SCIENTIFIC AMERICAN

March
1933

35c
a Copy

How You Can Test Telepathy

By E. E. FREE

Scientific American's New Investigation
Starts in This Issue, Page 140

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THE TRUTH ABOUT HIGH-ALTITUDE FLIGHT

By W. H. Evers

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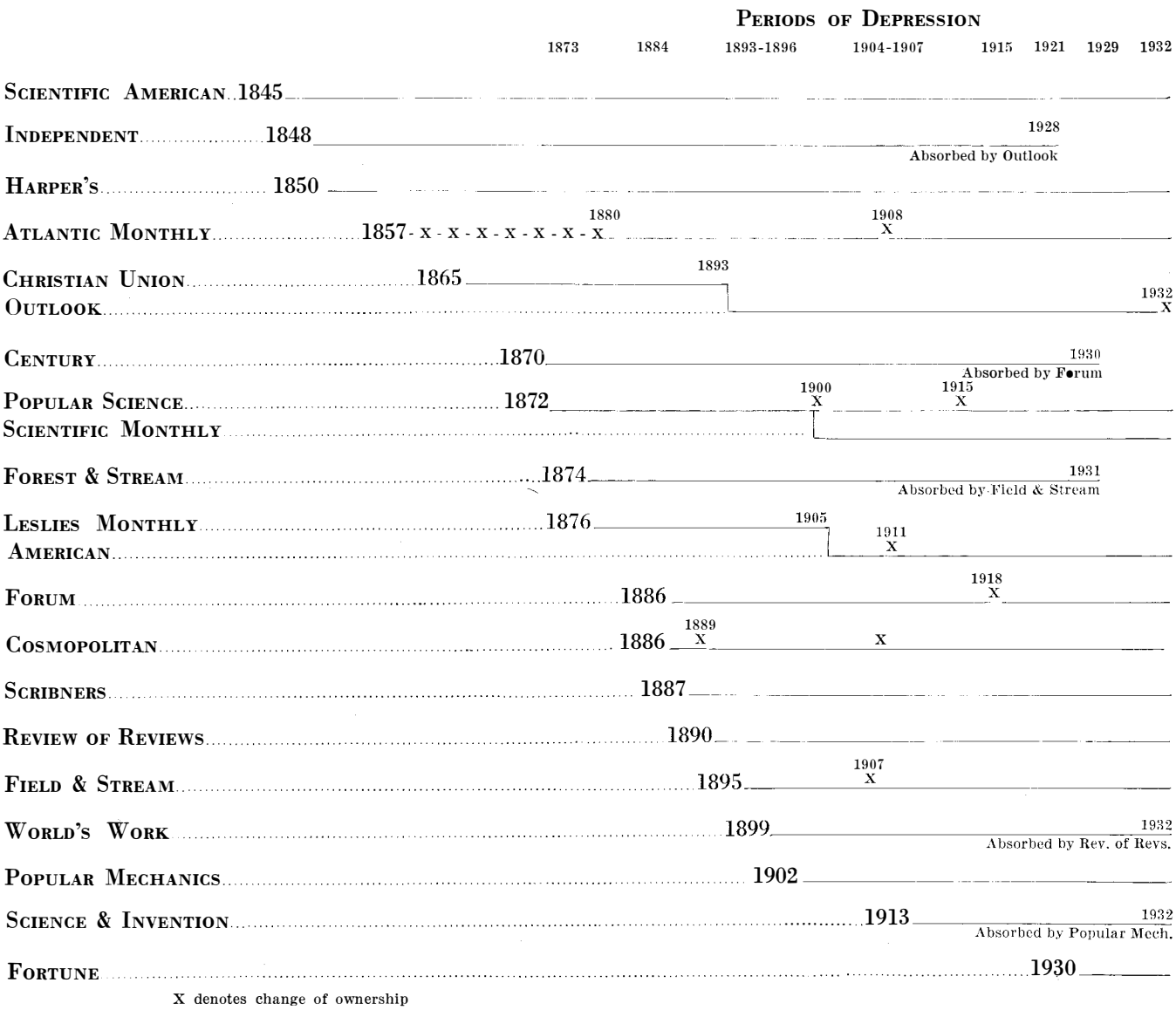
WHEN MICKEY MOUSE SPEAKS

By Andrew R. Boone

•

AND A DIGEST OF APPLIED SCIENCE

Life and Ownership of Magazines



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EIGHTY-NINTH YEAR • ORSON D. MUNN, Editor

CONTENTS · MARCH · 1933

An index of articles appearing in back numbers of *Scientific American* is to be found in The Reader's Guide, Industrial Arts Index, Engineering Index, and Dramatic Index. These can be consulted in any large library.

Another Advertiser Speaks

ON being inducted as President of the Association of National Advertisers, Stuart Peabody, manager of sales and distribution analyses of the Borden Company, said:

"We are firmly convinced that what our business needs is *quality circulation.* We will admit that perhaps it has been at least partly the advertiser's fault that so much premium has been put upon quantity. However, those days are fast disappearing, if they are not gone forever.

"I want to say emphatically, that I am not pessimistic toward advertising. I know that it is one of the most tremendous forces we have in business. But this power must be directed. We cannot in these stirring times afford to waste our ammunition. We must advertise boldly and courageously, but we must aim our advertising most carefully—no more hit or miss salvos for the sake of hearing the guns go off. We've got to wait until we see the whites of their eyes.

"Business has spent three years in ridding itself of the frills which almost concealed its true purpose in 1928. Management has awakened to a new era. We have eliminated much waste in our own businesses. We are selling our goods at a much lower cost. The buying power of the consumer has been reduced.

"The national manufacturer wants to advertise. He has to advertise. But he does not have to stand for the wastes in advertising which have grown up through the years. What he wants are facts—bare, unadulterated, undressed facts—about where his advertising money is going."

SCIENTIFIC AMERICAN

is second to none in the quality of its circulation

ACROSS THE EDITOR'S DESK

TELEPATHY. Everyone knows the word, and has some conception at least of its meaning. But no one can say definitely that telepathy is or is not possible. The word itself was coined in 1882 by F. W. H. Myers, who defined it as meaning "the communication of impressions of any kind from one mind to another, independent of the recognized channels of sense." In the 51 years that have elapsed since the definition was set up, there has been no scientific proof definitely established that such communication actually can take place. Therefore, SCIENTIFIC AMERICAN is starting, in this issue, an investigation of telepathy that may lead to results which will give to psychology an opening wedge. With such a tool available, it is possible that a new chapter may be written which will bring us still closer to a complete understanding of the human mind. This investigation will continue, and our readers will be kept informed through these pages. They will also be asked, from time to time, to assist in collecting data. Try the experiment described on page 140. Watch future issues for results and further experiments.

●

"Milk, the perfect food" is an expression often heard. But milk is not just milk, which is the reason for the search for "The Most Perfect Milk." This search has entailed an enormous amount of research and careful planning in an endeavor to bring to children all of the valuable properties of milk that it contains when fresh from the cow. An article now ready for publication tells of this work at one large dairy and concludes with the following statement: ". . . . we are approaching nearer to the ideal milk supply, especially for children."

●

"The cutter put a shot across her bow and the rum-runner stopped." Statements such as this, and descriptions of captures of prohibition law offenders by Coast Guard cutters, have become so common in the newspapers that the wide scope and humane nature of the duties of the Coast Guard have been lost sight of by many. We, therefore, asked the Superintendent of the Coast Guard Academy to prepare for us the sort of article that would straighten out the matter in the minds of our readers. This article, now completed and scheduled for early publication, outlines the customs protection duties of the Coast Guard, its hazardous life-saving work, patroling of coastal waters, its iceberg patrol in the north Atlantic. In addition, it tells a bit of the Coast Guard's history, its remarkable record during the World War, and of some notable Coast Guardsmen of the past, one of whom invented the airplane catapult for ships and another who flew across the Atlantic.

●

"The fundamental ideas of the behavioristic and gestalt psychologies justify attempts to construct and develop machines of a new type—machines that can think. Such machines are entirely different from the integraphs, tide calculators, and the like, to which the term 'thinking machine' is sometimes applied, for, unlike the latter, they are not designed to perform with mathematical regularity but can 'learn' to vary their actions under certain conditions." This is quoted from the opening paragraph of an article, "Thinking Machines" scheduled for publication next month. The author goes on to describe a device that exhibits an ability to "think" . . . and reading the article will make *you* think about thinking.

●

This telescope-making hobby is growing to a point where the harassed telescope editor has raised another cry for "more space." The usual four columns devoted to the subject are apparently not sufficient to bring to our readers the news of what other readers are doing in this field. Therefore, it has become necessary to heed the cry; in our April issue, two pages will be devoted to photographs and short descriptions of a number of home-made telescopes. Maybe this hobby is one that is worth looking into, after all. Why not try it?

●

Air conditioning in industrial plants, office buildings, railroad trains, department stores, and so on, is a factor that looms large on the horizon at the present time. What advantages has it to offer? Is it economically desirable? Definite answers to these and other questions will be found in an article that will appear next month. The article was prepared for us by Willis H. Carrier who has pioneered in the development of air conditioning, and who, therefore, writes with the authority of one thoroughly familiar with his subject.

Editor and Publisher

Your Hearing

By W. C. PHILLIPS *and* H. G. ROWELL

HOW to preserve and aid hearing by facts from the experience of two outstanding authorities. The mechanism of hearing, the varieties and causes of hearing trouble, with a careful statement on the possibilities of remedial medical treatments, are all carefully explained, as well as lip reading, mechanical aids, and systematic hygiene for the conservation of hearing. This is a constructive attempt to supply the lack of knowledge which results in making a disaster out of a mishap.—$2.15 postpaid.

Finger Print Instructor

By FREDERICK KUHNE

THIS is the standard work on the subject of finger-print identification. It is used in the schools of instruction of the U. S. Department of Justice, the Connecticut, New York, New Jersey and Pennsylvania State Troopers and by the Police Departments of most of the larger cities of the country. It is written so that anyone can learn by self-study and many individuals are taking up this fascinating hobby. There is a great opportunity in this line if one will but study attentively.—$3.15 postpaid.

The Metals

By A. FREDERICK COLLINS

THE alloys, amalgams, and compounds which are so rapidly being developed in a wide variety of applications are here explained for the nontechnical reader: common metals, noble metals, uncommon metals, rare-earth metals, radio-active metals, and so on—also the discovery of each, how and when first found, what use is being or probably will be made of each. There is an interesting chapter on hypothetical metals —metals once believed to exist but later proved to be non-existent. A handy compact reference.—$2.15 postpaid.

Cyclopedia of Formulas

By ALBERT A. HOPKINS

STEADILY this premier reference book maintains its place both in the libraries, where Librarians tell us it is one of the most frequently consulted books, and in the laboratory where it will invariably be found in well-used condition. There is a formula for almost every conceivable industrial and home purpose.—$5.50 postpaid domestic.

Marvels of Modern Chemistry

By BEVERLY L. CLARKE, PH.D.

BASED on "Every Man's Chemistry" by Ellwood Hendrick, which was the first comprehensive book written for the layman, this goes a bit further and brings this branch of science up to the present day. Natural divisions of Theoretical, Inorganic and Organic Chemistry are again divided into constituent parts and developed according to the interest and value of each in industry. Thirty photos "bleed" the pages, thus giving larger illustrations than the size normally allows. It would be difficult to imagine a more intriguing and substantial presentation than is here to be found. Lucky are the classes that will have this as a text or reference book and it should with equal propriety be available in all general libraries.—$3.20 postpaid.

Book of the Microscope

By GERALD BEAVIS

THE FASCINATING hobby of Microscopy is gaining new enthusiasts every day. This popular book provides a pleasant approach to its marvels. Without any of the ear-marks of a treatise or text-book it tells how to observe in the animal, vegetable and mineral kingdoms. This vast world contains an endless variety of subjects. Microscopy, once tasted, becomes a life-long hobby and incidentally it is an inexpensive one. A large sale of this book proves it is filling the needs of the neophyte.—$2.65 postpaid.

For Sale by

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

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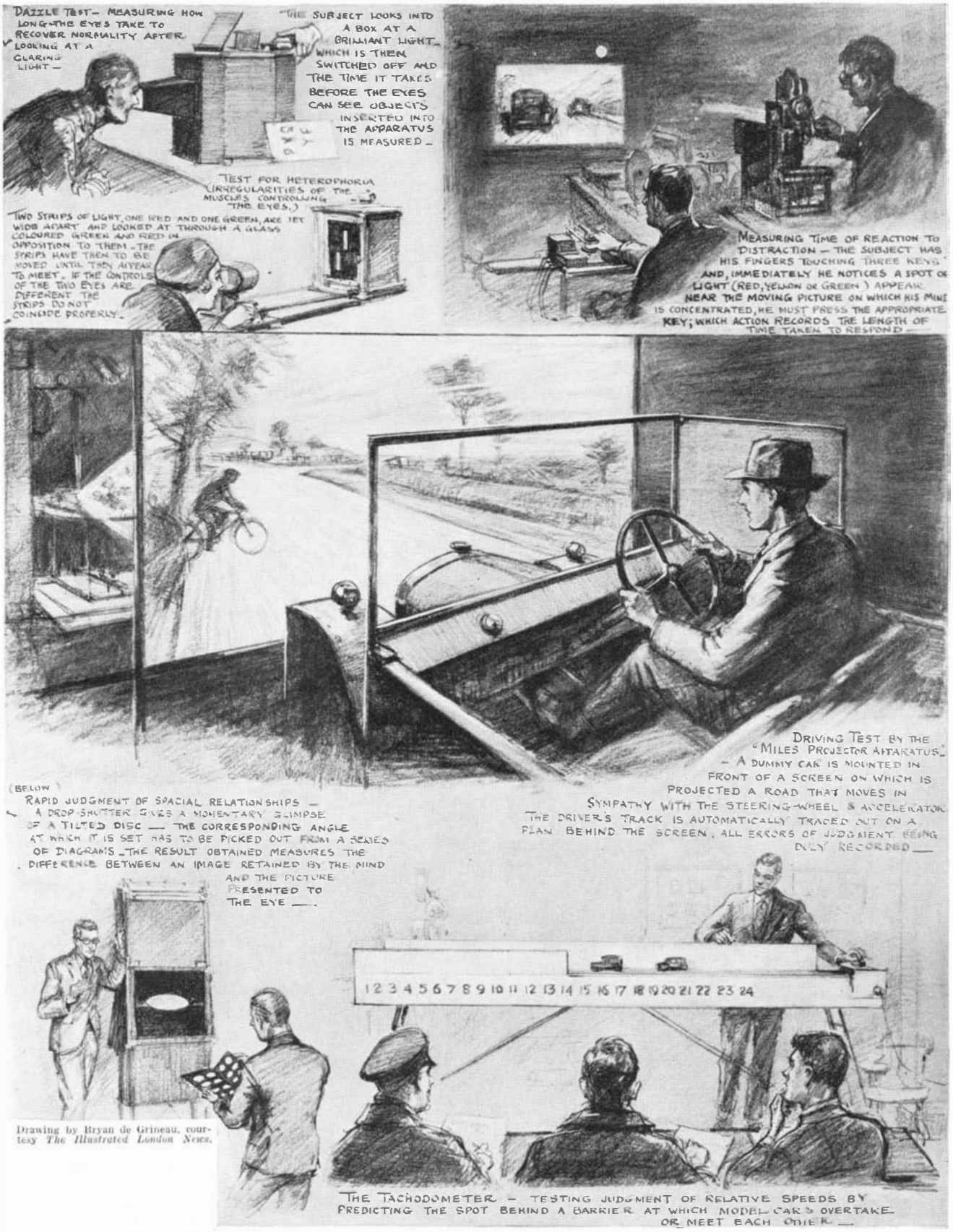
Photo by *Science Service*

HENRY NORRIS RUSSELL

READERS—and there are very many of them—who regularly follow Professor Russell's monthly astronomical articles in this magazine often urge the editor to publish his photograph, arguing in favor of this their natural wish to see the man behind the writings. This request is acceded to on the present occasion, when our astronomical editor has just been elected to the Presidency of the American Association for the Advancement of Science, the largest of all organized bodies of general scientific men. The A.A.A.S. has almost 20,000 members and comprises practically the entire personnel of the many branches of American science—mathematics, physics, chemistry, astronomy, geology, and geography, zoology, and so on. It is unofficially the great general "holding company," federation or overhead organization of the several sciences, each of which has its own organization, and the award of its presidency is regarded by all men of science as a signal honor. This honor is customarily awarded to men who, usually later in life than Professor Russell (who was born in 1877) have attained by their own merit a stellar position among the scientific men of our country. Professor Russell is a member of both the National Academy of Sciences and the American Philosophical Society; also of the American Academy of Arts and Sciences—all being bodies of limited size which select their members on the basis of actual attainment in science, not newspaper fame.



Drawing by Bryan de Grineau, courtesy *The Illustrated London News*.

Temperament and Psychology at the Wheel

ORDINARY practical tests do not show how a driver of an automobile will act in an emergency. Therefore the National Institute of Industrial Psychology, of England, has brought this problem into the laboratory and, by means of psychological tests, is determining the temperament of motorists. These tests, some of which are illustrated above, have been applied to bus and truck drivers over a period of 18 months, and their driving records have, as a rule, corroborated the laboratory findings. The principal value of this laboratory work is in weeding out poor drivers of automobiles.

Where dividends are paid to taxpayers: The 400-acre farm of the Department of Agriculture at Arlington, Virginia. It is devoted to experimental work with different plants, and research in fertilizers, insect pests, and other important problems

When Cabbage Has the Yellows

By T. SWANN HARDING

THE accompanying article discusses with much vigor a different kind of "Report to Stockholders." From the facts presented here—and they are authoritative—we begin to suspect that, hidden away in the maze of governmental departments, divisions, and bureaus in Washington, there may be, must be, many others besides the one discussed that pay huge dividends to their stockholders: to you and me. Slashing governmental expenditures for greater economy should be based, therefore, not on political expediency but upon a judiciously calm consideration of the facts in each case. There was a goose, that laid a golden egg, you know. . . . *The Editor.*

A FEW days ago some Wall Street trust company in which I must own a few shares of stock (I am trying to forget my transgressions but they will not let me) sent me a series of printed documents to inform me that it had suddenly burst in twain and had become a bank and a holding company. Among a great number of "Witnesseths" and a red rash of "Whereases," I apprehended that "my" officers and directors had given the matter a great deal of time and thought, and had ultimately decided that the best possible thing to do would be to divide into two parts. However, they sought my consent!

MY first tendency was to write in immediately and tell them they simply could not do any such thing, at least not so long as I retained my 20 shares of stock for which I had paid 48 dollars and which would now bring me at least 23 dollars, if I could only find a buyer! Then it occurred to me that such rash action without reflection might not match up well with the "great deal of time and thought" *my* officers and directors had given the matter, and might so upset them that the bank would split into many parts instead of merely two and leave us all broke. So I carried the printed matter about for days and mulled over it, finally exploding one morning to my seat mate in the street car:

"I wish somebody would get out some sort of a report to stockholders that somebody with a one-cylinder financial mind could understand." To this there came the astounding reply:

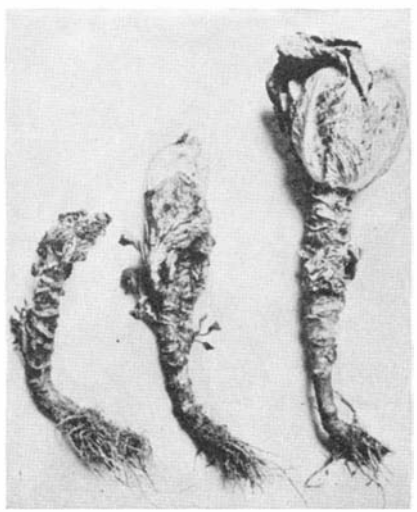
"Well, I am a phytopathologist." I glanced at the speaker and found a small, somewhat humble, but nevertheless intelligent looking wisp of a little gray man, and, out of the fullness of my anguish I said:

"I believe you are. At least I shall take your word for it. But I don't see how that is going to help matters."

"Oh, but you are a stockholder in the corporation that employs me," he said. "At least it costs you about $2.41 a year to help keep that entire corporation going."

"Don't be mysterious so early in the morning," I said. "If you must mystify me, then— Or should I bite? I shall. Of what corporation do you speak?"

"The United States Department of Agriculture. I am in the Division of Horticultural Crops and Diseases. You never heard of it. You can't even imagine what it does. Yet you are a stockholder in it and it pays you big dividends. Here!" At that, he thrust a paper at me and scuttled off the street car. Oddly enough, this purported to be



Cabbages with the yellows, a costly disease now successfully controlled

"A Report to Stockholders" and it actually contained something I could understand. Indeed it was refreshing to turn from the morass of banking to the work of one small division in one moderate sized bureau in one government department at Washington and see what my $2.41 annually (the per capita cost of maintaining the entire department) was wasted on!

For, despite the paucity of my fiduciary equipment, I at least knew that a dollar collected for taxation crawls into a rat hole and is gone forever. It buys nothing. It brings no returns. It does not help money circulate. It can never be spent again. It simply crawls into the rat hole and is gone forever and forever. Amen. To my wrath and astonishment, this report started off by boasting that a total of 14,000,000 dollars had been spent by this one Division of Horticultural Crops and Diseases—in a period of 44 years, that is. What a howdy-do!

