF THE AIR

*By Chelsea Fraser, author of "The Story of Aircraft"*

THE 13th printing of this admirable book brings it up to date to the summer of 1935 and includes the now well known proposed commercial air route across the Pacific and the test flights which have already been undertaken over this route. The 744 pages of the book cover the subject of its title from the earliest days of flying up to the present time. The first chapter is devoted to a summary of the past and present of flight, while the second chapter plunges directly into the first transatlantic flights in 1919. From this point forward the author presents a running story of the more spectacular flights which have been made since that time. The text is supplemented by 56 maps which in themselves present vividly the progress that has been made and is still being made.—$2.70 postpaid.—*A. P. P.*

## MODERN CRIMINAL INVESTIGATION

*By Dr. Harry Söderman and Deputy Chief Inspector John J. O'Connell*

IF you are writing detective fiction these days—and who isn't, judging from the number of "pulp" detective magazines?—you will positively need this book to check on your facts. To the student criminologist however, and all those who are interested in the many applications of science to criminal investigation, this book will prove most informative, and so interesting that it will be impossible to lay it down once it has been started. These two experts carry you through the entire range of scientific criminal investigation to show you how the tiniest clue is examined minutely and often will lead to the criminal. Detective story addicts will read this so that later they may, with much glee, pick flaws in some of the very unscientific detective fiction that is now on the market.—$3.20 postpaid. —*F. D. M.*

## HODGE-PODGE PHOTOGRAPHY

*By Edwin D. Benedict*

"EARNING Money Via The Camera" is the sub-title of this little book which, despite the fact that it is atrociously written and very poorly printed, goes straight to the heart of the subject. The author writes from his own experience and does not, as is so often the case, mislead the reader into thinking that he can become wealthy overnight by taking pictures. Sound, commonsense instructions are given for photography under varying conditions and whether or not you want to make money with your camera, you will find much in this little book that will improve your photography. 144 pages, 5½ x 7 inches, paper covered.—$1.00 postpaid. —*A. P. P.*

## THE BINARY STARS

*By Robert Grant Aitken*

THE director of the Lick Observatory, a noted specialist on double stars, has revised his well known treatise, entirely rewriting some of the chapters in the light of the new knowledge of the subject gained by science since the edition of 1918 appeared. This is the standard treatise on its specialty. It covers the history, observing methods, and detailed theory, and is a technical treatise in full. It is now virtually a new book.—$3.75 postpaid.—*A. G. I.*

## DIET AND LIKE IT

*By Mabel E. Baldwin*

THIS book, which opens with an introduction by Daniel C. Darrow, M.D., of the Yale University School of Medicine, is dedicated to two main ideas: (1) that diets should be safe diets, and (2) should require no special cookery. The methods recommended are not monotonous or hunger diets but consist of correcting errors of appetite. A practical diet book for fat men—and others.—$2.65 postpaid.—*A. G. I.*

## MECHANICS AND APPLIED HEAT WITH ELECTROTECHNICS

*By S. H. Moorfield and H. H. Winstanley*

NO reviewer could expect to peruse this book completely as it is a text-book of mathematics and diagrams. While the authors explain that it was written with the object of producing a course in engineering science for the student, it is, in our opinion, more adaptable to the needs of a relatively advanced engineer. In 328 pages, most fields of physics are covered, starting with force and its effects, strain and elasticity, equilibrium of forces, friction, motion, energy, hydraulics, heat, and so on; in 63 pages is given a very concise outline of the fundamentals of electricity.—$2.40 postpaid.—*F. D. M.*

## SCIENCE AND THE PUBLIC MIND

*By Benjamin C. Gruenberg*

THIS book presents a survey of conditions in an age in which scientific advances and study have reached their

highest point, yet in which appreciation by the general public remains at a low ebb. The survey traces the development of scientific thought in America, and suggests a program designed to further public understanding of the importance of science as a manner of thought essential to the kind of civilization and the modes of living which we desire to see realized.—$2.15 postpaid.