The next paragraph, however, brought me up against the wilt-resistant tomato known as the Scarlet Topper (née?) but now officially designated the Pritchard in honor of the late Fred J. Pritchard of this Division. I landed here without disaster and discovered that this division regularly developed, and then gave to the trade, tomatoes that resisted a tomato disease called wilt. I discovered that, even allowing for the low prices of the past two years, wilt-resistant tomatoes introduced by this division now make up a fourth of our annual 45,000,000-dollar tomato crop, and return to the growers more than six times the amount spent each year to maintain *all* of the work of the division. That began to look like dividends, something my trust company had never bothered to discuss with me at all.

THEN, there is lettuce! This division has made double-resistant lettuce because, apparently, fruits and vegetables have to be "serviced" like automobiles to keep them in good running order; new models are required to meet new conditions; and disease-resistant varieties, in the case of growing things, must be produced. This lettuce resists both mildew and blight. Department investigators have visited growers in various regions of the country; have produced the kinds of disease-resistant lettuce best suited thereto; and during the past five years the crop of such lettuce has brought 8,000,000 dollars annually to the growers. In short, this single achievement of a division in a government department has returned to Americans, in a few years, more than double the amount appropriated for all horticultural investigations over a period of 44 years, the 14,000,000 dollars which so horrified me in the beginning.

The specialist goes the rounds of farms and orchards examining farm products and explaining plant disease control

Where is that Chamber of Commerce? Who was it that said tax dollars crawl in rat holes and die?

Next I struck an item about standardization. I knew about this business of reducing 44 types of bricks to one type, and 1819 varieties of sheet metal to 261, but I was unaware that the idea could be applied to vegetables. I discovered that this same division was showing the canning and vegetable industries how to select the really important commercial varieties of peas, tomatoes, and cabbages. If the unprofitable varieties of these three vegetables were eliminated there would result a 10 percent saving to growers, or some 7,000,000 dollars a year. Apparently, commerce and industry do not themselves think of these things. They have to have government employees in such places as the Bureau of Standards and the Bureau of Plant Industry to initiate reforms and then educate the trade up to using these discoveries.

The stockholders' report next mentioned a new potato seedling named Katahdin which has unusual promise because it is resistant to mild mosaic, is highly productive, and yields more No. 1 grade potatoes than most standard varieties. Its general introduction will more than repay the American taxpayer for all the money spent on potato investigations since the Department of Agriculture was created. These investigations have distinct economic and social value also, although that is usually forgotten—at least I never thought of it.

Consider, for instance, the fact that sweet-potato growers in this country have reduced production 10 percent during a recent period of years while at the same time, and in spite of declining prices, having their monetary returns cut only 2 percent. The explanation, of course, is that sweet-potato diseases have been reduced by 61 percent, so that much more of the crop produced is actually marketable than ever before. Indeed one might truthfully say that the sweet-potato disease project of the Department of Agriculture has now become a minor one, its allowance being reduced because most of the problems are solved and it is only necessary to prevent the patient from relapsing.

WHAT does this mean in terms of money to me, a small stockholder? The loss from sweet-potato disease in this country between 1918 and 1924 was 31,000,000 dollars. From 1925 to 1930, the figure was only about 8,000,000 dollars for a period only a year shorter. This difference goes far also to wipe out the original 14,000,000-dollar debit. Its social and economic significance is this: Farmers are told to reduce production but they would far prefer to do so while at the same time reducing income as little as possible. Here is an instance where government employees have shown growers how to reduce a crop by 10 percent while losing only 2 percent in income. Again page business-men-critics of governmental expenditures!

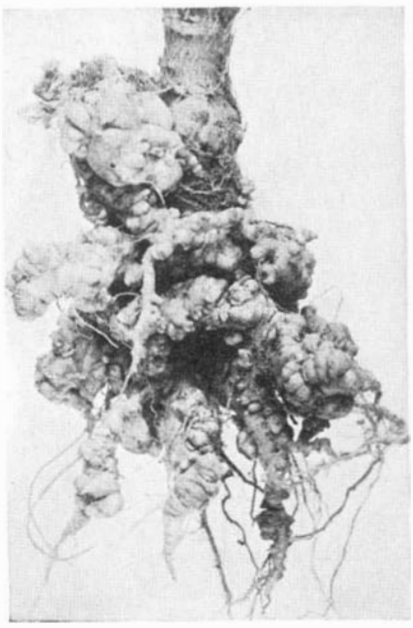
That brings me to cabbage yellows which, as far as I knew, might mean some sort of radical movement among the cabbages. However, it is a disease, caused by a soil fungus which never seemed to die out even if the land were abandoned for cabbage culture for many years. The economic effect of the disease was alarming. Not only were crop growers deprived of an important source of revenue, but many sauer-kraut plants, representing thousands of dollars in investments, were faced with extinction or the necessity for shipping in their raw material from

localities at ever-increasing distances.

Soil treatments of sorts were tried without avail. It became evident that someone—apparently a government employee—had to devise a disease-resistant cabbage. One was found. The resistance factor was inherited. Soon various yellows-resistant varieties of cabbage, suited to various localities, came into existence and today 80 percent of the cabbage crop in southern Wisconsin, Chicago and vicinity, and Ohio, 75 percent in southwestern Virginia, and 50 percent in southeastern Iowa consists of such varieties.

IN districts where yellows occurs this simply means an absolute difference between profit and total loss. Many of the sections now successfully growing the disease-resistant cabbages were unable to grow any cabbage at all 15 years ago. The emergency was met. Government employees came to the rescue at call. The returns to growers are now 1,000,000 dollars, not counting the saving of the kraut manufacturers. This strikes me as a stockholders' report with some sense to it. I seem to understand it. However, the businessmen who are in fulmination against what they call the wild extravagance of the Federal Government and of the Department of Agriculture seem as incapable of comprehending it as I am of making head or tail of bank statements.

The thing goes on and on. I can only go on so far. All good street cars stop somewhere and I am still on one, in a manner of speaking. I discover, before I leap off to dodge automobiles, that spraying and dusting for celery mosaic have reduced losses to Florida growers from 60 to a mere 6 percent of their crop—another item of millions saved, for it is a crop worth 6,000,000 dollars to them annually. I discover that these government employees have shown the California fruit industry how to get oranges east with only one, in lieu of a former 10 or 12, re-icings in transit—a saving of another million a year.



Another disease which takes a toll from farmers: Cabbage club root

I discover a public service patent gotten out by government employees on a method to prevent the shattering of vinifera grapes during marketing, meaning a saving of from 50,000 to 100,000 dollars annually for growers. Government employees have found methods of giving good color to poorly colored, but otherwise excellent, fruit and have saved Florida growers 3,000,000 dollars a year losses. They have shown that pears and apples in the bottom layers of commercial carlot shipments were injured by jarring and bruising, en route, and not by freezing as the railroads thought, and have prevented the railroads from losing 200,000 dollars a year on such cargoes by having growers place resilient corrugated cardboard linings in their shipping boxes and crates.

AGAIN, the commercial culture of the date was introduced by this same agency to the United States. Today the Goachella Valley of California produces 5,000,000 pounds of dates annually, and the industry is expanding. Date growing constitutes one of the great prospective fruit industries of the southwest—a non-competitive fruit industry in the bargain. Within the near future, this industry will be returning annually to growers more than the 14,000,000 dollars expended for all horticultural work of the department to date.

According to this stockholders' report, the entire picture of fruit and vegetable production has changed within recent years. Whereas growers had formerly to depend upon chance seedlings, today plant breeders work along very definite lines leading to definite ends—the securing of a desirable combination of characters to make a vegetable or fruit fit well into specific environmental conditions. If a fruit or vegetable industry is threatened in a certain locality, appeals are made to certain professional government employees, state or federal, who take the problem under advisement and eventually produce a product that will resist disease and thrive in the locality; thus they re-establish an old or find a new source of revenue.

Specifically, this stockholders' report informed me that there is one relatively small division laboratory in the Bureau of Plant Industry in the Federal Department of Agriculture that has produced results which, in strict monetary terms, would actually pay the entire annual appropriation of this department each year, with some left over. Just why the yowling about the excessive expenditures of this department, when it pays its way in the only manner public service can in a profit economy such as ours? Roughly speaking, the return on every dollar this Department spends on research is 500 dollars collected by agriculture and industry as profits. Thus my $2.41 investment yields me 1205 dollars. I must try to get hold of it some time.

In pears, shipped from the Pacific coast in untreated paper, a mold often spreads and spoils the fruit—see left. Copperized paper, developed by the Department, prevents this—see the firm pear at the right

MORE important is the fact that this work, so valuable and so profitable to agriculture and to industry, as well as to business in general, is being performed by those time-serving, incompetent, lazy, good-for-nothing government employees about whose shortcomings I have heard so much these many months. Businessmen, industrialists, and politicians say: Cut out such expenditures; let all this valuable work go into the discard. In short, let us reduce our own profits and our income enormously in order to save relatively insignificant sums expended by government.

This suicidal attitude simply does not make sense to me. Instead, it completely mystifies me. My respect for phytopathologists is enormously enhanced by what I have just discovered, whereas my distrust of bankers and businessmen remains unaltered. Somebody is as crazy as the devil in this country and I don't believe it is the professional employees of the Department of Agriculture. When I find out just who it is I shall let you know. Meantime I have very healthy suspicions of the fellows who wrote me that letter from the New York bank.

OUR POINT OF VIEW

Cure-Alls, Catch-Words, and Cant

IT is not new—this bombardment of analyses, criticisms, and correctives for a culture that is supposed to be decadent. Self-styled and almost as often self-publicized saviours of the world have been with us always. The bombardment just now, however, waxes furious, iconoclastic, as though each of those with a plan is afraid the depression will be over before he can make capital of his idea. Nothing is so firmly entrenched by years upon years of successful operation, nothing so tried by the long test of human needs, nothing so sacred to the deep-seated traditions of the ages, that it does not stand the brunt of fierce attack.

The strongest criticism now voiced is leveled against our American social order. Our social development, say the critics, has lagged behind our technological advance which, admittedly, is higher than that of any other nation. Reams of generalities, platitudes, and involved and obscure English have been written to expound theories of reform, but somehow the public has not been let into the secret. The mass of people is mystified and confused by a plethora of plans and a plethora of words; hence, traditionally opposed to any dogma limiting individual emprise, it raises cries of "radicalism," "Socialism," "Communism," hoping thus by epithets not always deserved to fend off these ideas that are beyond their comprehension and which might, actually, serve the public good.

There is no doubt that our social advances have been negligible in comparison with our inventive progress. Engineers, industrialists, and economists everywhere, and even so capitalistic a man as President Hoover agree on this point and say that the one must catch up with the other if we are to solve the problems facing us today. But how may this be accomplished? By inflation of currency to start business moving again? By the adoption of Socialistic theorems? By establishing a dictatorship in this country? By revolution? Is assistance in this direction possible by the adjustment of the world financial situation through the establishment of a new currency not based on gold but upon the unit of electrical power measurement: the kilowatt? This particular idea has merit; the "electrical dollar" would, possibly, serve as a balance wheel, but then, as prosperity returns, the people would promptly forget the past and go on another financial spree.

Can we solve our problems by first denouncing as fools the great majority of our people? Damning an evil condition does not cure it. Yet this is what, in effect, the promoters of the widely heralded Technocracy have done and seem to be attempting to do. They say that Technocracy "has made invalid every social, economic, and political postulate now in use," but, for the average man at least, their evidence does not carry their point. It is all very well to say that all human activity should be integrated on the basis of energy, that the substitution of kilowatt-hours for the present man-hours is inevitable, but how accomplish the transmutation? What if it did take 1291 man-hours in 1904 to build an automobile while it now takes only 92?; that has decreased employment *per automobile* only, but millions more of automobiles are now sold. Result: a net gain in employment. It is easy to talk of building imperishable automobiles, a permanent suit of clothes or pair of shoes, or a life-long razor blade; but let's not forget that human nature is innately opposed to standardization, at least of the hard-and-fast long-term sort. It sounds impressive to talk of a few great industries where the life of the product is relatively short, where efficiency is low, and employment per unit of product is lower than ever before. Something, however, may be said for all of these. Short-lived products permit steady replacement, a circulation of cash, and increased employment. Low efficiency per man in industry is exactly what the experts are aiming at in a different way. And the decreased employment per unit of product has the effect mentioned above in connection with automobile manufacture.

It is hardly fair to assume that the "experts" have not balanced all these things one against the other, but if so, they have not made it clear. They seem to have left out of their discussions the fact that momentous new inventions can, and perhaps will, take up the slack, once we recover from this depression, as automobiles, the telephone, airplanes, radio, and the movies have done in the past. In a very short lifetime, these five industries have become leaders, employing many millions of people. Other new industries of the future may repeat these successes. Furthermore, though we may talk glibly of over-production, no one yet knows just what is implied by this term, for the depths of human demand have never been fully plumbed and probably never will be.

Technocracy no doubt has many splendid points. Its greatest virtue is, we think, that it does exist; in itself it is evidence that men of many minds are testing this social problem of ours in laboratory crucibles. They may not be alchemists and thus may not be able overnight to transmute the present dross into an aureate future, but they have assuredly turned up truths which will slowly exert a great influence on our future civilization. Under the aegis of the Technocracy experts and similar bodies of scientists, changes may really come, but they must be accompanied by cultural influences that do not bear the "taint" of the machine age.

As for the catch-words with which modern social reformers would lead the people, so far they all seem to be exceedingly unfortunate. The individual, still imbued with a preponderant percentage of human nature, judges, at a superficial glance at the word used, that the whole thing is cant and chicanery, and with a shrug reminds us of the tragic fate of German "Kultur."

Predictions

FOR awhile, a year or two ago, it was the fashion to utter dire and gloomy predictions as to the future of civilization. Having, like the Roman Empire at its peak, become softened by a period of hitherto unbelievable prosperity and luxury, we were doomed never to recover from the ill effects of the capitalistic scheme of things, from our mechanization program, and our own stupid short-sightedness; it was the end of everything, and only plans, plans, and more plans would save us. Nowadays, the fashion has waned among the populace in general but has become more intensified in certain quarters.

It now appears that, unlike the Roman Empire, we are to have no long period of decline, but, instead, are to fall plop! into oblivion. Statistics, graphs, intricate mathematics prove it! In one year, two years, three years, the number of unemployed in this country will number 20,000,000, or even 25,000,000. The size of American families has dropped from 4.6 persons in 1900 to 4.01, and since it is still dropping, we can not continue to expect a steadily expanding home market for our products. Technological progress has been such even during the lean years that,

were normal demand to make itself felt suddenly, a small proportion of those required for the purpose in 1929 could easily meet it now with the aid of machines.

Such predictions seem primarily a philosophy of fear. Advanced at a time when hope and confidence are taking hold and creating the will to fight the fight to better times, they are in exceedingly bad taste. On all sides one now hears not only predictions of improvement to come in all lines during this year but also accounts of better business already in evidence. The automobile industry, for example, itself a barometer of business conditions to a large extent, has already shown improvement. In December, it showed an increased production over December, 1931, this being the first month such an increase over the same month of the preceding year has been made since 1929. This industry uses normally enormous quantities of rubber, cotton, lumber, plate glass, copper, lead, iron and steel, and many other products. It employs millions, directly and indirectly.

If, therefore, the automobile industry has definitely begun its period of convalescence—as is generally believed—its activity will serve not only to stimulate many diverse industries but will indicate the general trend. The calamity howlers will then have great difficulty in finding quotable statistics with which to alarm us.

Automobiles

TO speak of predictions and automobiles in the same breath is just now the worst sort of faux pas. At least that is the impression gained from the attitude of the industry's executives. Some of them frankly say that they are afraid to make statements that bear the least resemblance to predictions concerning the future of the industry; others will not even reply to questions; and only one in our experience has had the courage to tell, confidentially, of some of the ailments of the industry.

There is no question that this great and typically American industry has been hard hit by the general depression. Production of cars declined from 5,600,000 in 1929 to 3,500,000 in 1930, to 2,500,000 in 1931, and finally to less than 1,500,000 in 1932. Consequently, reckoning by the Department of Commerce's estimate of an average life of seven years for all cars, there should be an accumulated replacement demand for more cars in 1933 than were built in 1929. Yet, faced with the possibility of greater purchasing power this year and therefore the possibility of making larger sales than they did last year, what have automobile executives done to take full advantage of their opportunity? To meet the problems with which, admittedly, they are faced? Have they produced this year anything outstanding to tickle the public's fancy or to merit the enthusiastic approval of mechanically minded motorists? The answer appears to be: "Nothing."

Here, indeed, is one place where the inauguration of plan and purpose seems indicated. The industry is apathetic regarding the future. The present is sufficient. No need to do more than improve odds and ends about the car. Then, if one maker adopts a new down-draft carbureter, a new transmission, freewheeling, a new rubber engine suspension, or some atrocious body style, the others copy at once. On the whole, improvement is made thereby but, taken alone, each item is primarily a sales argument to beguile the public, whether or not it is a real contribution or possesses the merit of originality.

It has been said that manufacturers all have on hand completed plans for a "tear drop" car, but each awaits the initiative of some other maker to start the fashion. Why the delay? Experiments with Diesel engines for automobiles have been carried out, but so far no company has perfected a commercial engine of this sort. Why? Other possibilities, which we shall not attempt to enumerate here—the industry knows them better than we do—have been passed up. Again, why?

One noted, far-sighted maker says he believes the point of saturation in per capita ownership of cars has not as yet been reached. This, together with the present replacement demand and the fact that the foreign market is being more tightly closed against American cars, points to the necessity for concentration on the local market. By concentration, however, is not meant an efflorescence of ballyhoo and high pressure salesmanship, but the production of real and outstanding improvements.

Blazing Ships

SUPERSTITIOUS French seamen are probably by now thoroughly convinced that some new jinx has singled them out as particularly good victims for disasters to come. Another great French ship, the 20,000,000-dollar liner, *Atlantique*, is the latest victim of a series of fires that have taken toll of the French merchant marine since 1930. The *Paris* was damaged by fire at Le Havre; the *Lutesia* sank after being burned at St. Nazaire; the *Asia* sank after being destroyed by fire while carrying pilgrims to Mecca; the *Georges Philippar* was burned and sunk on the return trip of her maiden voyage to the Far East; and the *Atlantique* was burned in the English Channel early in January and was practically destroyed.

What is the explanation for these fires? Sabotage? Perhaps. If so, those responsible have covered their tracks well. The fact that in some cases fires broke out in several places on doomed ships simultaneously would argue against pure accident, at least in those cases. Also, the more modern of these ships were equipped with the latest fire signaling devices to indicate the location of a fire before it gained such headway as to be beyond control, and with fire doors and most efficient fire-fighting equipment. For these reasons and, furthermore, because there is a limit to coincidence, accident could not have been responsible except perhaps in one or two cases.

When the German liner *Europa*, partly completed, burned at her pier several years ago, it was quickly learned that labor trouble was the cause. Nothing so definite has been learned about the French ship fires. If sabotage has been responsible, either in the form of malicious arson by some one on board at the time or in the form of purposely defective workmanship, then what is the purpose behind it all? If it *has* been sabotage, then the malcontents—who have become murderers because many lives have been lost in these disasters—have failed to dramatize and capitalize their deeds in not making known their reasons. That is, unless they wish simply to throw suspicion on all French ships.

Transairlantic

THE groundwork for transoceanic airlines having been laid, both in regard to airplane design and scheduled ocean flight experience over a long period of time, the establishment of transatlantic and transpacific airplane services now seems imminent. Some time ago, the Pan-American Airways System announced that contracts had been signed for at least six Clipper type monoplane transports larger than any heavier-than-air craft now in commercial use. These new ships, to be built in two types by the Sikorsky Aviation Corporation and the Glenn L. Martin Company, are expected to carry passengers, mail, and freight from the United States to Europe and the Orient. They are discussed in the Digest section of this issue.

With this assurance that sufficient knowledge of ocean flying has been obtained, there can now be no possible excuse for foolhardy private attempts to span the Atlantic by airplane, other than that some obscure flier seeks the attendant publicity. There was no sane excuse for the disastrous attempt of the "Flying Hutchinsons" last year nor for that of the "American Nurse." This year, we hope that, if other fliers seek, in like manner, the adulation of the crowd, public opinion will discourage and if possible put a stop to their plans.

How YOU Can Test Telepathy

By E. E. FREE, Ph. D.

MOST experiments on telepathy seem to have been inspired by an idea which I cannot help thinking improbable—the idea that telepathic powers, if real, are possessed by only a few individuals. This is a reflection, doubtless, of the prevailing theory of mediums, many believers in the so-called psychic phenomena holding that the intervention of one of these rare and gifted human individuals is necessary to provide contact between ordinary humanity and the mysterious powers, whatever they may be, which mediums are supposed to invoke.

Whatever may be true about the alleged abilities of mediums, it is not logically necessary to apply this idea of peculiar power to telepathy. If telepathy is real at all, if it ever happens that there is exchange of information or of emotions between mind and mind, other than through the known channels of sense such as the eyes and ears, it is inherently probable that the power of sending or of receiving such telepathic impressions is innate in virtually all human beings, just as the power of seeing is innate in everyone who has reasonably normal eyes.

SOME persons may have developed these telepathic powers more highly than others, just as some individuals can read print better than the average or can distinguish very slight difference of color or can use their noses to detect the tiny differences in odor between varieties of coffee or tea or perfume.

The question is, can telepathy be likened to these well-known abilities? Is it possible that there exists in humanity a forgotten ability of some kind to communicate with each other, an ability which modern human life does not encourage or develop? If the claims for telepathy represent anything more than delusion and fraud this idea seems inherently more probable than the more conventional belief that each generation harbors a few "telepathists" who possess a power quite lacking in the rest. At least, this is an idea worth testing and one which happens to be easier to test conclusively than the contrary hypothesis of special and mysterious powers.

Present-day investigations of telepathy seem all to have ended in blind alleys. There are unquestionably many facts which suggest the possibility that telepathy is real but there is none, to my knowledge, which provides what could be called satisfactory proof. Incidents of premonition or of sudden mysterious knowledge of supposed events later found to be true mean nothing. The arm of coincidence really is long and the only way to extract proof from these instances would be to reduce them to mathematical formulation according to the rules of chance; discovering, for example, just how many previous premonitions had been experienced by each such "telepathic" individual but found *not* to be correct. In no instance which I have been able to find by inquiries extending over several years has it been possible to produce facts completely excluding both illusion and coincidence and proving the supposed telepathy to be a fact. This does not disprove telepathy. It merely shows the difficulty either of proving or of disproving it by collecting supposed instances of its occurrence. The method of study needs to be changed.

OBJECTIONS almost equally fatal may be brought against another common kind of telepathy test, the familiar experiment in which some fact, object, or message is agreed upon and a person not in the secret is asked to "receive" telepathically some inkling of what the secret is. In tests of this type, first suggested by E. F. MacDonald of the Zenith station in Chicago, and conducted some time ago in England under the direction of Sir Oliver Lodge and in America by Professor Gardner Murphy, the aid of radio was enlisted, the selected list of secrets being known only to a group of persons in the broadcasting studios. At given signals radio listeners all over the country were asked to guess what object or message was being thought of and to send in their reports. Thousands of these records yielded only very small percentages of success and not a scintilla of the desired proof that telepathy is real.

A variant of this test is to seal up a drawing or some similar object inside an opaque envelope and to ask the supposed telepathist to reproduce this concealed object by an independent drawing. Notable experiments of this type have been made by Dr. Carl Bruck of Berlin, Professor R. Tischner of Munich, Mr. Malcolm Guthrie of London, and others. Some of the most striking results have been described in SCIENTIFIC AMERICAN [May, 1927, and March, 1932] by the veteran psychic in-

IN the accompanying article, Dr. Free proposes a test of telepathy in which you can take an active part. Your cooperation will assist us to obtain valuable evidence on this important scientific subject. There are no prizes or recompense other than the satisfaction that you will feel in having contributed your personal services toward the solution of a problem of science.

The test is interesting and the rules are few. You will surely want to try it with your wife or sweetheart, a friend or even with a casual acquaintance. When you do, record your results on the convenient chart which is published opposite, and send to us. We have arranged the page so that it can be cut out without damaging the binding of your magazine.

Dr. Walter Franklin Prince, well-known psychic investigator and Research Officer of the Boston Society for Psychic Research, has been consulted in the preparations for this test and has agreed to take part in analyzing the results obtained by you.

Other articles on the subject of telepathy will follow. We have also in preparation other tests that will be just as interesting as this one and in which you will again be invited to take part. The results of the present test will be published just as soon as the committee is able to compile and analyze the totals on the charts as they are received.

It is inevitable that any discussion of telepathy (or even the mere mention of the word) should arouse controversy. So little factual material is available that many different opinions are bound to be expressed. Dr. Free maintains that "it is inherently probable" that the power of telepathy, if there be such power at all, "is innate in virtually all human beings." This may or may not be true, but if it is, a comprehensive test, such as the present one, should reveal results that exceed those that could be ascribed to chance.—*The Editor.*

SCIENTIFIC AMERICAN

TEST OF TELEPATHY

THE rules governing this test of telepathy, in which SCIENTIFIC AMERICAN readers are invited to conduct the preliminary research, are few and simple. They are given in detail in the accompanying article and are condensed here for convenience:

(1) "Sender" (agent) sits facing a table.

(2) "Receiver" (percipient) sits on opposite side of table with his back to agent. To prevent distraction by near-by objects, percipient is blindfolded.

(3) Agent has one of a pair of opaque dice, a cup, a pencil, and this chart. When all is in readiness, agent shakes die in cup over which his hand is held and then sets cup down sharply on table so that die comes to rest in bottom of cup. Agent looks straight down on die, concentrates on the number he sees, and percipient "guesses" the digit as soon as possible after he hears the thump of cup on table, voicing this guess aloud.

(4) If the percipient's "guess" is correct, the agent notes an "R" (for right) in the first space provided below. If incorrect, agent notes a "W" (for wrong) in the same space. This procedure is continued for 500 shakes of the die, the letters R or W being entered in the spaces in their numbered sequence.

(5) The percipient must not be told of accuracies or inaccuracies until the test is completed. In fact, there should be no conversation between the agent and percipient during the test.

(6) The surroundings should be such as not to distract the attention of either of the two participants.

(7) When the 500 shakes have been completed, add up the number of correct "guesses" and enter the total in the space provided on the other side of this chart. Also record the number of incorrect "guesses."

(8) Mail the completed chart to: Editor, SCIENTIFIC AMERICAN, 24 West 40th Street, New York City.

It will not be possible to acknowledge receipt of charts, nor can charts be returned. It is suggested that you make a record of your results for reference when the analyses of all results are published.

By conducting this test in accordance with the above rules, you will be making a valuable addition to the data on the subject of telepathy.

1		31		61		91		121		151		181		211	
2		32		62		92		122		152		182		212	
3		33		63		93		123		153		183		213	
4		34		64		94		124		154		184		214	
5		35		65		95		125		155		185		215	
6		36		66		96		126		156		186		216	
7		37		67		97		127		157		187		217	
8		38		68		98		128		158		188		218	
9		39		69		99		129		159		189		219	
10		40		70		100		130		160		190		220	
11		41		71		101		131		161		191		221	
12		42		72		102		132		162		192		222	
13		43		73		103		133		163		193		223	
14		44		74		104		134		164		194		224	
15		45		75		105		135		165		195		225	
16		46		76		106		136		166		196		226	
17		47		77		107		137		167		197		227	
18		48		78		108		138		168		198		228	
19		49		79		109		139		169		199		229	
20		50		80		110		140		170		200		230	
21		51		81		111		141		171		201		231	
22		52		82		112		142		172		202		232	
23		53		83		113		143		173		203		233	
24		54		84		114		144		174		204		234	
25		55		85		115		145		175		205		235	
26		56		86		116		146		176		206		236	
27		57		87		117		147		177		207		237	
28		58		88		118		148		178		208		238	
29		59		89		119		149		179		209		239	
30		60		90		120		150		180		210		240	

(OVER)

Cut chart along this line and you will not damage the binding of your magazine

241		275		309		343		377		411		441		471	
242		276		310		344		378		412		442		472	
243		277		311		345		379		413		443		473	
244		278		312		346		380		414		444		474	
245		279		313		347		381		415		445		475	
246		280		314		348		382		416		446		476	
247		281		315		349		383		417		447		477	
248		282		316		350		384		418		448		478	
249		283		317		351		385		419		449		479	
250		284		318		352		386		420		450		480	
251		285		319		353		387		421		451		481	
252		286		320		354		388		422		452		482	
253		287		321		355		389		423		453		483	
254		288		322		356		390		424		454		484	
255		289		323		357		391		425		455		485	
256		290		324		358		392		426		456		486	
257		291		325		359		393		427		457		487	
258		292		326		360		394		428		458		488	
259		293		327		361		395		429		459		489	
260		294		328		362		396		430		460		490	
261		295		329		363		397		431		461		491	
262		296		330		364		398		432		462		492	
263		297		331		365		399		433		463		493	
264		298		332		366		400		434		464		494	
265		299		333		367		401		435		465		495	
266		300		334		368		402		436		466		496	
267		301		335		369		403		437		467		497	
268		302		336		370		404		438		468		498	
269		303		337		371		405		439		469		499	
270		304		338		372		406		440		470		500	
271		305		339		373		407							
272		306		340		374		408							
273		307		341		375		409							
274		308		342		376		410							

TOTALS

RIGHT ☐ WRONG ☐

IF the result does not suggest any cause in operation other than chance, the giving of name and address is optional. But if it does suggest that telepathy may be involved, names and addresses of agent and percipient must be given, as it may be then desirable to ask a few questions or to suggest further experiments and give directions for their governance. No name will be published unless written permission is first obtained.

Date of test.....

AGENT	PERCIPIENT
Name .....Sex.....	Name .....Sex.....
Address	Address .....
.....	.....
.....	.....

FOR obvious reasons, it is important that the committee know, when analyzing the results, the *exact* relationship between the agent and percipient. Please, therefore, indicate on the following dotted line whether the participants are husband and wife, sweethearts, brothers, sisters, cousins or other relatives, friends, acquaintances, strangers, et cetera.

.....

vestigator, Dr. Walter Franklin Prince.

Not only does this method of reproducing supposedly sealed drawings open the way for types of fraud well known to skilful conjurers but it seems to be an almost universal characteristic of the results that the reproduced drawings or writings never duplicate the sealed-up original exactly but merely resemble it more or less remotely. Thus enters an element of individual interpretation unfortunately provocative of personal argument and frequently fatal to the tests' real scientific value.

What are generally recognized, I believe, as the most important tests of telepathy (from a statistical viewpoint) yet made are those of the department of psychology of Groningen University, Netherlands, and of Dr. G. H. Estabrooks, now of Colgate University, the latter published by that admirably conservative and level-headed group of investigators, the Boston Society for Psychic Research. Dr. Estabrooks' materials were ordinary playing cards, one person attempting to "send" and another attempting to "receive" the names and suits of cards turned up at random out of the deck. Similar tests have been made by Professor Gardner Murphy, by Dr. J. E. Coover of Stanford University, and by others. All have given results of some interest but still far short of being conclusive, either for or against the supposed telepathic facts.

PERHAPS not every investigator in this field would agree that all the lines of inquiry thus briefly mentioned have ended hopelessly in blind alleys but all will concede, I imagine, that it would do no harm to try a new street. This street ought to be, I submit, a widening of the human experimental material. Professor Coover's tests involved some 200 subjects. The radio tests, slight as they were in subject matter, did include many thousands of individuals. With these two exceptions, tests of telepathy have been made either on individuals claiming to have special powers or on a few individuals who inevitably became accustomed in each case to the methods of the tests and the results expected. Might it not be useful now to apply some test of telepathy both simpler and more comprehensive than the radio tests, to an audience almost equally large?

Most students of the subject would agree that it might and here lies, I believe, an important opportunity for the readers of SCIENTIFIC AMERICAN.

There has been devised and tried out privately a very simple test of telepathy. Its materials are no more complicated than a single opaque die (one of a pair of dice such as used in backgammon and parchesi), and a cup of cardboard, wood, china, or glass. Anyone can give the test; anyone can take it. An hour suffices for a complete series with one individual. Some information can be obtained in 20 minutes. If even a small fraction of the thousands of readers of SCIENTIFIC AMERICAN will try this simple test and will report the results to the magazine, it almost certainly will be possible to decide whether any rudiments of telepathic ability for simple ideas like numbers exist in this wide-spread group.

TO carry out the suggested test, two people are necessary; a "transmitter" (agent) and a "receiver" (percipient). The agent and percipient sit on opposite sides of any small table; the agent faces the table, the percipient (blindfolded) has his back toward it. Since the die is to be shaken and then exposed in the cup on the table top, where it can be seen by the person acting as the agent, the percipient must be seated so that he cannot possibly see the die, even under the edge of the blindfold. There must be no mirror or other reflecting object in which he might see the number of the die, even unconsciously.

The agent shakes the die in the cup over which he holds his hand, and then sets the cup down sharply on the table, right side up, the die inside. The thump of cup on table is the signal to the percipient. As the die comes to rest, the agent looks straight down on the number that falls uppermost on the die and concentrates on this number. As soon as possible after hearing the final thump of the cup, the percipient "guesses" what number is uppermost and speaks this number aloud. There being six numbers on the die, the percipient has only six choices; one, two, three, four, five, or six. When the percipient speaks the number that he has "received," the agent makes a record on the printed form provided here, by writing either "R" or "W" for right or wrong. There should be no word spoken by either party that would indicate to the percipient whether his report is correct or not.

Five hundred such records, each of one shake of the die, constitutes a sufficient series with one individual. With a receiver who responds reasonably promptly such a series of 500 trials may be completed in an hour. Now comes the important problem, that of determining whether the receiver's guesses indicate a greater percentage of correct guesses than would be expected from the mere theory of chances. If they do, there is evidence either of telepathy or of some unusual knowledge acquired by the receiver. If they do not, no such evidence appears.

Unfortunately, the computation of exactly how many correct guesses might be expected by mere chance is not altogether simple. Were it possible to make many millions of shakes of the die with one person guessing, very nearly equal numbers of shakes would turn up for each of the six possible die faces. The guesser depending on pure chance would get almost exactly one sixth of these correct. With practicable numbers of shakes and guesses, these rules are less certain.

It is even to be expected, the mathematical theory of chances tells us, that among a great many separate series of 500 guesses each, there might be one series or two which would be almost entirely correct. Common sense might jump at the conclusion that this would indicate individuals of marked telepathic powers but for once common sense would be wrong. This is only one of many pitfalls that the theory of chances holds for the unwary amateur in mathematics.

That is why it is so essential that many separate series of 500 tests each, taken by many individuals, should be assembled at one place for joint study. To such collections of tests, the complete mathematical theory of chances can be applied with assurance. Anyone familiar with this theory can collect records for himself and can compute their joint results. In addition, the Editor of SCIENTIFIC AMERICAN will receive series of tests which readers will record on the prepared form and send in, in accordance with the instructions printed on the first page of the form.

WHAT may be the results if some thousands of observers make such tests and send them in? Two possible results would have significance.

First, it might be found that the complete series of results showed exactly the number and distribution of correct guesses to be expected from the theory of chances. This would be highly presumptive evidence, if not absolute proof, that the readers of SCIENTIFIC AMERICAN as a class possess no telepathic ability. The inference would be strong that telepathy of the kind disclosable by simple tests with numbers is not a general human quality.

Second, the results might show a distinct leaning in favor of correct guesses; more of them being right than the latitude allowed under the theory of chances would permit. That would be very strong evidence, amounting practically to proof, that telepathy is real and that it is, in some degree at least, a common possession of mankind, needing only to be recognized and trained in order to become of vast use to the world.

Persons interested in uncovering the real facts about this much-disputed matter of telepathy can render real service by inspiring and reporting series of tests, as here outlined, to the Editor of SCIENTIFIC AMERICAN.

THE LIMITS OF THE SOLAR SYSTEM

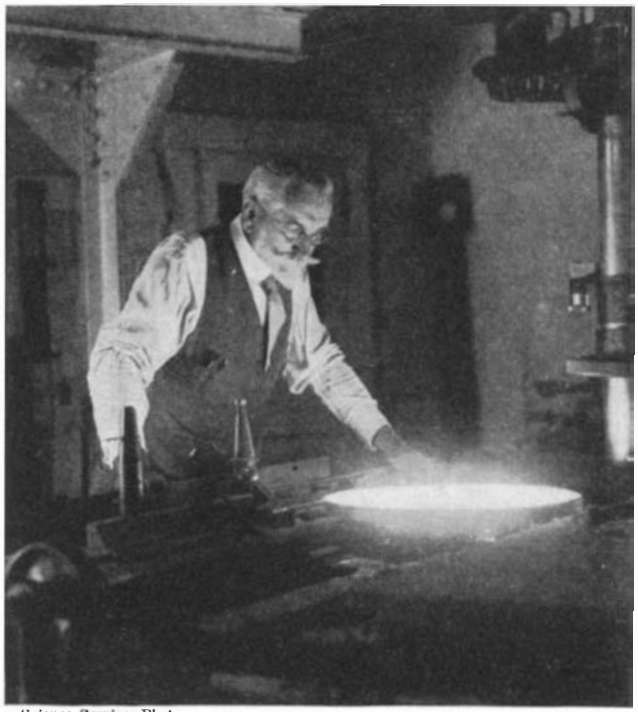
By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

HOW large is our solar system? The remotest known planet at times is five billion miles from the sun; but this is not the limit, for most comets go farther. We can be certain that many of them have come from more than a thousand times the earth's distance from the sun, and are on their way to return at least as far; but to set the outer limits is not so easy.

No comet has ever been seen at as much as ten times the earth's distance. They fade out and become invisible long before this. Our only way of finding the maximum extent of their paths is by calculations which depend essentially on determination of the velocity of their motions in the observable region. For any given distance from the sun there is a definite speed, called the "parabolic velocity," such that a body moving with this speed, relative to the sun, in any direction, will just be able to escape from the sun's gravitation into infinite space. Faster moving bodies will escape more quickly, but slower ones will reach a maximum distance and return. At the earth's distance from the sun, one "astronomical unit," the parabolic velocity is 42.09 kilometers per second. A comet with a maximum distance of 100 astronomical units would have a velocity smaller by one part in 200; with a maximum distance of 1000, by one part in 2000; and so on. Unless our observations are precise and cover a long arc of the orbit, we can hardly hope to distinguish between a comet with a maximum distance of 10,000 units, which would return in about 350,000 years, and one with a parabolic orbit which would never return at all—and yet 10,000 astronomical units is less than 4 percent of the distance of the nearest star.

How far off can a comet go and still belong to the sun's family? If our system were utterly isolated in space there would undoubtedly be no limit. Though it had receded to any finite distance, however great, the sun's attraction would pull it back if it was then receding slowly enough.

But space is strewn with stars, which also attract the comet. We might expect that, as soon as the comet had gone so far that the attraction of any other star exceeded the sun's, it would be drawn into the depths of space and irretrievably lost to us. This would certainly happen if the sun and stars were held fixed in space and only the comets were free to move. The sun's domain would then extend roughly half way to the nearest stars in every direction —more or less, according as the star was less or more massive than the sun. Between us and Alpha Centauri the limit would be at some 110,000 astronomical units, or 1¾ light-years. In some other direction it would be twice, or possibly three times, as remote.



Science Service Photo

Ferdinand Ellerman, astronomer at Mt. Wilson Observatory, examining the 16-inch image of the sun at the deep underground base of the 150-foot tower telescope

But the stars are moving and this makes a remarkable difference, as has recently been shown in an interesting discussion by Professor Öpik, a distinguished Esthonian astronomer and a leading spirit in the plan of meteoric observation of which we told last month.

Near aphelion a comet moves very slowly. For example, one with a period of a million years will have a maximum distance of 20,000 astronomical units. To travel the last hundred units of this distance, out and back again, takes it 90,000 years. The stars, on the contrary, are moving at an average rate of six or eight astronomical units a year. At a distance of 10,000 units a star of the same mass as the sun would attract the comet four times as strongly as the sun at aphelion; but with this rate of motion the star could not be as near as this to the comet for more than about 3000 years. Its attraction therefore gets a grip on the comet (so to speak) for only a short time, while the sun is at work steadily for a vastly longer interval. Hence, even at great distances, the sun prevails and the extent of its effective domain is much larger than had previously been supposed. The net effect of the star's attraction on the comet is to give it a pull toward the nearest point on the star's track. The closer the star comes, the greater is its attraction but the shorter is the time while it is near, so that the effect does not increase nearly as much as that of the steady pull of a fixed body.

A DISTURBANCE great enough to pull the comet away from the sun into a parabolic or hyperbolic orbit would be produced only if the star came really near it. For a comet 20,000 units from the sun the approach would have to be within 200 units; for one million units away, within 1400 units. The stars are so far apart that such approaches must be exceedingly rare. Dr. Öpik calculates that, if the sun had a family of comets with orbits so elongated that their maximum distance was one million astronomical units, it would take 3,000,000,000 years for one half of the number to be lost by encounters with passing stars. Only seven percent of comets within an aphelion distance one tenth as great would be lost at the same time (which is about the estimated age of the planetary system). With the larger distance a comet's period would be about 350 million years, with the smaller about 11 million, so that the former group is likely to make several returns to the sun, and

the latter a great many, before they vanish into space.

The chance that a comet of such long period will continue to return near enough to the sun to be seen is a very different matter. To make discovery probable the perihelion distance must be less than two astronomical units. At this distance the orbital velocity would be 30 kilometers per second. At aphelion, if the distance is 100,000 units, the orbital velocity, by the law of areas, would be 1/50,000 of this, or only 60 centimeters, or *two feet*, per second. To raise the velocity to eight feet per second would double the perihelion distance and destroy all hope of seeing any ordinary comet from the earth.