## THE PRACTICE OF COLLOTYPE

*By Thomas A. Wilson*

THE collotype process is a photomechanical method of printing with ink from the surface of a photographic film. This compact little handbook—96 pages, 5½ by 8 inches—gives clearly and concisely the various steps in the process. From the instructions given, supplemented by line drawings, any mechanically inclined photographer should be able to produce excellent examples of collotypes. A chapter is devoted to doing this work in colors, a glossary of terms is of great assistance, and a comprehensive index makes any specific phase easy to locate.—$2.15 postpaid.—*A. P. P.*

## HEREDITY AND THE ASCENT OF MAN

*By C. C. Hurst, Ph.D., Sc.D.*

A NOTED geneticist explains in this small 136-page book, and in a popular, readable manner, the principles of heredity: what the gene is, how evolution progresses, the experimental creation of new species, and so on.—$1.65 postpaid.—*A. G. I.*

## A SQUARE DEAL FOR THE NARCOTIC ADDICT

*By William H. Ladue, M. D.*

IN the 131 pages of this neat, paper-bound book, Dr. Ladue gives much attention to the pros and cons of the question of the use of narcotics. He has gathered facts concerning the magnitude of the problem, the nature of addiction, and the laws concerning narcotics. He seems inclined to doubt that addiction is a menace, and discusses this doubt at some length. On the whole, it is a little booklet which should throw new light on this age-old question.—$1.10 postpaid.—*F. D. M.*

## MAGICAL CITY

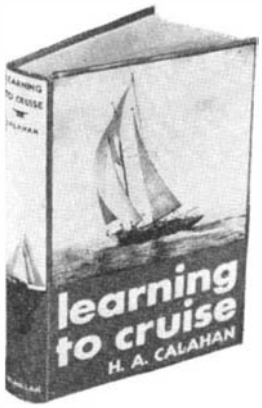
*By Vernon Howe Bailey, with text by Arthur Bartlett Maurice*

TO lovers of art and lovers of New York we can highly recommend this book of intimate pen sketches by the well-known artist, Mr. Bailey. In his drawings he has captured and preserved for the future the very spirit and personality of the Greater City. Churches, cathedrals, business sections, old residences, parks, historical spots—every little nook and corner of the city was visited by Mr. Bailey in collecting over 125 drawings, many of which are full-page size. The volume is a jewel measuring 10¾ by 8¼ by 1⅜ inches.—$2.75 postpaid.—*F. D. M.*

## LEARNING TO CRUISE

*By H. A. Calahan*

THE author of two successful earlier books, "Learning to Sail" and "Learning to Race," now gives us practical pointers on cruising, with much emphasis on the "practical." Only a well-salted old water rat would fail to pick up a whole world of valuable new experience (others' dearly won experience) from this book. It is for the man who cruises in sail, and it is a readable book as well as an informative one.—$2.65 postpaid.—*A. G. I.*




## PROFITABLE PHOTOGRAPHY WITH THE MINIATURE CAMERA

*By Edwin C. Buxbaum, A.R.P.S.*

BESIDES having a considerable amount of fun with the miniature camera, making trick "shots," art photographs, and the like, you can also use it for special paying work. This little paper-bound booklet of 72 pages tells not only how to make interesting photographs that are salable to news agencies or magazines but also gives many clues to the very large number of types of photographs that can be sold. For those who wish to mix profit with pleasure this booklet should prove most helpful.—$1.10 postpaid.—*F. D. M.*

## JOHN MULHOLLAND'S STORY OF MAGIC

THE fascination of stage magic which has gripped audiences for generations, and which reached the peak of popularity late in the last century, is here told by one of the masters. Mr. Mulholland gives you a glimpse into the lives of practically all the famous magicians of recent decades, and has included many photographs of tricks that are performed and of the magicians themselves. He does not explain the tricks, but your reading of them as Mr. Mulholland describes them will certainly set you puzzling over their solution. The book is as fascinating as magic itself.—$2.15 postpaid.—*F. D. M.*