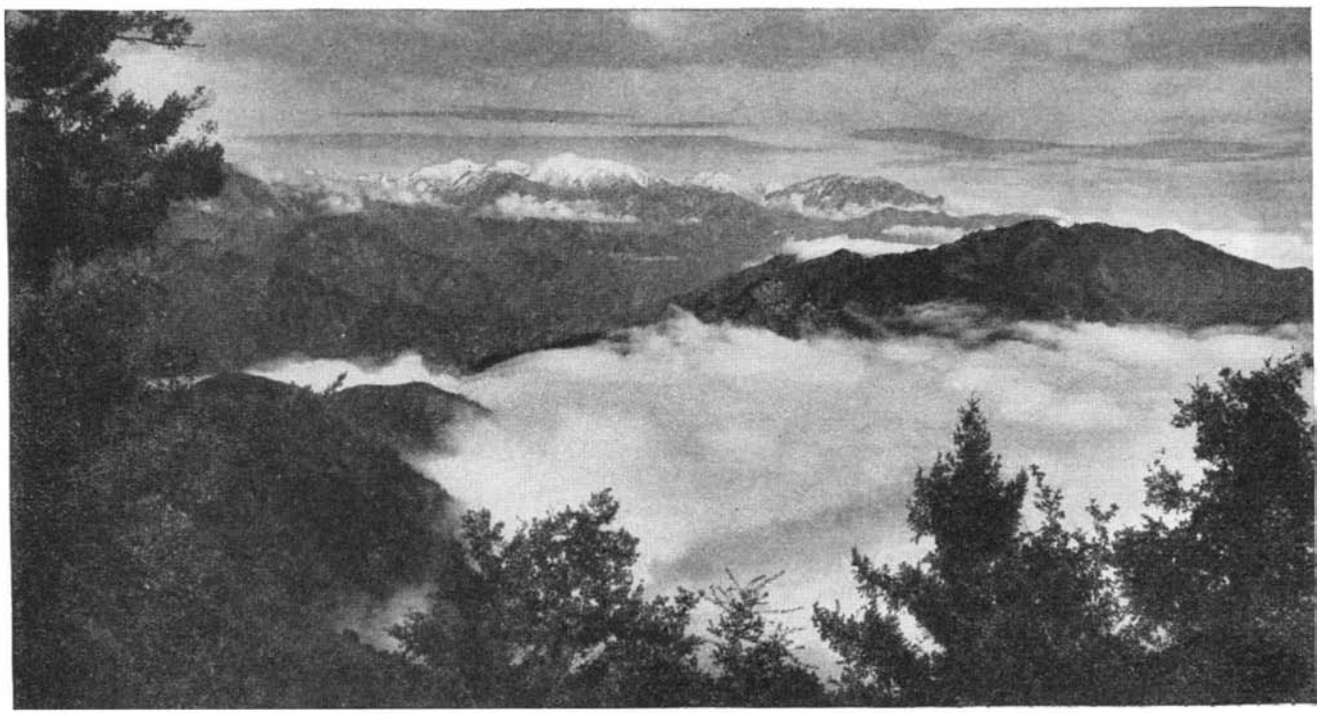
If the attraction of a passing star on a comet at this distance should impart to it a speed of 10 feet per second, the comet would be surely lost to human observation, though not to the sun's retinue. This is only 1/44th of the speed necessary for escape, and the chance of an encounter close enough to produce the corresponding effect is about 2000 times greater. Hence an observed comet with a period of 10,000,000 years stands less than an even chance of coming close enough to the sun on its return to be seen from the earth. Dr. Öpik, from a detailed investigation, concludes that a comet with a period of a million years would have at best an even chance of continuing during the probable past history of our system to return within the region where comets shine and grow tails. Comets with periods less than 30,000 years would be much less affected. But even these stand a good chance of having the direction of their motion changed, and with it the inclination of the orbit plane. This may go far toward explaining the fact that the orbit planes of comets of long period lie practically at random, with all possible inclinations.

The attraction of the stars is not the only, nor indeed the principal, danger to which comets are exposed. A single close approach to one of the major planets may alter the orbit greatly, or even speed the comet up so much that it flies away, never to return. An idea of the average amount of these perturbations may be obtained from Halley's comet, which can never come dangerously near any of the planets—that is, near enough to have its orbit radically changed. Nevertheless, the planetary perturbations during the 27 returns which have been observed have caused an average difference of one and a half years between the duration of successive revolutions, the period fluctuating irregularly about an average of 77 years.

THIS change in period corresponds to an alteration of the velocity, when at unit distance from the sun, by 7.8 meters per second. Small as this seems, an equal change in the velocity of a comet of longer period produces startling results. The average change in a period of a thousand years would be a century; a period of 10,000 years might be increased by 8000 years or diminished by 3500; while with an initial period of 100,000 years the comet might be deviated into a hyperbolic orbit and lost.

The attraction of the planets, even more than that of the stars, therefore operates to set a limit to the extent of our system. A comet with a period of 10,000 years and an aphelion distance of 930 astronomical units is already likely to show great variations in the distances to which it recedes and the intervals of its return, and one which reached a distance of three or four thousand units would lie in serious danger of ejection from the system at its next return. Except for such precarious hangers-on, our system would therefore appear to be limited to an extent of hardly more than a hundredth part of the distance of the nearest of the stars.

In view of the steady loss of comets it is remarkable that so many remain. Many, perhaps far more than now belong to our system, must have been cast out from it in times past. Whether they owe their fate to the influence of planets or of stars, they are doomed to isolation. The attraction of a passing star, though great enough to eject a comet from the sun's domain, is far from adequate to carry it along with the star as a member of its own system. The comet wanders away independently, pursuing after a while an almost rectilinear path in the depths of interstellar space, deflected, now this way, now that, by the attraction of passing stars, but keeping company with none —in actual realization of the ancient Biblical image of "wandering stars to whom is reserved the blackness of darkness forever."—*Princeton University Observatory, January 5, 1933.*



A striking autumn photograph looking east from Mt. Wilson Observatory. Taken by the astronomer Ferdinand Ellerman, who is also an expert in photography. This is one of a series of his fine photographs which have occasionally been published in these pages because of their general interest. This picture includes the spot in the San Antonio Mountains, 23 miles distant (one inch below top and three from right edge), where Professor Michelson made one of his light velocity tests

When Mickey Mouse Speaks

By ANDREW R. BOONE

WHEN that amusing mite of the screen, Mickey Mouse, cavorts through his antics, whistling, talking, and sometimes singing, he does it to the rhythm of a predetermined mechanical beat. Strictly speaking, Mickey's dad, Walt Disney, furnishes the voice. He substitutes for the vocal cords of the movie character which he has created, and which has become as well known and as popular as the brightest stars. When Mickey's fair lady utters mouse-like yet human sounds, the vocal cords of Marcelita Garner are the ones that are in action.

In order to achieve perfect synchronism of sound and picture in the production of these cartoons, a mechanical "beater" is employed to carry a definite rhythm throughout the work. You, sitting in your comfortable theater seat, do not hear the timing beat, but without it the smoothness of the action might be interrupted by lack of synchronism. The mechanical beater consists of a motor that drives a series of contacts which interrupt a buzzer circuit. The beats so produced are delivered to headphones where they are audibly reproduced to guide the makers of the cartoons in many of the essential steps.

SINCE sound pictures run at a standard rate of 90 feet per minute, the tempo for sound cartoon production is developed in terms of film frames per second. The shortest beat used by Disney is four per second.

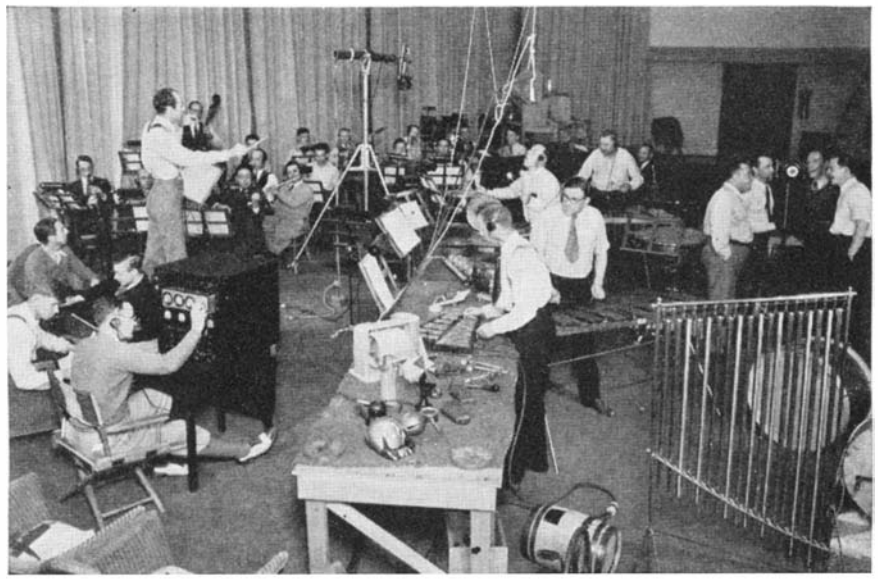
The voices given to the tiny animals of the cartoon cannot be separated in production from the music and other sound effects. Pluto the Pup may sniff in response to Mickey's command, but the sniff comes on, say, the 24th note of the mechanical beater. Some member of the orchestra, at the time playing background music, counts the buzzes as they reach him through earphones, and on the 24th inhales through one nostril. This inhalation, performed within a few inches of a microphone, corresponds with the exact frame on the picture where the hound begins to sniff. Later the sound track and completed picture are double printed and sniff and picture match perfectly.

Voices, music, and sound effects are recorded simultaneously. In the case of a dialogue sequence, where the action requires both sound and lip action, this is "pre-scored." Then the sequence is studied to determine where each vowel and consonant occurs. From this an exposure sheet is prepared for the animators, who prepare thousands of drawings for each picture. The exposure sheet shows the animator where the mouth is to open, where it is to close, and where the initial and final sounds occur.

FROM the "human side," Disney endeavors to translate all his characters into personalities, except Pluto the Pup. Pluto spends most of his time barking and sniffing up trees. Minnie may scream and fall into a lake as Miss Garner "doubles" for the shriek and an assistant twiddles his fingers in a pan of water within two inches of a microphone, but there is a definite tie-up of mechanical beats between every sound and the picture itself. They cannot be divorced in explaining how voices are given these imaginary characters and the picture is filmed.

"We always keep in mind the definite rhythm of music," Mr. Disney explained, "even though the rhythm varies from time to time in the picture. We always score the back-ground music before the picture is finished. Before we go into production we know the music to be used, the tempo and exact number of bars of each phrase to be played. Were we to finish the picture first, it would be impossible to bring the sound effects, voices, and music into perfect synchronization. If the effects vary one frame—1/24 of a second—we consider that to be an error; if they're two frames off audiences will know there's something wrong, though only 1/12 of a second will be represented."

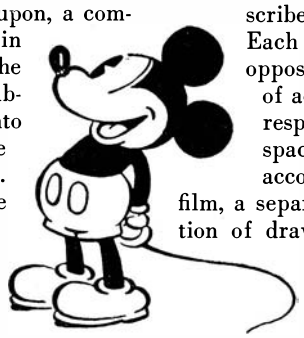
So, from the beginning, each step in the making of a movie sound cartoon is taken with scientific accuracy. At the outset a "gag" meeting is held, attended by the studio staff. At this meeting a general idea of the picture to be produced is formulated and discussed. Suggestions as to story, plot development, comedy gags, music, and sound effects are talked over and either elaborated upon or discarded according to their merits. The musical director sits in on all "gag" meetings and as various types of action are suggested, music appropriate to that action is suggested and played. In this manner a skeleton



Recording voices, music, and sound effects for a movie cartoon. Note the headphones through which the synchronizing beat is brought to each participant

of a story is finally built, as is an idea of the appropriate music and sound effects to accompany it.

After the idea, plot, "gags" (including conversation), music, and sound effects have been decided upon, a complete scenario is written in continuity form, covering the story. This scenario is subsequently broken down into individual scenes for the various artists or animators. These individual scenes are then distributed to each artist, and each and every separate scene so distributed carries a particular continuity of action which the animator or artist is to portray or draw. The sheet upon which the action or scene is described is termed an "instruction sheet."

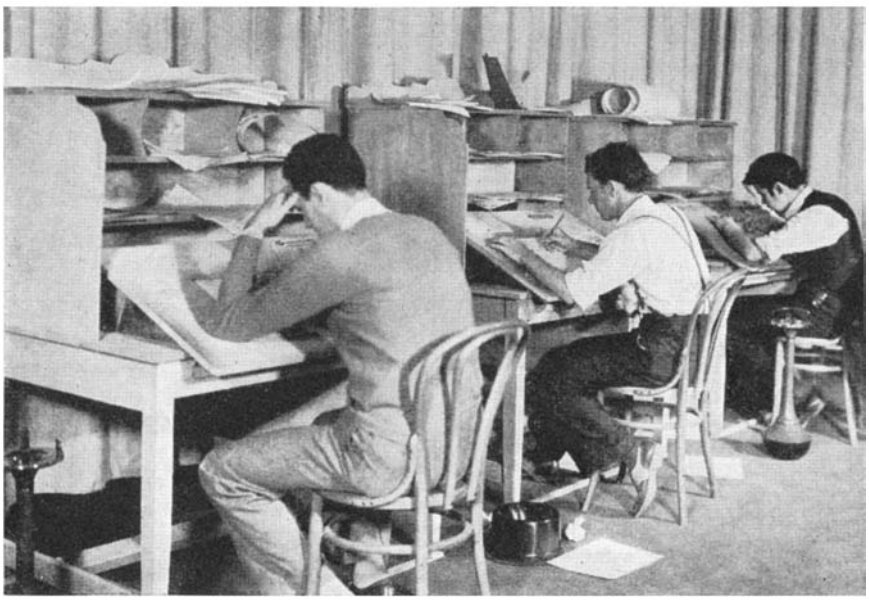


WHEN the artist or animator receives from the scenario or story department the particular scene he is to animate, or draw, complete information regarding the action of the scene to be depicted in that particular portion is described in detail on the instruction sheet. At the same time he is given an exposure sheet. It is on this that the music to fit the action described in the sheet is indicated. "The idea of synchronizing musical 'beats' with animated action is purely mathematical," explained William E. Garity, Chief Engineer for the studio. "We know there are 16 frames of picture in one foot of film, and this is run in projection at the exact speed of 24 frames per second. Therefore, the exposure sheet is laid out in a manner that conforms to a foot of film, which is to say that on this exposure sheet are provided spaces to correspond with frames of film, and 16 spaces on the exposure sheet represent one foot of film. In other words, one space on the exposure sheet represents one frame of film."

"It is on this exposure sheet that the music is indicated to fit the action described in the instruction sheet. Each 'beat' of music is placed opposite the particular position of action to which it must correspond, when finished. As the spaces on the exposure sheet account for every frame of film, a separate drawing, or combination of drawings, must be made for every space. Therefore each space is numerically numbered in consecutive order, and whenever a certain position of action is to correspond with a particular beat of music and sound effect, a musical symbol is placed on that numbered space on the 'exposure sheet' opposite the particular position of corresponding action. Thus the action, music, voices, and sound effects are tied together."

As the artists complete their animation of the action, their drawings are then traced or inked onto transparent celluloid sheets and subsequently painted. These celluloid sheets are then photographed, a frame at a time in numerical sequence, against an appropriate background which gives the picture its depth and character. As the cameraman can only photograph one frame at a time, he carefully checks the action back to the exposure sheet to see that each frame of action is photographed exactly as is shown on the sheet.

Furthermore, when the exposure sheets are first made up, the musician writes the music and sound effects to conform to the tempo or beats as shown thereon, his musical measure being numbered to correspond to the spaces on the exposure sheet. In this manner each measure is recorded on a piece of sound film, in exactly the same place on the film as the action to which it must correspond will be on the corresponding picture film, when completed.



Movie cartoon animators at work drawing the separate scenes, thousands of which are required for one reel. They are guided by pre-arranged instructions

Photographing the finished cartoon drawings, one at a time, and checking sequence and synchronization

TO insure accuracy of tempo and unison of time for the entire orchestra, the mechanical beat is transmitted to each individual, or in some instances to the director alone. Under such circumstances he stands within a tiny room, looking at the orchestra through a glass window and hearing their music, greatly reduced in volume, through a loudspeaker.

Meantime Mr. Disney and his "vocal assistants" stand near the several microphones, their instruction sheets in hand. On the indicated "beat," one may cluck like a hen, another may yowl like a dog, Mr. Disney may speak as Mickey would speak, or Miss Garner may shriek as in fright.

The sound recording may either precede or follow the creation of the drawings to accompany it. After the sound track and the picture film have been made and developed, the two strips, matched frame for frame and of exactly the same length, are transposed through "double printing" to a positive print. This is the final cartoon, with both action and sound in synchronism.

Mickey Mouse cartoons are produced on a two-week schedule, each one taking 10 weeks to complete. The estimated production cost of each film is in the neighborhood of 20,000 dollars, and a total of 125 people may co-operate in making one cartoon. The picture that takes 10 weeks to make provides for you just seven minutes of screen entertainment.

BACTERIA FOR AMATEURS

Practical Microbe Hunting for the Amateur Microscopist

By R. M. WATROUS

A FEW years ago there appeared in the SCIENTIFIC AMERICAN a series of articles on the home construction of telescopes, wherein a genial and clever man exposed a surprising fact. To pursue astronomy, it seemed, required no colossal fortune; telescopes could be made by the exercise of some muscle and a moderate degree of skill and intelligence. To me, as to many others, that article opened a rich and pleasant field of endeavor.

It has occurred to me that there is another of those doors to be opened; it leads into corridors dark and unknown and to chambers exquisitely ornamented by the work of good men. My own experience has convinced me that men of the type who, as amateurs, build telescopes and follow scientific hobbies can equip a serviceable laboratory for the study of bacteria with little expense and little effort.

There is much to say about the fascination and excitement of peering down a small magnifying tube at the smallest of known living things, and little space in which to say it. The history of that itch to know about these forms of life is fantastic and colorful and has had its martyrs greater, as martyrs, than Galileo and more eccentric than Newton. I have opened my home-made incubator more times than would be convenient to count, and peered at microscope slides without number, yet every morning the tubes and plates in that warm little box—some clouded with white, some irritatingly clear, some red with acid, some ominously green—every morning they have the same old thrill of the unknown. What will you find? God alone knows, and you can but conjecture.

With the indispensable instrument of the amateur bacteriologist, the microscope itself, we come at once to the most expensive, and hence the most thorny item in our list of things to be acquired. Begging, borrowing or even stealing may produce one for a man who has the hunting itch but if these methods fail, he must buy one. This should be a good instrument with an oil-immersion lens, giving a magnification of 1000 diameters. Koch himself could not ask for more.

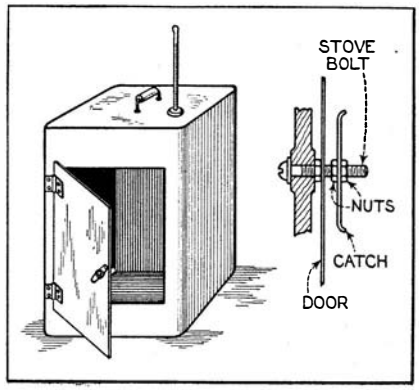
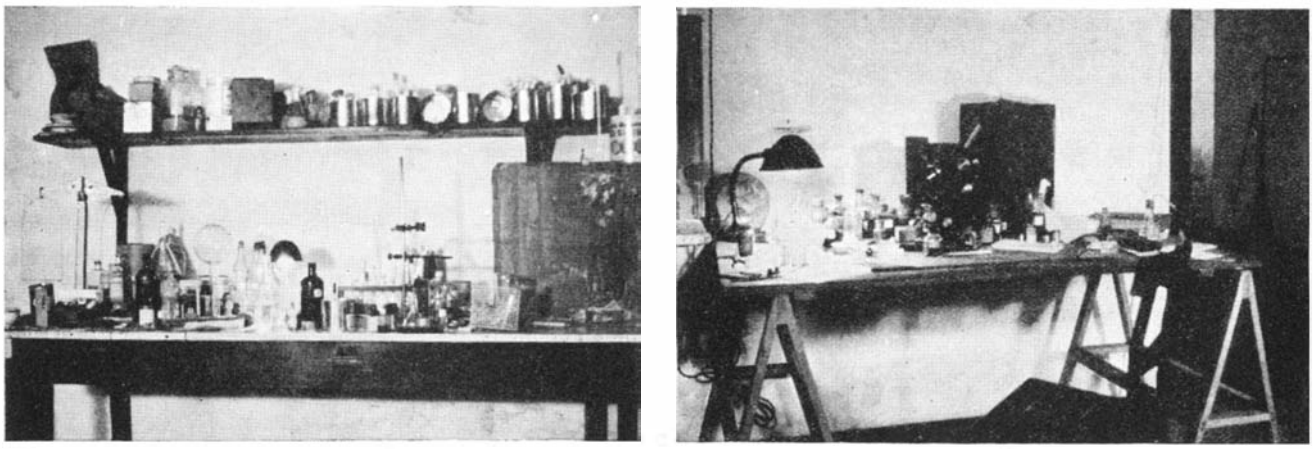


Figure 1: **An old tin can was made into a perfectly good hot-air oven**

It must seem strange that, in preparing to grow bacteria, our first thought should be how to kill them—wholesale, utterly, and efficiently. Yet one has only to remember that practically nothing can be learned about so small an organism until we can grow it absolutely pure, apart from all of the too-friendly little neighbors which linger everywhere with a pious urge to be sociable. Therefore we shall need two sterilizers: a hot-air oven for glassware and metal, and a steam-box for our soups and jellies, for these must not be heated above the boiling point.

The catalogs of instrument companies bristle with elaborate and expensive machinery for accomplishing these two simple ends but two discarded five-gallon oil tins do the work easily and painlessly for me. Let us first consider the hot-air oven.

IN the side of an empty five-gallon oil can of the old square type a square hole was cut, large enough to make an ample door. The iron was bent in and backward upon itself for ½ inch about the margin, eliminating the rough-cut edge. A door was cut about an inch larger in each dimension than the hole, hinges were bolted on with stove-bolts, and a handle-catch attached, as shown in Figure 1. The oven is also shown in one of the photographs, page 150. A cheap thermometer, registering up to 200 degrees, Centigrade, was fitted with a perforated cork in the erstwhile vent of the can, and a low shelf—a simple piece of bent galvanized iron standing on its down-turned ends—was set in place. The oven was then ready for use and, ever since, it has functioned as faultlessly as if it had cost 50 dollars. It is heated by placing it over the burner



Two views of the author's home-made and homely laboratory. ***Left:*** **The general work table, with the incubator, closed, at one end, and a home-made chemical balance at the other.** ***Right:*** **The plain staining and microscopic examination table**

WHAT especial risks are connected with the hobby of amateur bacteriology? Many persons link bacteria—microbes—in their minds with infection, disease, horrible death. For this fear a special circumstance may be largely to blame: the science of bacteriology originated and developed mainly because of the practical urge to rid man and beast of diseases caused by bacteria, and by the general public it is still heard of mainly in that connection. Yet not one kind of bacterium in a hundred is a disease (pathogenic) bacterium. The other 99 bacteria—the harmless kind—are seldom heard of except by the scientist. Not only are most of the bacteria harmless but they are actually friendly; they jump up in our lap and purr and we literally could not survive without them.