## SCIENCE: A NEW OUTLINE

*By J. W. N. Sullivan*

THE author of several successful previous books on science here presents a survey of the sciences in general, under the headings, The Earth, Gravitation, Matter, Radiation, The New Outlook (atomic theory), Life Evolution. Numerous writers have covered essentially the same ground in books, but what especially characterizes this one is its elementary nature. Its language is simple and it does not try to go deeply into any of the subjects treated, hence it is best suited to readers who may have little previous scientific background. Your grandmother could follow it—well, maybe.—$2.15 postpaid.—*A. G. I.*

## CHEMICAL GUIDE

*11th Annual Edition*

NO matter what queer-sounding chemical you desire, be it of mineral, animal, or vegetable origin, you most likely will find it in this volume, together with addresses of companies who supply it. There is also a geographical directory, by states, of chemical firms. This 9 by 4¼ by 1¼-inch handy volume contains 801 pages.—$2.20 postpaid.—*F. D. M.*

## THE NEW AMERICA; THE NEW WORLD

*By H. G. Wells*

THIS little book contains Mr. Wells' thoughts after his most recent visit to the United States. He tells how we are facing the problems that face us, writes vividly of the situation in Russia, Italy, France and Germany, and tells us how a world state is or ought to be organized, ultimately, with its center of gravity in London or in Washington—among the English-speaking peoples. He discusses our three universal discussers, General Johnson, Senator Long, Father Coughlin. This is a vivid, lively little pocketful, sure to start equally lively argument wherever it is read. Good reading.—$1.10 postpaid.—*A. G. I.*

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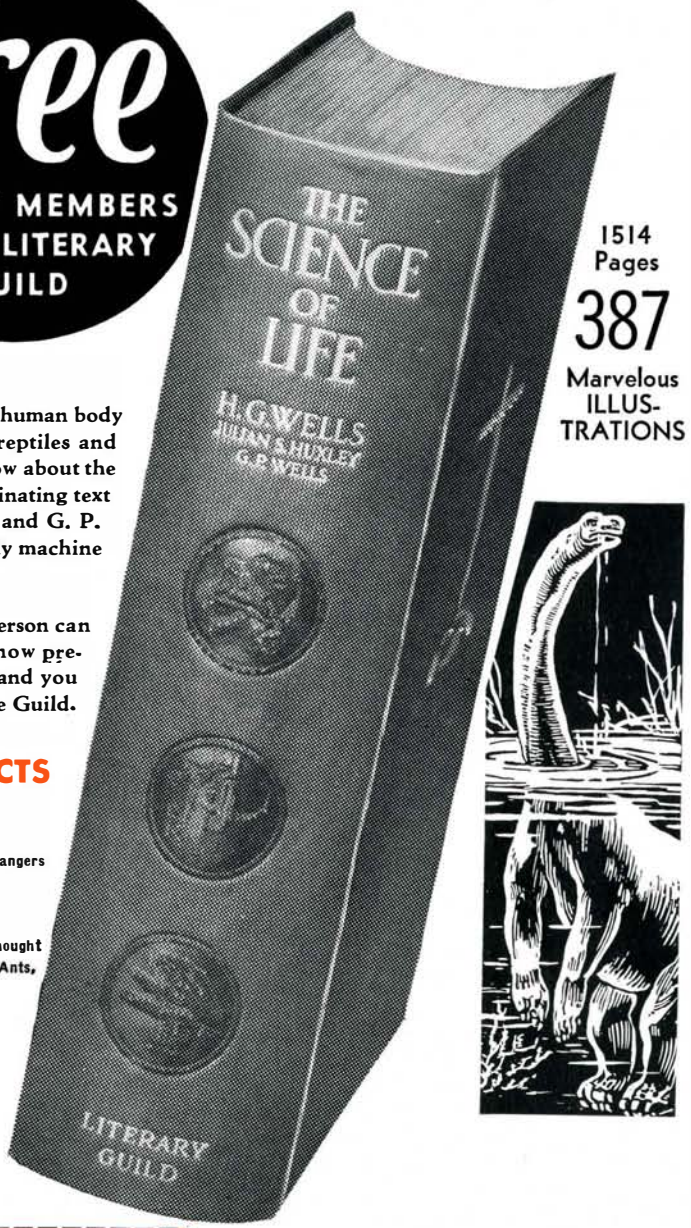


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