One scientific man—he may have been a wag—in commenting on the accompanying article and the disease germ bogey, said: "Oh, why spoil your readers' fun? Let them have the thrill of believing they are 'living dangerously'—it costs so little." But we have let the cat out of the bag.—*The Editor.*

on an ordinary gas or other stove. Glassware held in it for one hour at 150-160 degrees, Centigrade, has always proved rigorously sterile.

The steam-sterilizer was even simpler (see the same photograph). For its construction, a round oil tin of five-gallon capacity was pried loose from its lid and washed out with soap and hot water. A square of coarse wire mesh (¼-inch) was cut, each side being a little less than the diameter of the can. The corners were turned down, leaving a flat octagon supported by four feet. This was set in the bottom of the can, and an inch of water poured under it. Placed on the stove with the closely-fitting lid merely set on, the can rapidly filled with steam and its temperature,

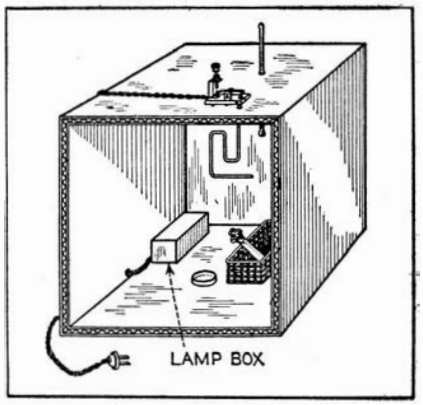
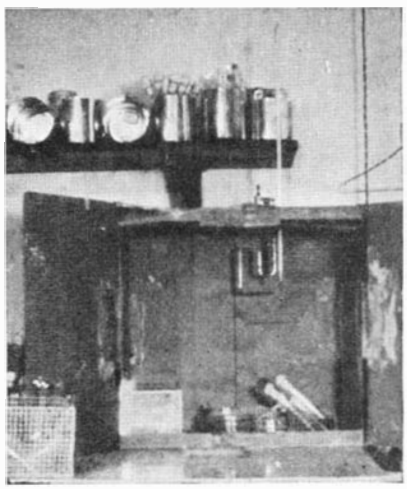


Figure 2: **The incubator lacked many frills, and it cost one dollar**

as I measured it, was so close to 100 degrees, Centigrade, as to mean the doom of any vegetative microbe inside.

Sterilizable media are heated in this steam-box for a half hour each day, on three consecutive days. The first heating kills all of the vegetative forms in the media, but cannot kill spores—the resistent form they assume when threatened by hard times. By leaving the media for a day at room temperature, the innocent spores, believing that better times are at hand, sprout into the vegetative form and are easily killed on the second day. The third heat treatment is a safety measure to dispose of spores that might have been less ingenuous.

Perhaps no other instrument deemed necessary for the study of bacteria raises more spectres of complication and great expense than the mysterious incubator, whose temperature is supposed to remain constantly exact. Fig-



The incubator, opened, revealing heating bulb (on left) and thermostat. On the shelf outside are cans with tubes of culture media

ure 2. Its value to the amateur lies chiefly in its acceleration of the growth of otherwise slowly-growing organisms; most of those he will be able to isolate will grow quite well outside of it and some will grow better outside than inside. However, ever since I saw an incubator advertised in a catalog at a price well over 200 dollars the humorous impulse to describe one which cost two hundred times less has been quite irresistible.

The main condition to be met is a fair degree of insulation for heat. A good box could be made of two layers of wall-board with an air space between. Being not so ambitiously disposed as this would imply, I used an old box of common corrugated cardboard. It was set on its side, and one of the flaps of the lid served as a door. One 60-watt electric bulb gave ample heat, and was shrouded in a tin cracker box to obviate any harmful effect of its light. Another

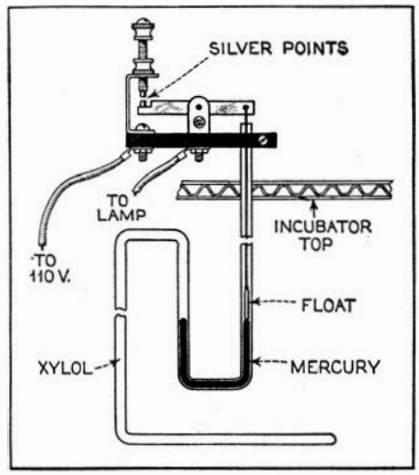


Figure 3: **Detail of thermostat for the incubator. Explained in the text**

thermometer (see note at end of article.—*Ed.*) capable of registering up to 100 degrees, Centigrade, was installed in this box, and a heat-regulator or thermostat was built. I had always considered the latter devices to be extremely complicated, but the model I finally used proved to be surprisingly easy of construction, and quite accurate. I do not know who deserves the credit for designing this thermostat, but I shall describe it below and include my blessing for its inventor.

FIGURE 3 shows the structure of the instrument. It is essentially a glass tube, closed at one end and bent to the shape indicated. Xylol, which has a high coefficient of expansion, is poured into the closed arm, and should occupy as much of the tube as is later to be filled with mercury. The mercury is poured in, and will readily displace the superfluous xylol, which may then be drawn off with a fine pipette, the last drops being left to evaporate. The tiny float may be made of wood or cork, and must fit quite loosely. The lever and its support, both of copper scrap, are self-explanatory.

The Bakelite base, which also attaches the lever rigidly to the glass tube, may easily be cut from an old radio panel, and is equipped with the homely but useful stove-bolt throughout. The electrical connections, in series with the lamp, are obvious. When the regulator is new, some sticking of the silver points may occur, but they seem to become "broken in" after a few weeks, and give no more trouble. Sticking of the points can be reduced by making them of platinum.

Thus may the terrible and inscrutable incubator be turned out in a home shop in a day. In thinking of the vast and complicated instruments now deemed necessary for microbe-hunting, one is reminded of the remark of Sinclair Lewis's fictional investigator: "Maybe they should better buy their results

along with their fancy equipment" (from "Arrowsmith").

All books on bacteriology describe media for growing bacteria, and I dare say that some of the hoary formulas have remained unchanged ever since the venerable German gods of that science laid them down long years ago. It would be sheer waste of paper and ink to describe in detail here what may be

The sterilizers—hot-air (on left) and steam (right) ready for use, on a small gas stove. The motor oil industry contributed both articles

found in almost any public library in the land. (Also see "Encyclopedia Britannica," 14th ed., articles on "Bacteria" and "Bacteriology."—*Ed.*) It is sufficient to say that most of the useful culture media are nutrient soups or jellies, easily prepared from cheap ingredients. Among them one of the most useful is plain raw potato. The tyro will need a jar of beef extract, some peptone (Swift or Armour), table salt, a box of agar flakes (now widely sold as a laxative), some sodium hydroxide sticks, and a 50 cc. burette. With these he may calibrate some old bottles and a set of weights, and make up the two standard media for bacterial gardening —beef broth and beef agar. With these bestowed and sterile in suitable glassware, he may then proceed at once to the isolation and study of the millions of unseen dwellers in air, water, milk, and the surfaces and cavities of the body.

SOME glassware must be acquired. One hundred small bacteriological test-tubes will cost about two dollars. The ½ x 4-inch size takes less media and less cotton, and is quite as satisfactory as more ample containers. About six "petrie" dishes 3 inches in diameter (One of these is shown in Figure 2.—*Ed.*), and one thin glass flask of one-liter capacity, make up the remainder of the equipment which one must buy. This can be eked out with any derelict bottles that will withstand the heat necessary to sterilize them. The bottles and tubes are plugged with common cotton batting and baked in the oven. The media are poured into them as needed, and the filled tubes sterilized by steam as explained above. The petrie plates are merely baked and are then ready for pouring.

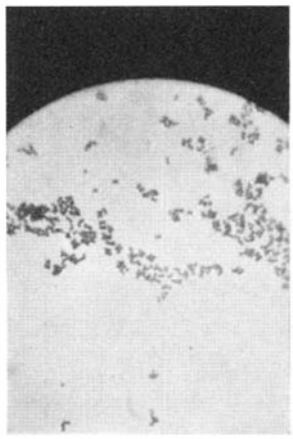
The multitudinous other pieces of glassware described in books on microscopy can be devised or substituted for with glass tubing, test tubes, and odds and ends. Nothing very complicated is necessary.

Like media, stains are described with unfailing uniformity in all of the microscope books. Any of the strong stains are adequate for rendering visible the gross body of bacteria and I shall describe the one I think the easiest to obtain. It is the famous stain of Löffler, and the methylene-blue used in it can be found in any drug-store worthy of the name. Its composition is as follows:

Sat. alcoholic methylene blue: 30 cc.
Potassium hydroxide, 0.01 percent: 100 cc.

Specifications for other useful and differential stains will be found in all of the books on bacteriology, with directions for using them, and these can be had from scientific supply houses at moderate cost.

Each worker, as he goes along, will



A pure culture of *staphylococcus tetragenus*, isolated by the author from the mouth of a healthy man, using only the apparatus described

devise the thousand and one little tools, racks, gadgets, and machines that suit his work. Wire mesh baskets may be conveniently made of the kind of material which was used in the false bottom of the steam-box. Capillary pipettes may be drawn out of glass tubing, the large end plugged and the pointed end inserted through the stopper of a test-tube, thus suspending them in a chamber which will remain sterile after baking. Two glass rods with short pieces of fine nichrome wire set in their melted ends will serve respectively as a loop and a needle for the transfer of bacteria aseptically from one medium to another. The list could be prolonged indefinitely.

We shall suppose that the tyro, with that "itch to know" that makes him entirely incomprehensible to people who would rather read the Sunday papers, has completed his simple but adequate apparatus. He has taken a potato, cut it into thin slices and placed these, with a little blotting paper and water, in the covered sanctity of a petrie dish. This dish he has religiously steamed on three separate days, and then exposed it to the air of his room for ten minutes. He has left it for two days at room temperature, and now finds its surface dotted with mysterious little colored circles—green, brown, yellow, white, bright pink. These are colonies of bacteria from the air.

He has heated his wire loop red-hot, and when it cooled he has barely touched one of these yellow circles, and then rubbed the loop carefully into a drop of clean water on a microscope slide. He has dried it, heated it in the flame and dropped on it the rich blue stain. He has washed and dried it, and now, with a drop of cedar oil on the slide—necessary for the high-power lens —he focuses his microscope. Intense blue shapes emerge into the field as he turns the screw. There they are—tiny, myriad, sharp and clear, blue on a creamy background of light! He has entered a new world, as fascinating as ever we have found with our tyro telescopes. Here the bodies are measured in microns, one 25,000th of an inch, instead of light-years. And here we leave him—to grope, and perhaps to find.

●

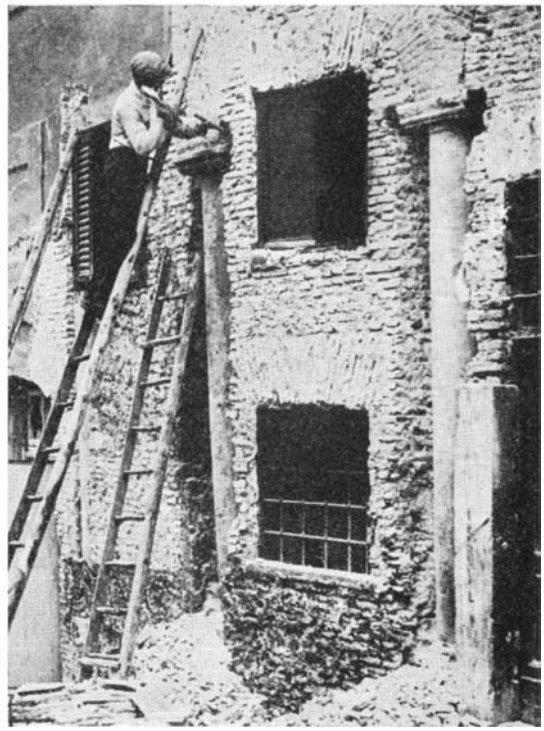
The supplies—test tubes, petrie dishes, glass tubing, rods and flasks, nichrome wire, thermometers, xylol, mercury, peptone, stains, microscope slides—mentioned in the accompanying article, as well as others, may be obtained from The Central Scientific Co., 460 East Ohio Street, Chicago, or from E. H. Sargent and Co., 155 East Superior Street, Chicago, dealers in laboratory supplies for schools. There are numerous other dealers in the same supplies.

In the following words the author recommends two books on bacteriology for the beginner: "Jordan, 'General Bacteriology'—a good general text. Gives all media, stains, and so on. Bergey, 'Manual of Determinative Bacteriology'; a very useful book for the tyro who has isolated an organism and wishes to know its name and family connections. Every known bacterium is fully described, and the means of identifying is given. Another excellent work is Greaves and Greaves' 'Elementary Bacteriology'."—THE EDITOR.

From the Archeologist's Note Book

Rediscovery of Old Rome

THE Fascist archeological plans are obliterating many mistakes of the past by their carefully thought-out demolitions, excavations, and restorations. Our illustration at the right shows a colonnade of the time of the Caesars, discovered in the wall of a house which was being demolished to make way for a street which is to cross the forum.



Egyptian Tomb Models

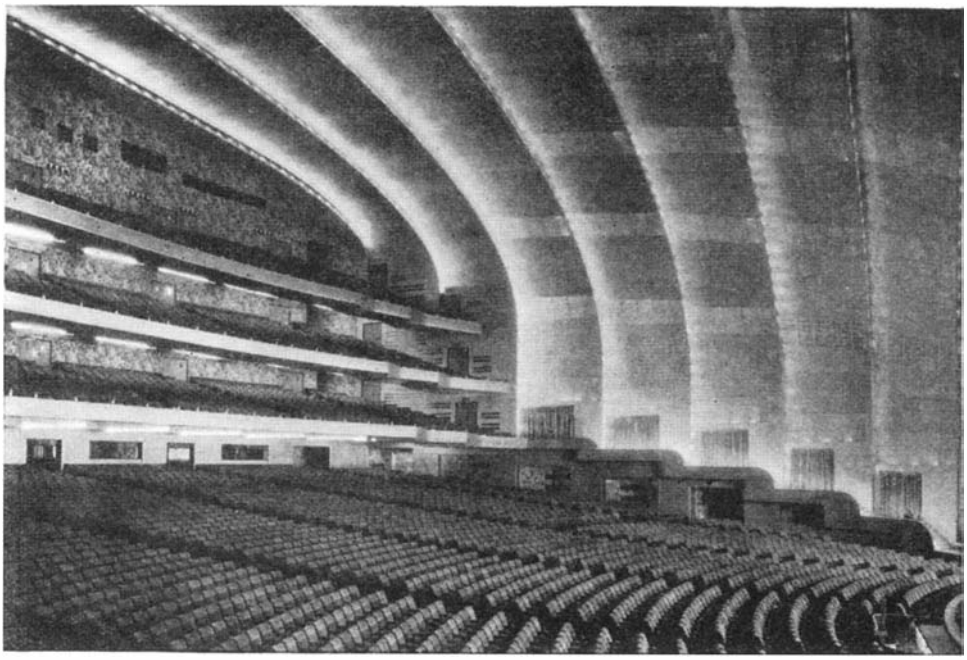
BELIEVING, as did the ancient Egyptian, that the soul lived on after death and that in the life after death there were the same needs as the individual experienced in this life, it is easy to account for the numerous models of objects and people associated with mortal life, which are to be found in the tombs. Among the numerous minor objects that are often found in the tombs are groups such as the one shown, upper left, (Boston Museum), of servants making bread and beer. Water is being carried on the shoulders of a man; another brings a pottery jar for the beer. Women are kneading and baking. Through some mysterious or magical power, it was believed that such represented activities would continue throughout eternity to provide sustenance for the shadowy soul.

Tutankhamen's Wife

A NEW portrait of the girl-wife of that well-known Egyptian Pharaoh has been unearthed at Tel-El-Amarna in Upper Egypt. The portrait shown on the right is a beautiful little head, with exquisitely modeled features. It is less than two inches long. The face is like that of a woman on the back of a chair in Tutankhamen's tomb. Evidently both must be the same person—the wife of the young ruler.

A Household Group

AT right and left are shown the front and back of a cheerful little Melian terra-cotta relief which was made in the island of Melos. Such articles were exported as far east as Troy, 460-450 B. C. One girl is playing on a flute and the other is dancing (only a portion remains) while a youth looks at the pretty scene. The back gives the key to the process. The clay was pressed in open moulds and the excess removed with the aid of a string. The original is in the Metropolitan Museum of Art.



The largest theater in the world is in Rockefeller Center, New York City. It has a seating capacity of 6200. In the illustration at the left, note the lighting control board in the lower right corner. From this point, in the house proper, are controlled all the stage and house lights

AN ENTERTAINMENT TREASURE HOUSE

By ALBERT A. HOPKINS

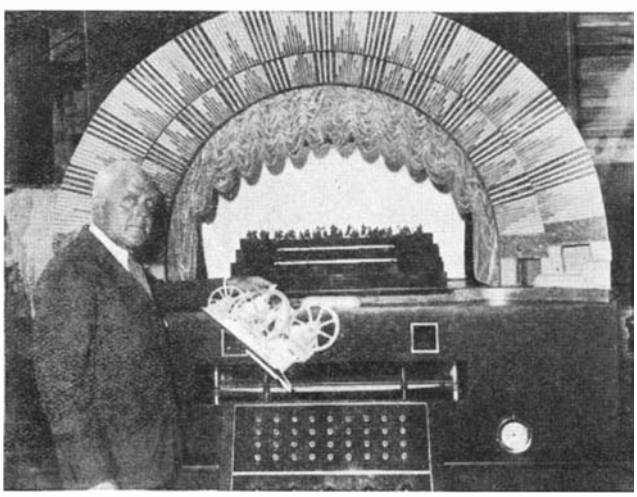
ON the rainy evening of December 27th, 1932, 6200 people entered the largest and best equipped playhouse in the world for the "première"; some 90,000 unsuccessful would-be patrons, nursed their disappointment and probably tuned in on the radio which broadcast the enthusiasms of the crowd and much of the entertainment.

Rockefeller Center is in the heart of New York. By great good fortune this enormous and intensive real estate development was rendered possible by the ownership by Columbia University of three deep city blocks between 5th and 6th Avenues from 48th to 51st Streets. The development includes a 70-story building and other office buildings, a motion picture theater seating 3700 and a great Music Hall seating 6200 persons—the largest theater in the world. Entrance to the beautiful foyer is through a 31-story office building.

THE Radio City Music Hall has no pillars and everyone can see and hear. The orchestra is very large and there are mezzanines which take the place of galleries. Every seat has a self-closing mechanism so that when you rise the seat folds up. A push button, on the seat in front of your own, lights a program scanning light. There is no chandelier but remarkable lighting effects are obtained from lamps of various colors concealed in the overlapping arches which cover the ceiling and the side walls. Horizontal bands of light are controlled independently.

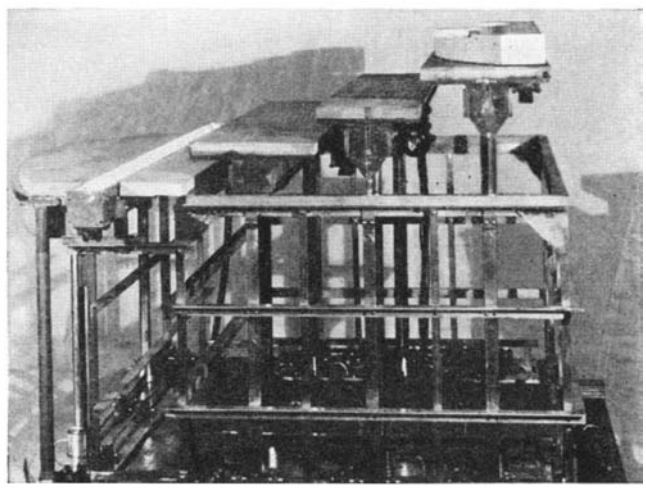
One of the principal decorative effects is the immense "sun burst" which emanates from the round top of the proscenium arch. The stage and house lights are all controlled from a switchboard in front of the orchestra seats.

The most complete system of sound reproduction and amplification ever designed for a theater is installed. Seat phones for the hard of hearing are provided. The stage director can produce thunder, wind, and other effects by pressing buttons connected with specially built film phonographs in a sound projection booth in the rear.



Peter Clark, designer of the stage and his 19,000 dollar model. The contour curtain assumes many positions

Model of stage showing elevators in "stepped" position. "Band-wagon" moves with the aid of storage batteries

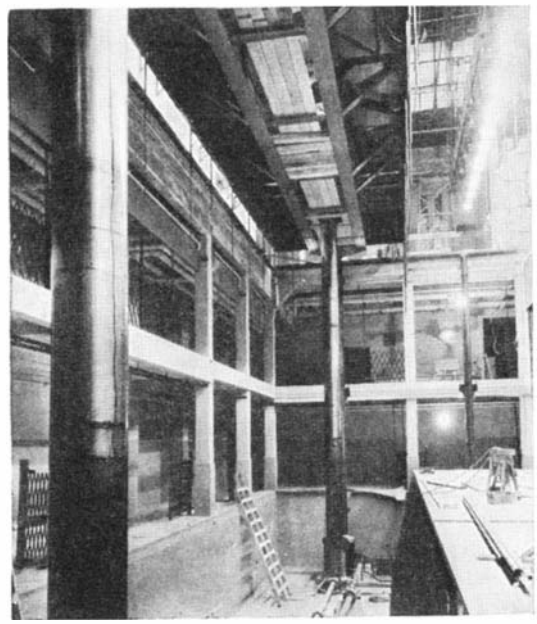


The "RKO Roxy Theater" in the same development is a sound motion-picture theater named after the impresario, S. L. Rothafel. It accommodates 3700 persons. The house is panelled in wood and it has a completely equipped stage

Above the stage are four motor-operated light bridges 104 feet long, any one of which has a capacity equal to the entire lighting equipment of the average theater. Four portable light towers have a capacity of 25 spot and arc lights each. Spot and arc lights are in the wings and great batteries of invisible spot lights serve to flood the stage. There is a steel and wood cyclorama 113 feet wide and 73 feet high which tips the scales at 15 tons. This acts as a sounding board and is used in cloud and star effects. It is illuminated by its own foot lights.

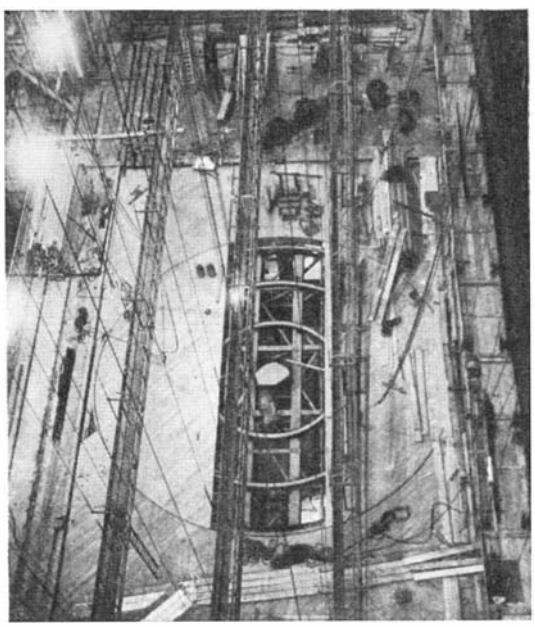
THE stage proper offers the most interesting mechanical features. It is 144 feet wide and is 80 feet deep. The stage elevators, three in number, are 70 feet long and 16 feet wide. They rise from the sub-basement level to a position 14 feet above the stage, a vertical trip of 40 feet. In the Music Hall they are operated by hydraulic power as is a plunger elevator, but in the near-by movie house screws are used for the elevators. An ingenious interlocking device makes it possible to raise or lower the three elevators in unison, in step formation or independently. A portable water tank can cover the entire space occupied by the elevators and can be raised to stage level.

Set in the surface of each elevator is a section of a revolving turntable, 47 feet in diameter. The sections of the turn-table are so arranged that they can be interlocked and revolved in either direction while being raised or lowered. There is an opening in the center of the turn-table for fountains or other water effects. In front of the elevators is a fixed section of the stage and in front of this is the orchestra elevator which forms an apron, increasing the stage depth to 81 feet. The orchestra "band-wagon," which usually is located on the elevator in front of the curtain, is extremely mobile. When the "band-wagon" is at the sub-basement level it may enter a tunnel or passageway running from the front to the rear of the stage. The three sections of the stage elevator form part of the floor of the tunnel. The orchestra carriage is operated by storage batteries so that there are no power cables to foul. The "band-wagon" at stage level can be propelled backstage for 60 feet. The platform passes over foot lights which are lowered below stage level to permit of its passage.



Holes were bored 54 feet in solid rock for the hydraulic cylinders three feet in diameter. Valves work electrically

Looking down on the turntable during construction. It forms a part of three elevators and can turn even while rising



The steel and asbestos fire curtain weighs 48 tons and there is another fire curtain below the stage level to protect the tunnel already referred to. Seven feet back of the main proscenium arch is a second proscenium or portal, rectangular in shape, which is adjustable as to size, the motions being regulated by motors. The main plush curtain is operated by 13 electric motors, giving a wide variety of designs.

The second Rockefeller Center theater, known as the "RKO Roxy Theater," is a block away from the Music Hall and is dedicated to sound films, but an efficient stage permits of varied entertainment. It contains the world's largest chandelier which was illustrated in our February issue. In both theaters S. L. Rothafel (Roxy) was the leading spirit during the difficult formative period.

THE TRUTH ABOUT HIGH-ALTITUDE

By W. H. EVERS

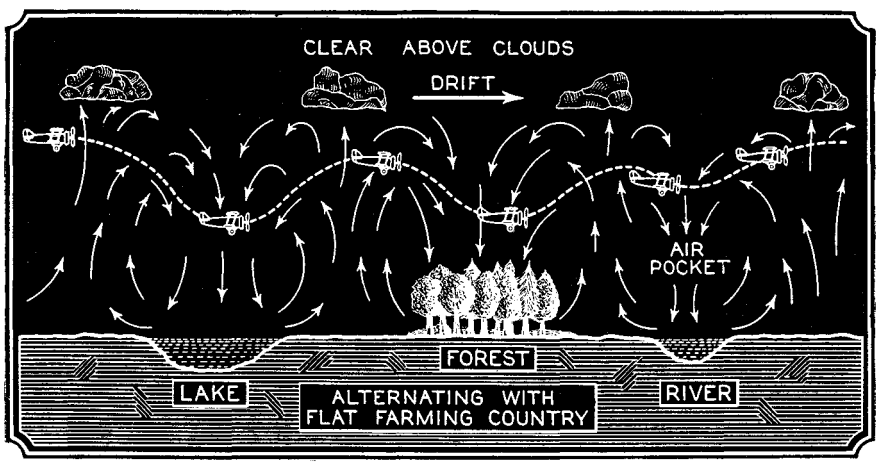
THE next step in aircraft design—the conquest and exploitation of the higher regions of our air belt, the so-called "stratosphere"—is close at hand. The German and French entrants for pioneer honors in the exploration of the stratosphere are almost ready for high altitude work; the two thrilling balloon flights of Professor Piccard and his aide into the stratosphere to make observations have done much to pave the way for power flights in that region.

Once the problems of stratosphere flight are tackled, engineers and scientists will attain the goal just as they have in other fields, and will probably find a strata where air travel will always be a pleasure because of the absence of "bumps" and other atmospheric disturbances. This is the reason why not only scientists are greatly interested in the coming flights in the "thin air region," but why our air-line operators as well will follow closely the exploration of the higher altitudes. The high-altitude ship may solve many present-day difficulties in connection with long distance, non-stop flights on a profitable commercial basis. The anticipated higher speeds in the thin air, with sea-level horsepower and fuel load, will leave room for the pay load necessary to make transport operations worth while at lower rates, and will make possible twice the present range of from 500 to 700 miles.

NO present-day transport plane can carry enough pay load to make profitable non-stop flights from New York to St. Louis, Miami, New Orleans or to other cities within about the same radius, without considerably raising the rates charged at the present time.

Every airplane is designed and licensed for a certain gross weight. The gross weight consists of the weight of the plane itself, plus the weight of the crew, oil, fuel, and the pay load. If the non-stop range of a plane is changed, oil, fuel, and pay load have to be altered correspondingly, with the weight of the ship and of the crew remaining constant. The larger amount of fuel and oil required for longer ranges reduces the pay load to such an extent that it costs about three times as much to carry a passenger or other pay load a certain distance on a plane of 1250-mile range, as it would cost on a similar ship with a range of only 500 miles. This is one of the reasons why we have at present no long-distance air travel without stops for refueling at intervals of about 500 miles or less. The extension of our air lines to Europe, or any other country separated from us by a large body of water, is impossible with our conventional land or water transport planes, unless artificial airdromes for refueling are anchored at such intervals that passenger and freight rates can be kept at about the present level.

The most direct way to increase the comparatively short economical range of our transport planes and to reduce the cost of transportation is to use higher speeds with present engine power and fuel consumption. If the speed could be doubled without an increase in power, the range could be doubled and present passenger and freight rates cut approximately in half. This would be a great boon to air travel and transportation of mail and fast freight, but to achieve such an end we probably shall have to wait for the coming of high-altitude planes, since the practical and economical speed limits of our present day transport planes have almost been reached. No substantial increase in speed can be gained without arriving at excessive landing speeds, which reduce the safety of take-off and landing in general and the safety of forced or emergency landings in particular. Speed increase at the cost of safety is most undesirable to our air-line operators; so also are higher speeds requiring higher passenger and freight rates.



The pilot of a low-altitude plane may encounter many different kinds of weather. The drawing shows the origin of cumulus clouds and sun squalls or bumps. The arrows indicate the approximate direction of air flow; broken line shows flight path of the airplane as it passes from one atmospheric condition to another

IN order to understand the factors which govern the speed and other performances of an airplane it is necessary to know something of the principles of flight. We must think of the air as a fluid, having body and weight, but about 1/810 as dense as water. Air also differs from water in respect to compressibility. If we take a tire pump or a squirt gun, fill it with water and close the outlet nozzle, we are unable to move the piston, although we may use all our strength. But if we fill the pump with air instead of water, we can move the piston downward a certain distance, depending on the force applied, because the air is compressed to a smaller volume of higher density, but with weight remaining constant.

Our experiment clearly shows that the air is compressible and this is the explanation of why air decreases in density and weight as altitude is gained. Consequently, an airplane with constant power output will, up to a certain point, increase its speed as the air becomes thinner and the resistance decreases, whereas the speed of a submerged submarine, operating in uncompressible water, remains the same at all depths when the power remains constant.

We may compare our atmosphere to a huge ocean, completely encircling the world, hundreds of thousands of feet deep, having the solid and liquid surface of our earth as its bottom. Due to compressibility, the density and weight of our air is greatest at sea level. The decrease in density with altitude follows a certain law which enables us to calculate the density and weight at different heights, or to compute the altitude from density or weight, as the case

FLIGHT

may be. While 13 cubic feet of air weigh one pound at sea level, 86 cubic feet weigh one pound at 50,000 feet altitude, because the air at that height is less than one sixth as dense as it is at zero altitude. With increasing thinness of the air, the resistance offered to flying objects—airplanes, airships, or shells—diminishes, which is one reason why engineers and scientists are turning to the upper levels of the atmosphere for high-speed and long-distance flying of the future.

The stratosphere planes now being developed will probably be the forerunners of extreme high-altitude ships with rocket propulsion, but it may take a decade or more before rockets can be utilized. The new stratosphere planes, with supercharged gasoline or Diesel engines and propeller propulsion, will fly at altitudes between 40,000 and 55,000 feet; this appears to be the maximum altitude for economical and practical flights for this type of craft with our present equipment and our limited knowledge of conditions. For still greater heights and speeds we shall have to wait for the rocket propelled planes, flying at altitudes around 100,000 feet, where the air is about one one-hundredth as dense as at sea level. The efficiency of the rocket increases continuously with increase in rarity of the surrounding air and, therefore, the ideal condition for rocket propulsion is the perfect vacuum. Under such conditions, of course, no plane with engine or propeller could fly on account of the absence of air which is necessary to give buoyancy to the wings and "grip" to the propeller.

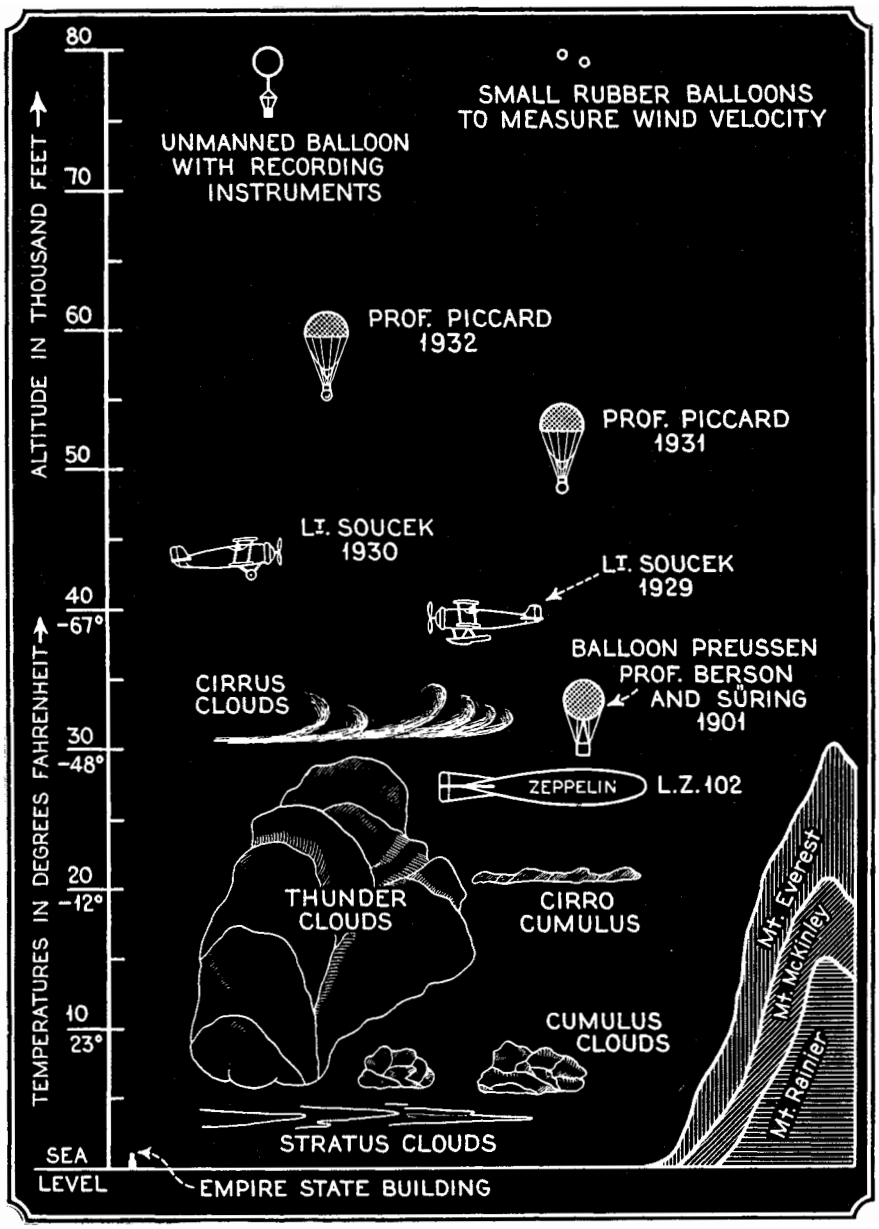


Chart of observed and measured altitudes and temperatures

FOR thousands of years human beings have been living at the bottom of the great atmospheric ocean and our whole organism has adjusted itself to the existing conditions at this level. Here the body and vital organs have the right pressure to function normally and the lungs draw in the proper air to supply the blood with oxygen. Just as deep-sea fish cannot live close to the surface of the ocean and generally die on their way up when caught in a net, human beings and animals cannot survive at great altitudes, even if oxygen is supplied, on account of the reduction in pressure to which the body is not accustomed. Experiments have been made in variable pressure chambers, to determine the effect of the "thin air region" upon the human body. The air pressure in these chambers can be regulated to simulate high-altitude conditions, with the exception of temperature, but as the latter is of little importance it can be neglected without affecting the results and ultimate conclusion.

These experiments revealed that "altitude sickness" generally begins with chills and laboring of the heart and terminates in complete loss of mental perception. The stomach and intestines, partly filled with air, expand with an increase in altitude and the corresponding decrease in outside pressure. The diaphragm in turn is pushed up against the heart, impairing its proper function. Bursting of blood vessels from expansion has also been observed on several occasions. The experiments further disclosed disturbances of the mental faculties, usually common with progressing altitude sickness. Bad headaches were generally followed by decreasing sensibility of balance and touch. It has also been noted that the power of self-control and ability to observe, conclude, and decide generally disappeared, succeeded usually by convulsions and complete unconsciousness.

The range in temperature encountered during an altitude flight to the stratosphere is approximately 130 degrees, Fahrenheit. This change, from about 60 degrees at sea level to approximately 70 degrees below zero at 50,000 feet, does not affect our well being, if we dress accordingly, but it is nevertheless at times very disagreeable. Heavy clothes—fur-lined flying suits, boots and helmets, leather masks and heated goggles—are necessary, even on the hottest summer day, to conserve the body heat. Occasionally, electrically heated suits and gloves are used to keep the altitude flier warm.

It is now apparent that high-altitude flying in a conventional plane, although equipped with oxygen apparatus for breathing, is a very precarious under-

(*Please turn to page* 187)

HOME-BREWING THE RAINBOW—

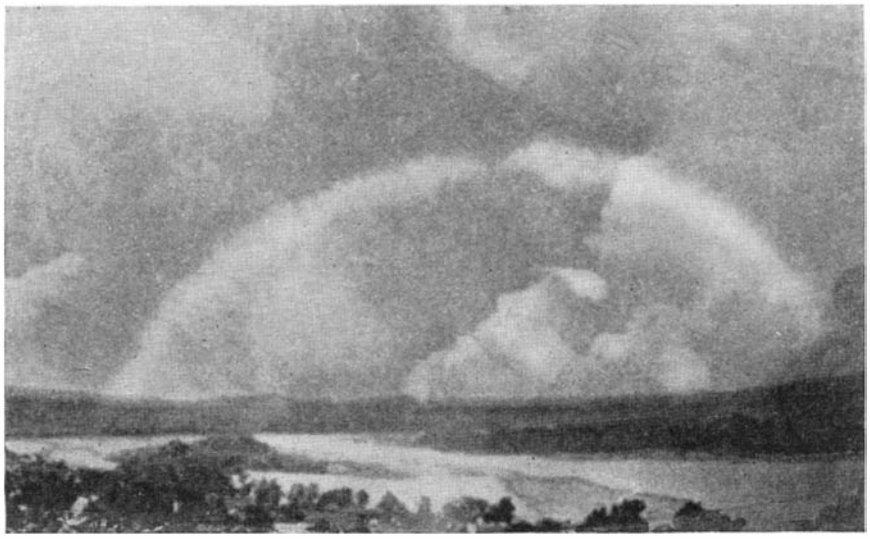


Figure 1: **A close-up photograph of the home-made rainbow shown in the photograph below. The spectral colors of the original do not, of course, show here**

HERE is a photograph of the rainbow I *made* (Figure 1). It has all the characteristics of the one in the sky. It begins with red above, and blends through orange, yellow, green, and blue to violet below. Also the sky is lighter in tone inside the bow, and darker outside it, just as the sky is when a rainbow appears in a shower opposite the sun.

Yet my rainbow was made and photographed on my workroom table, on a bright day without a cloud in the sky. To understand how Nature paints one of her most lovely pictures upon a canvas of falling raindrops, I repeated her process with simple laboratory materials.

I had read in textbooks how the prismatic hues of the rainbow are produced by those rays of sunlight which enter the falling drops, are split by refraction into a spectrum—and are then reflected back to the observer's eye by the curved backs of the drops. But I wished to catch a raindrop in the act and see the process at work.

Since it was impossible to study the path of light reflected from a single raindrop, I looked about for a substitute. A small two-inch crystal "gazing ball" in an optician's window gave the answer. Its refraction of light would be slightly different from that caused by a drop of water, but the principle would be the same. I bought two of the balls and took them home for experiments.

The first test I tried is shown in Figure 2, and the diagram which explains it in Figure 3. The ball is held by a cardboard standard, in a beam of sunlight which falls through a hole in a shield of heavy paper. This shield is slightly conical in form, like a straight-ribbed Japanese parasol. Above the hole is pasted a half-tone landscape print. The parasol serves to cut off those rays of the sun which would otherwise dazzle the observer's eyes and likewise make photography impossible.

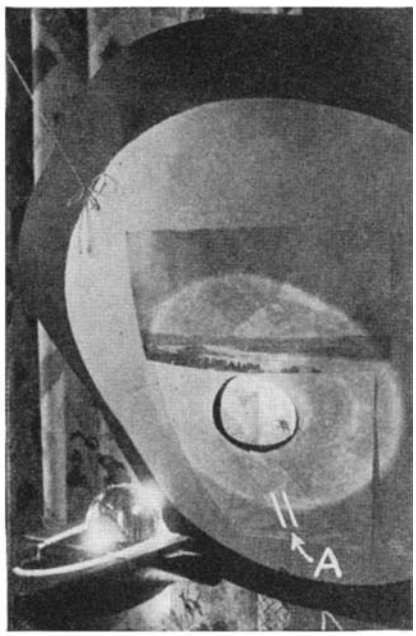
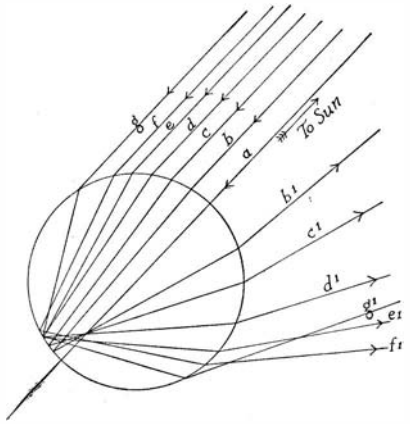


Figure 2: **How the rainbow was made: a large low cone of cardboard with its apex clipped off, with sunlight shining through the hole on a ball of glass. *Figure 3* (at the right) is explained in text**

All of the rays of light coming from the sun through the circular opening are of course sensibly parallel. Let us see what happens to them as they are refracted and reflected upon the top of the parasol by the glittering ball. What holds true for the ball, as far as the laws of optics are concerned, will also be true for the raindrop, of which the glass sphere is only a much magnified duplicate.

First, we notice that the sunlight reflected by the ball has a characteristic pattern. There is a colored circle—red outside, blending through the other spectrum colors to violet inside. The entire circular area enclosed is filled with scattered white light, but outside of the spectrum ring the reflected light stops suddenly, for beyond the red circumference no light is sent to the parasol top.

THE diagram (Figure 3) explains the optical formation of the spectrum ring and the whitish area inside it. For clearness, however, the figure is concerned only with a single small segment of the ring on its lower side, indicated by (A) in Figure 2. This spectrum segment is formed by only a small fraction of the sun's rays—those which enter the upper part of the ball and leave its lower part. Their paths are, in fact, all confined to a very thin vertical slice through the center of the ball. What is true of this paper-thin section will be true of any other slice



made through the ball's center parallel to the beam of sunlight—horizontal or at any slant whatever. Hence the complete ring will be simply the sum of the light passing through all sections like the one our diagram illustrates.

To begin: Ray *a*, Figure 3, passing through the exact center of the ball, is partially reflected directly back upon itself without being bent at all. But ray *b*, just above it, is slightly bent (refracted) downward upon entering, is reflected from the concave back sur-

AND UNDERSTANDING IT

By GAYLORD JOHNSON
Author of "The New X-Ray Microscope."
Scientific American, May, 1932

face, and upon leaving the ball it is still further bent—after which it travels in the direction b^1 below the center line *a*. In the same way, rays *c* and *d*, each entering the ball at a higher point, are refracted at sharper angles upon entering and leaving, and diverge along the lines c^1 and d^1. It is rays such as these which produce the inner circle of scattered white light.

Up to this point each of the successive *parallel* rays of the sun which we have traced has left the ball in a direction different from its predecessor. But when we arrive at two rays such as *e* and *f* we shall find that, after the usual refraction, reflection and refraction, these leave the ball's surface along the *practically parallel* paths shown by e^1 and f^1. If we suppose that ray f^1 sends out the bit of the red ring shown at A, then we can suppose that ray e^1 must be responsible for the corresponding tiny segment of the violet ring. (Violet is always bent more than red.) It is then easy to imagine other rays lying between *e* and *f*, which naturally project the other intervening spectrum colors. It is because all of the entering rays lying between *e* and *f* are refracted out along the approximately parallel lines between e^1 and f^1 that we see *distinct* spectrum colors at A, instead of a continuation of the scattered white light above it.

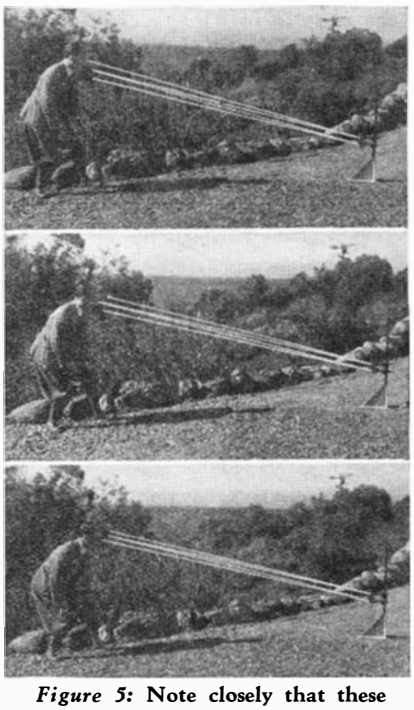


Figure 5: **Note closely that these three pictures are not alike. The crouching observer (bottom) rises and different rays reach his eye**

We now have only to account for the entire absence of whitish reflected light below the segment of the red circle at A. To do this, we must trace a ray, such as *g* would be, entering the ball above both *e* and *f*. If this were done, we should find that it was no longer nearly parallel to *e* and *f*, but would cross them upward and add to the scattered confusion of white light above the violet (within the violet circle of the spectrum).

TO obtain the synthetic rainbow shown at the beginning of the article, I simply photographed the *upper* curve of the chromatic circle cast by my magnified glass "raindrop" across a suitable landscape photograph, but I saw at once that this was not the part of the spectrum circle which we see in the rainbow reflected from the raindrop in Nature. We cannot, except from an airship, see light thrown upward from a raindrop which is high up in the sky above our heads. We must see the part of its chromatic circle which is thrown downward toward our eyes.

And then I ran into trouble, for the order of colors in this downward thrown segment is (as we have just seen in Figure 3) from violet downward to red, while the order in the sky rainbow is from red downward to violet. How does this come about? A physics textbook gave me the answer:—*the eye sees the red part of the circle reflected from one drop of rain, simultaneously with the violet part of the circle coming from a drop lower down in the shower.* Other drops in intervening positions of course fill in the blending colors from red downward to violet. In other words, *it takes more than one raindrop to make nature's rainbow.*

But I was not satisfied to take my solution ready-made. I must see the process in action—I must do the optical detective work necessary to catch two raindrops in the act of compounding, not a felony but a right-side-up rainbow.

In order to see this process with my own eyes, I built a standard to support both of the crystal balls. This is shown in Figure 4. The brackets carrying the balls could be moved up or down on their flat supporting strip of wood. Since I wished to study only the vertical

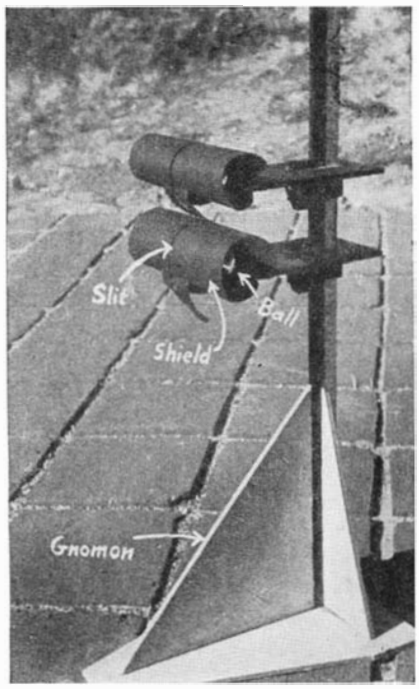


Figure 4: **Apparatus for holding the two glass balls. See the text**

slices of light rays forming the narrow lower segments of the spectrum circles, I cut off all other rays from both balls by means of two shields of black paper. A narrow slit in each shield permitted the passage of only the direct solar rays entering each raindrop ball in a vertical plane cutting its center. Thus one slit was located exactly above the other in a vertical line, and in line also with the plane of a triangular "gnomon" in the base of the standard.

I began by adjusting the brackets supporting the balls quite close together, and carried the entire apparatus out into the bright sunshine. Here it was set down and turned in such a direction that the large triangle or "gnomon" of cardboard in the base cast no shadow —in other words, with the sunlight entering straight through the slits into the upper parts of both glass balls and being reflected out from their lower parts.

After making this adjustment I took the position shown in Figure 5 and looked for the spectrum segment reflected from the lower part of the lower ball. I stooped low and raised myself gradually, eye upon the lower slit.

Suddenly a flash of glowing sunset red entered my pupil. As I gradually raised myself, this turned to orange, through yellow, green and blue, and became violet. And then, just as the lower raindrop ball's spectrum was complete, I received a flash of the glowing-coal red from the spectrum of the upper ball! It was a thrilling moment, for it proved to me, unforgettably, just how each of a succession of raindrops, arranged vertically in the shower, contributes its color element to a tiny seg-

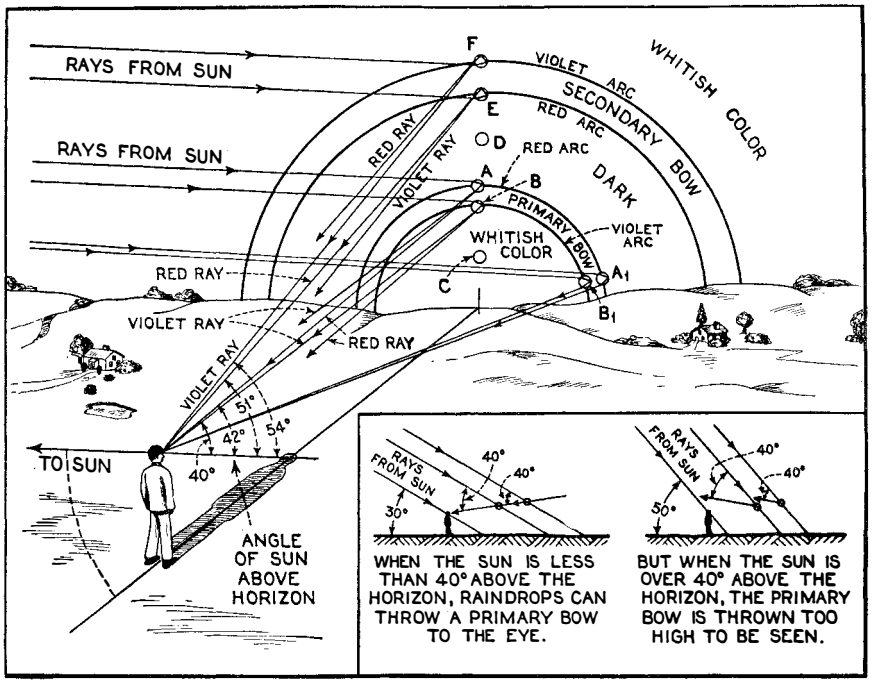


Figure 6: **The optical theory of a rainbow. A more technical explanation of the rainbow will be found in Humphreys' "Physics of the Air," pages 462-482. A number of popular questions about the rainbow are also explained, such as the rainbow's distance—the drops that produce it may be near or far, or both. The rainbow is seldom seen in winter because there is so seldom a combination of sun and rain at that season. Rainbows are not seen at noon (except in higher latitudes) because the sun must be less than 42 degrees above the horizon**

ment of the complete bow that we see in the sky.

The white lines on the triple photograph (Figure 5) show how my eye sees (as its position rises with my body) first the red line of the lower raindrop-ball's spectrum, then its orange, yellow, green and blue; and then how, just as the violet appears, the red ray from the upper ball is perceived. The picture at the top makes plain that, as my eye continues to rise, it finally sees the violet of the upper ball's spectrum, after perceiving in order the orange, yellow, green and blue. Only from the position illustrated in the middle picture can my eye see parts of both spectra. All colors except the violet of the lower one are cast too low to enter the pupil; all colors except the red of the upper are cast too high to reach the eye.

IN order to visualize clearly for myself how the identical process demonstrated with the two glass spheres is duplicated millions of times in the real rainbow, I made the diagram reproduced in Figure 6.

The eye of the man looking at the rainbow receives red light from the spectrum cast by every raindrop as it falls across the circular arc marked "Red arc," and violet from every drop crossing the arc marked "Violet arc;" while drops crossing a series of intervening arcs supply the eye with the remaining colors. We have already seen why the sky *within* the bow has a pearly, whitish appearance, while *outside* of it the cloud is dark as is shown in the diagram (Figure 6).

An interesting point, readily apparent from Figure 6, is that each person sees his own rainbow. The eye of another man, standing beside the one in our diagram, would receive his color impressions from an entirely different set of raindrops. In fact, the left eye of an observer sees a different bow from the one his right perceives!

I now felt that I had really demonstrated the formation of the primary bow which is always seen, but I still had to take for granted the textbook's explanation of the secondary bow (with the order of colors reversed) which is sometimes visible above the primary. This is due to rays of sunlight which enter the lower part of a raindrop at such an angle that they are reflected twice within the drop before being refracted out as a spectrum. See Figure 7, below.

Since these rays of the secondary bow are thus bent upon themselves through nearly two thirds of a circle (234 degrees) they reach the observer's eye from a much higher point than the rays of the primary (51 degrees for the red instead of 40 degrees).

I was able to demonstrate the presence of the secondary bow thrown downward from my glass raindrops in the following way:

After the experiment shown in Figure 5, I held underneath the lower ball a small, rather deep box having a white bottom. The sides of the box served to shut off the bright sunlight. As I moved the box gradually toward the base of the standard, a faint spectrum appeared upon the white bottom—with all of the colors reversed. This corresponded to the secondary bow sometimes seen above the primary bow in Nature. The fainter colors of the secondary bow are accounted for by the greater absorption of light, due to its longer path through the raindrop.

Now I shall never forget the optical processes which give us one of the most exquisite spectacles in the world—for I have used them to reproduce it upon a miniature scale. I have "home-brewed" a rainbow!

For a technical exposition of the optics of rainbows of different kinds the reader is referred to a 25-page chapter in Humphreys' "Physics of the Air" entitled "Refraction by Water Drops." This book is the standard reference work on various phenomena, common and peculiar, in meteorological physics.—THE EDITOR.

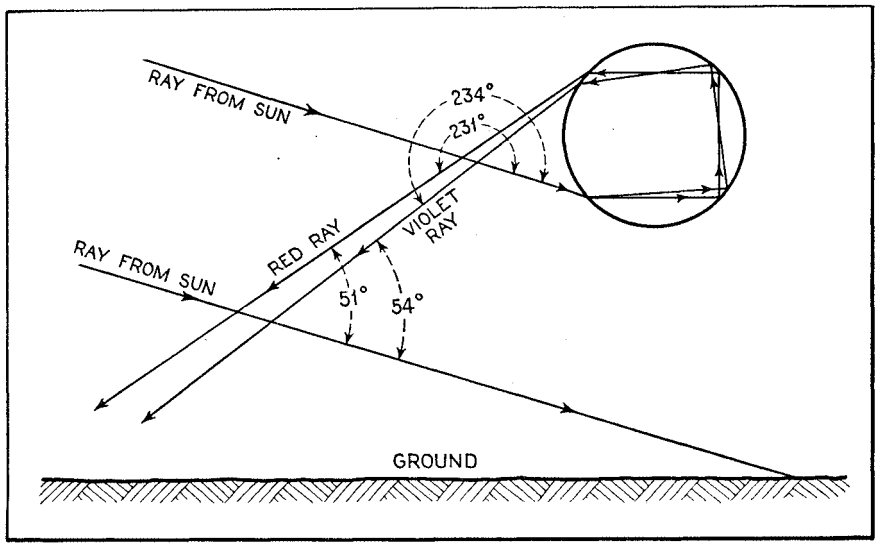
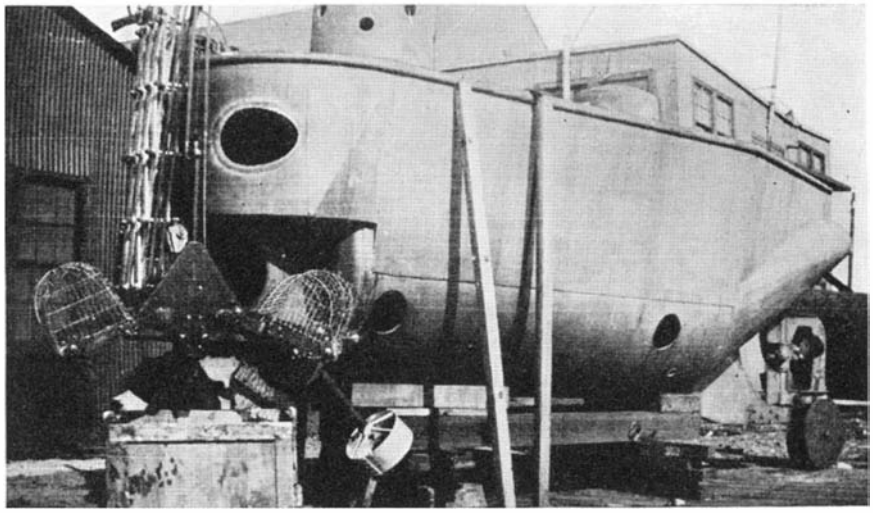


Figure 7: **Why the colors of the secondary rainbow are reversed: This arises from the double reflection within each drop, which reverses the normal order**

The Submarine Turns Peaceful

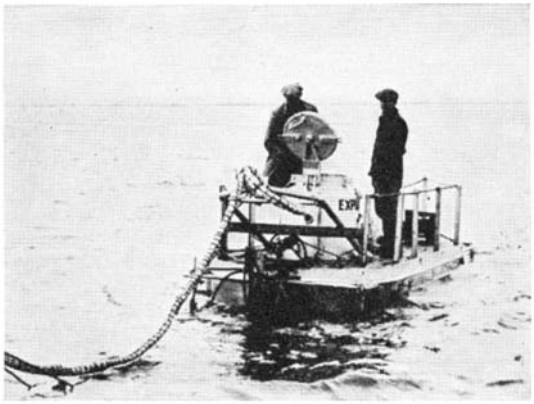
DR. WILLIAM BEEBE, well-known deep sea explorer and lecturer, recently tested the possibilities of, and praised highly, a midget submarine designed and built by Simon Lake wholly for peace-time use. Twenty-two feet in length, this tiny craft is the first commercial submarine ever built except Germany's huge *Deutschland*. It is especially adapted to sub-sea exploration, salvaging and other engineering operations, locating sunken wrecks, and harvesting shell fish, pearl oysters, sponges, and the like. Its beam is only six feet and it weighs 20,000 pounds complete.

The *Explorer*, as this first of the type has been named, is manned by a crew of two men, and two additional men can be carried. It operates in conjunction with a surface mother ship which supplies to it electric current, air, and telephonic communication through cables and hose lines. It is towed, either awash or submerged, by the mother ship but can operate in a limited area by means of its own 7½ horsepower electric motor while the mother ship remains anchored. Three heavy wheels enable it to ride along the bottom.



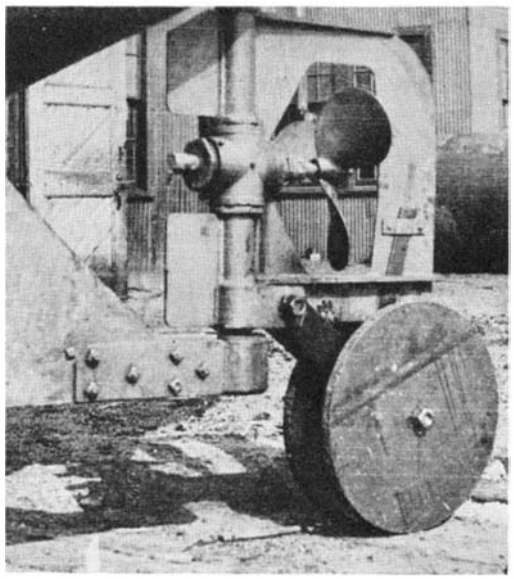
The tiny submarine on the ways at the Lake plant, showing the extensible arm on the bow, with the grab which is used to harvest shell fish or sponges

THE steel hull of the *Explorer* comprises an inner and an outer shell, the inner one being cylindrical to resist enormous water pressure. The outer shell is of light steel plate. The space between the two serves as a water tank for submerging. Other tanks provide for buoyancy and balance. Two conning towers accommodate the two men of the regular crew standing up. Twenty portholes in conning towers and hull permit ample observation, while powerful searchlights give the light for underwater work.

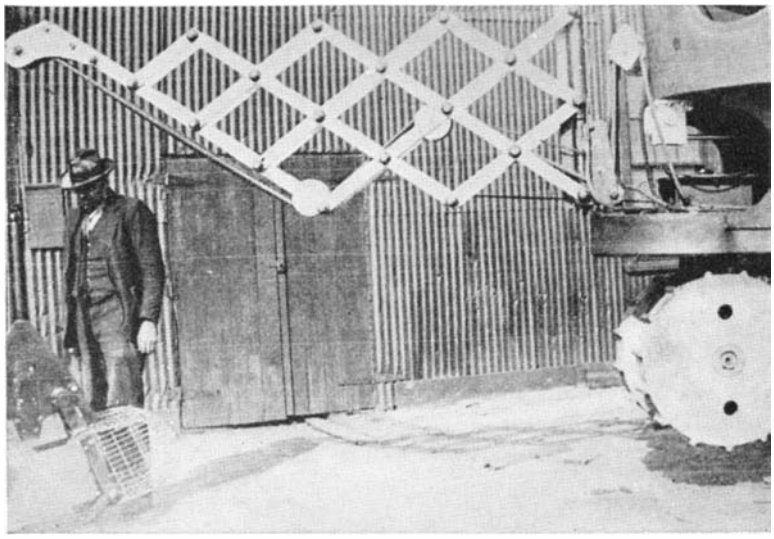


The *Explorer* at rest awash, with the main conning tower hatch thrown open. The hose and cables to supply air, electricity, and telephonic communication when the craft is submerged, extend from the mother ship

Working in conjunction with the *Explorer*, a deep sea diver can be taken to the scene of operations in safety and comfort. After submerging in the submarine, the diver can leave it by means of an underwater hatch and return at any time. The submarine can, moreover, descend 300 feet—deeper than a diver can work—in order to examine the bottom through the portholes under the rays of searchlights.



Lower stern of the new craft, showing wheel mounted on rudder and the motor driven screw



The lazy-tong derrick extended from bow, with grab bucket at left. Front wheels are at right

Gas Aids the Potter

By J. B. NEALEY

THE potter's wheel, the ancient trademark of the potter's art, stands unchanged over a period of approximately 3000 years as the basis of our modern pottery industry. The other processes incident to this art and industry, however, such as clay mixtures, glaze making, color production, decorative design, and burning, show an advancement from century to century that is very noticeable. Especially is this true in burning the ware, where the greatest step forward has been accomplished within the past few years with the introduction of the automatic, gas-fired kiln.

Hollow ware is finished on a sort of lathe similar to that in wood-shops

Pottery was first fashioned by hand by scooping out a ball of clay into the shape of a vessel or pot, or molding it on a round stone. Later, baskets of the desired shape were woven and the clay modeled about these. Then the method of making the desired forms with coils of clay rope was employed to some extent. Finally, the potter's wheel put in an appearance about 1500 B.C. This was first turned by hand and next by foot, and then, many centuries later, by mechanical means.

Sun baking was first used in hardening pottery and then, no doubt, burning by fire was discovered accidentally when a clay vessel was left in a wood fire. This led to the gradual development of crude furnaces, then to the upright and muffle periodic kilns, and finally to the modern mechanical kiln.

Egypt is credited with the first pottery, and tombs recently opened there disclosed unglazed ware of the Memphite Period, about 5000 B.C. Other pieces dating about 4000 B.C. show a superior basic material and are covered with fine turquoise glazes made from copper. That the pottery art was well under way by the end of the next thousand years was evidenced by the finding of a frieze in a tomb of the Theban Period, which depicts scenes from the lives of the potters of that time.

The famed painted vase of Egypt was evolved during the 12th dynasty while polychrome glazes, including blue, violet, purple, red, green, and yellow—all made from the oxides of various minerals—came in during the 18th dynasty or about 1400 B.C. Paralleling the Egyptian development, and no doubt influenced by it, was the evolution of the potter's art in Greece which had already reached a high point by 2500 B.C. Beautiful brilliant glazes in which lead was first used have been traced to the First Century B.C.

ETRUSCAN and Umbrian ware, which are thought to date back to 1000 B.C., show the influence of Greece on the Italian industry, which grew with the Roman Empire. Cumae and Mutina were pottery centers in Italy and the famous Samian ware was produced during this period. The art was carried into the Loire and Rhine Valleys where potteries were established at Arles and Orange.

New shapes, glazes, and designs were developed during the Persian civilization and following the fall of the Roman Empire, the most noted advancement being the use of oxide of tin to whiten the ware and the discovery of the fritted soda base glazes. The translucent Gombroon ware, covered with a soft lead glaze, was a product of this period. The Persians also developed the famous luster ware, in which alloyed gold was employed to produce the luster and silver to give it an iridescent appearance. There was a pottery center at Ispahan and here the Perso-Chinese style was evolved by importing numbers of Chinese potters.

European pottery came into its own many centuries later, that of Spain flourishing between the 12th and 15th Centuries, with its center at Malaga. The ceramic tiles found in the Alhambra are world-famous as is the Valencia luster wares which came into existence between 1400 and 1500. The world-known blue printed Delft ware came from the city of that name in Holland from 1600 to 1700 while the Continental hard porcelain was developed in Germany. Much beautiful pottery was made in potteries located in Rouen, St. Cloud, and Sèvres, France.

The most beautiful of all ceramic products, bone China, was developed in England, and it was in that country that the printing press entered into the decorative phase of this industry. Josiah Wedgwood became famous through his Jasper ware, and Wedgwood products are still being made today. Another name of equal importance was that of John Meir who operated a pottery in Derbyshire, England, about 1721. This business was continued for generations, the name being changed later to Mayer. In 1881 the brothers Joseph and Ernest brought the name Mayer to America and established a pottery in Beaver Falls, Pennsylvania, which still flourishes today as the Mayer China Company, a larger plant having been built in 1896.

The body of the ware made in this plant is composed of ball clay from Tennessee; feldspar from Canada, Connecticut, and New York; kaolin from England and Florida; and flint from Illinois. Correctly proportioned and mixed, this "body" is filtered and then pugged to mix and temper it thoroughly and is then delivered by conveyors to the potters. The potter's wheel still survives but modern ingenuity has added a motor underneath to rotate it and a mold on top having the exact shape of the piece of ware being made. Above this is a hinged tool or steel straight edge, the edge being cut to the precise outside shape of the ware. With the

A jiggerman working on oval ware. The tool is stationary; head rotates

clay body partially formed against the mold, it is rotated and the tool is pressed against the exposed surface to give it the correct shape outside.

The potter's wheel is now known as the "jigger" and two men form its crew. The first, or batterman, selects a piece of body clay of the exact weight desired, spreads it into a "bat" of the proper thickness on a revolving spreader and passes it to the jiggerman who forms it as already explained. The making of some shapes is accomplished by adding enough water to the body to form a liquid and this liquid is poured into molds which absorb some of the moisture, the excess being poured off, leaving the desired form caked on the mold.

All ware, by whatever process made, is then put through the dryer, is packed in containers called saggers to protect it from the kiln dust, and is then burned in a kiln for from 55 to 60 hours. The decorations are put on either by hand or are transferred mechanically. One method consists of engraving the designs on copper, printing them in colors on specially prepared tissue paper, and "floating" them onto the ware. The ware is next burned in the decorating kiln.

The glaze is a liquid of the consistency of cream made from borax, white lead, whiting, flint, clay, and feldspar. These ingredients are so proportioned that the glaze will have the exact coefficient of expansion and contraction as that of the body. Otherwise the two would pull apart or "craze" when subjected to variations in temperature. This glaze is dried by a trip through the dryer of about a half hour and the ware is then packed in the saggers. Here it is held up on three little "pins" to prevent it from sticking. Finally, the ware is burned in a kiln for from 30 to 32 hours.

The ware is then removed from the kiln and saggers and is "dressed"—that is, the small pin marks are removed from the back. It is then sorted and packed.

About 1896 there was developed a refined ware which was known as vitrified hotel china. It was hard to prevent the warping of this product during firing, so the sanding machine was invented and patented. This machine mechanically embeds the ware in sand which reduces to a minimum the rejects obtained in the first burning stages.

A new type of combination downdraft kiln was perfected a few years ago and the Mayer company built two of these and converted the old kilns to this method of firing, using gas as fuel. Then the most revolutionary type of kiln for burning glost-ware* was developed and one of these was built by this concern. This is a long brick tunnel, 175 feet in length, with four fireboxes on each side with a gas burner in each which fires directly into the kiln. There is a track through the kiln and a parallel one outside with a transfer track at each end. The ware, packed in saggers, is gradually heated to maturity as it progresses through the kiln and then slowly cooled before it reaches the discharge end. The highest heat is 2200 degrees, Fahrenheit.

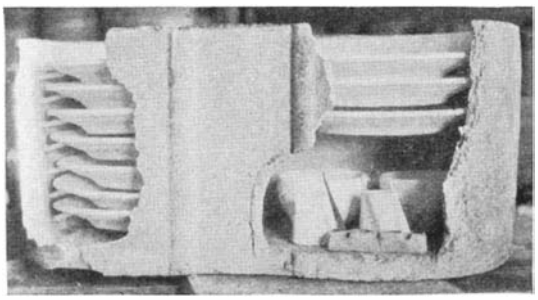
WITH this new type of kiln, delicate colors such as pink, purple, and violet—shades formerly unattainable—are now produced. The advance made possible by this new method of firing is probably the most important in the history of pottery for several hundred years. It has permitted the creation of many beautiful multi-color lithograph transfer patterns in shades to match any desired color schemes.

The success of the glost tunnel kiln led to experiments embodying the same principles in the initial, or bisque, firing. Since the fall of 1929, Mayer china has been made entirely by the gas-fired tunnel kiln process.

The bisque tunnel kiln is similar to the glost kiln but is 240 feet long and the high heat is reached at 2440 degrees, Fahrenheit. A complete system of temperature control is employed, the instruments being located on a control board conveniently disposed. Thermocouples are distributed throughout the kiln and these are connected to a multipoint switch and recording pyrometer on the control board. In this way, exact charts of heat variations, in various parts of the kiln, are obtained.

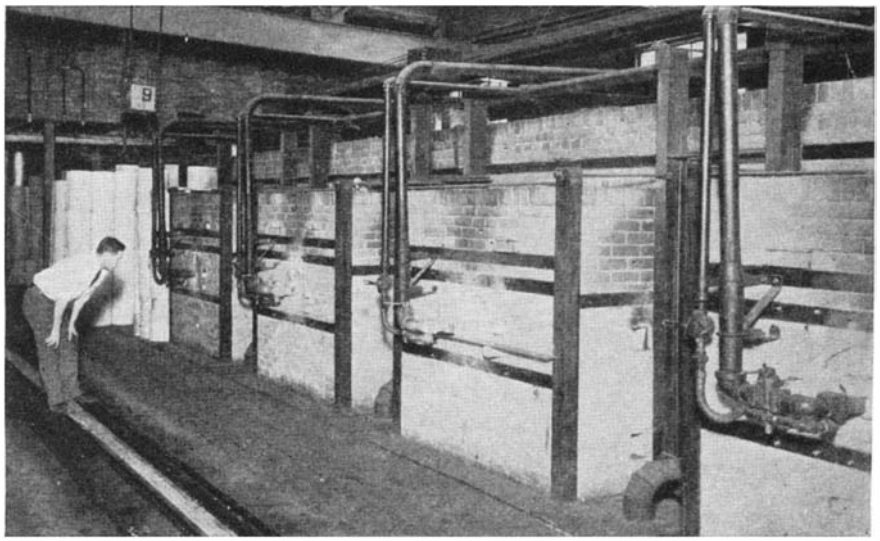
The decorating kiln is of the full muffle periodic type, the highest heat being 1000 degrees, Fahrenheit. Thus we have the three firings: the bisque kiln burning the body of the ware; the decorating kiln burning on the underglaze prints, lines, and decalcomania patterns; and the glost kiln in which the glaze is burned on overall.

*Pottery that has been fired, glazed, and refired.



A sagger, the clay container in which plates are fired, broken to show ware packed inside; also tiny pin supports

Putting the line decoration on plates requires a steady hand. Other decorations are commonly put on by printing or with colored paper transfers



Fireboxes of a bisque kiln showing location of the gas burners. This is one of the three types of gas tunnel kilns recently developed for the ceramic industry

SERVICING

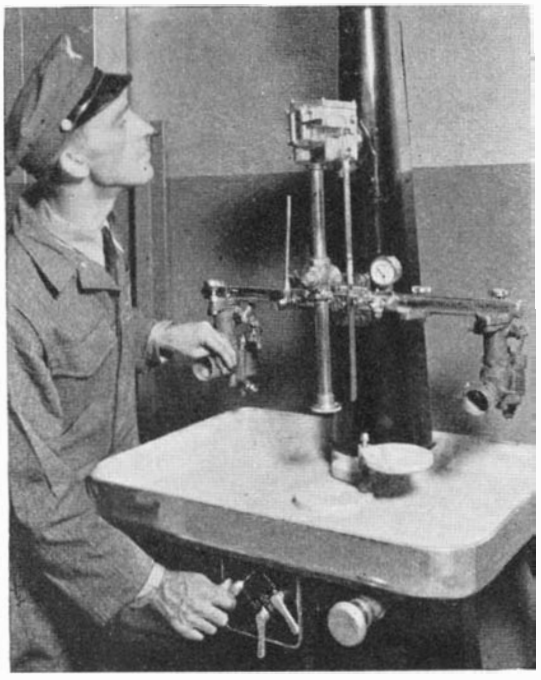
RESEMBLING a hospital for human beings in that it is equipped with all the latest scientific devices for determining practically every ailment of cars and for doctoring them, a remarkable new automobile service station has been opened in a recently completed building of the Standard Oil Company of New Jersey in Washington. The Capitol Servicenter, as it is called, is a six-story building of modernized classic design and monumental character, of Indiana limestone, fronting the Capitol grounds. It is equipped with machinery which includes every modern device known to service station operation, from an automatic wash rack to a squeak detector. The Capitol Servicenter is unique in both its scope and its location.

View of the first floor which, with the basement and sixth floor, is devoted to the Servicenter. Lubrication and wash racks are in glass enclosures at left

Right: **The wash rack operation. Here the men are washing the crevices in hard-to-get-at parts of the car with high pressure streams of water. Large brushes above and below whirl and, as water is supplied to them, clean upper and lower parts of the car as it rolls along. Sprays from the side help to make the job a thorough one—eight minutes being required to wash the car**

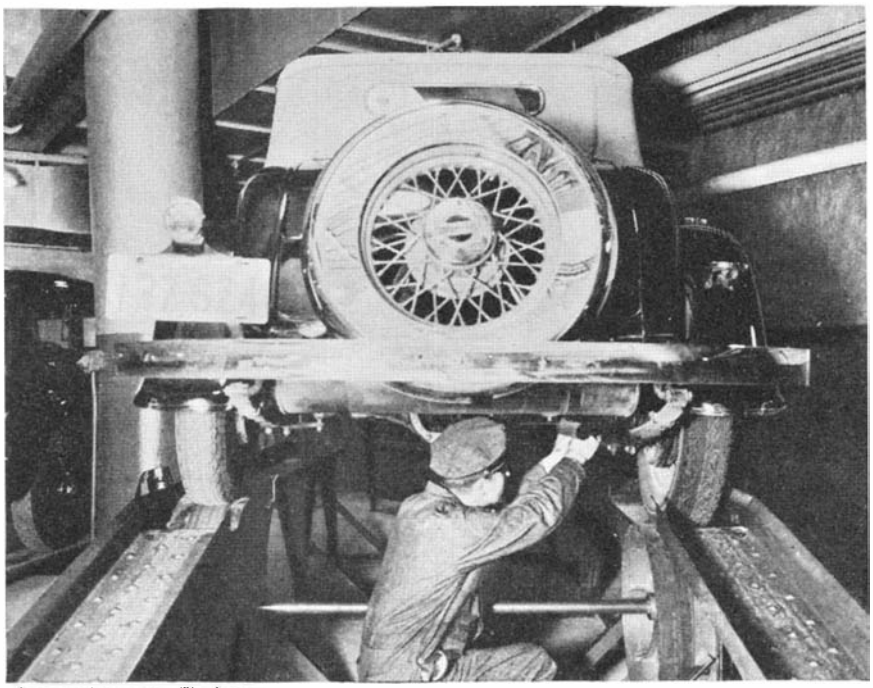
A paint spray booth in the body and fender department on the sixth floor of the Servicenter. Here scratches or spots left after dents have been removed are made to disappear entirely under matched coatings of lacquer

Below: **With the wheel and other parts which might interfere with the proper repair of a crumpled fender, removed, workmen iron out the dents with modern tools that make a perfect job. If finishing and polishing of the fender are then necessary, the car is sent on to other departments where every sign of damage is removed by paint or polish**



Left: **Adjusting a carbureter with the gas analysis machine. This machine is superior to the ear for tuning carbureters because it analyzes both the carbon monoxide and the carbon dioxide of the exhaust and thus permits setting the carbureter so that these two gases are in proper proportion**

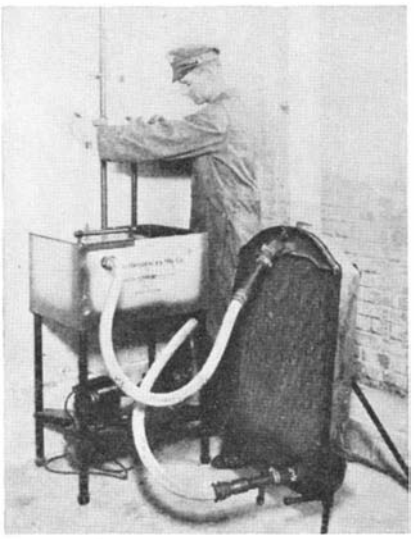
WASHINGTON'S AUTOS



Photographs courtesy *The Lamp*

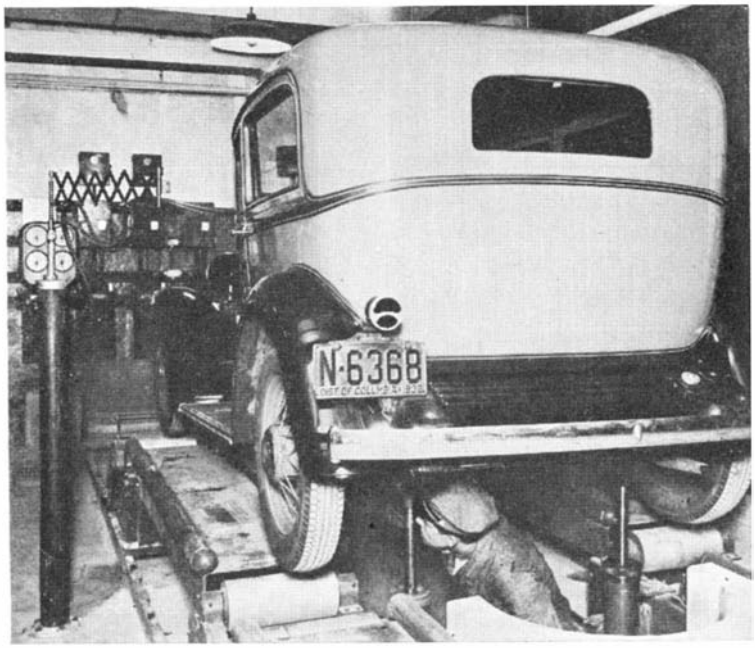
Squeaks hard to locate are found by placing the car on the squeak detector. This is a rack which permits the rear wheels to rest on drums that are slightly off center, and as they rotate, they jounce the car as though it were on a rough road. The body can then be properly tightened

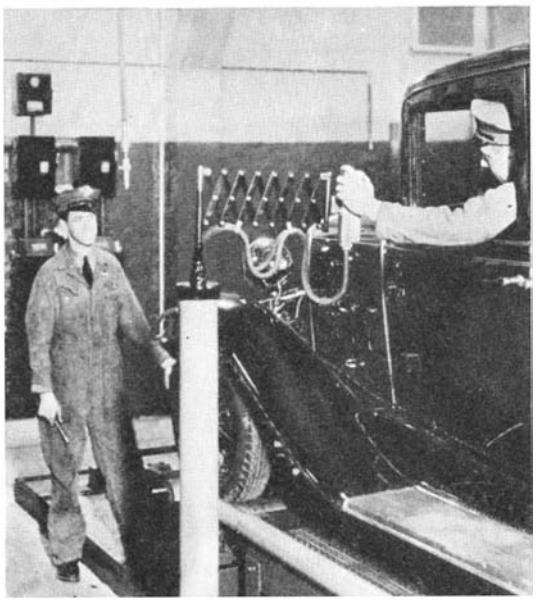
A mechanical buffer being used to give a high polish to the car. The Center is also equipped with machinery to renovate the upholstery, and to remove spots of all kinds from any part of the automobile



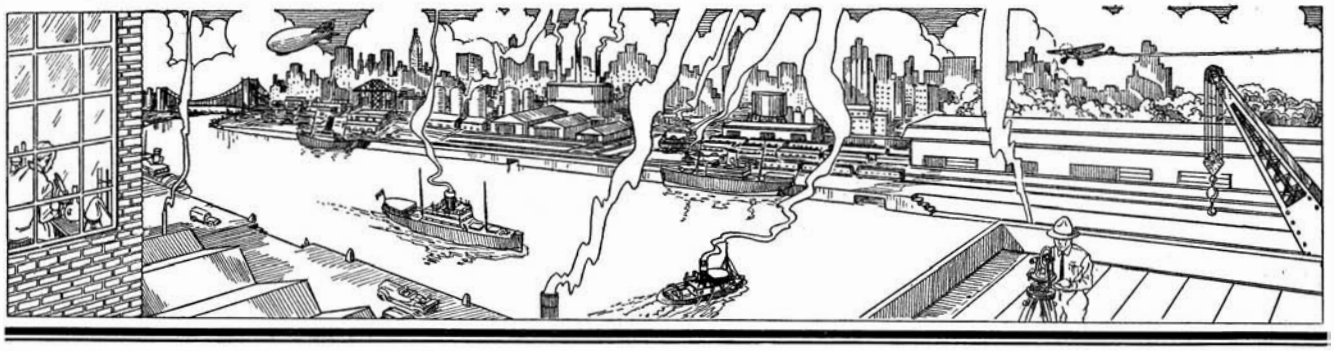
Right: **Not only are radiator testing devices part of the equipment of the Servicenter, but tools with which they are repaired have been specially designed for the job. In this view a service man is seen locating leaks and also any weak spots**

Below: **Adjusting brakes on one of the two brake testing machines with which the Servicenter is equipped and which are said to be the most efficient of any now in use. These machines give tests which are identical with road tests, as the wheels turn on rotating drums. Dials connected to these drums indicate braking efficiency of each wheel and make possible perfect equalization**





A button on an extended arm gives the tester positive control of the brake testing machine



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

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

A. E. BUCHANAN, Jr.

Lehigh University

An Electric Taster

AN "electric palate," or Electrynx, that tastes and indicates on a meter the ripeness of apples, oranges, lemons and other fruits and vegetables, by measuring their acidity has been developed by R. C. Hitchcock, electronic engineer of Westinghouse Electric and Manufacturing Company. The small portable device also registers the acid content of tea and coffee.

When the two dissimilar pins of this instrument are punched into fruit skins, ripeness is indicated

By proper application of the Electrynx, canners and preservers of fruits and vegetables will be able to keep the flavors of their products at a given standard because it will be possible for the samplers at the various orchards and fruit exchanges throughout the country to select the raw product more scientifically.

Other tests made with the Electrynx were the determination of the acid condition of the human mouth, palm of the hand, the hair, and other parts of the body.

The principle involved in the development of the Electrynx is not new but dates back to Alessandro Volta and his original Voltaic or "wet" battery of more than 130 years ago. The two dissimilar pins used in the Electrynx are the electrodes and the materials under test supply the solution or electrolyte.

This latest electrical measuring device is so sensitive that it records the action of one millionth of an ampere or about one tenth the "wing power" of an ordinary house fly and is twice as sensitive as any of its type now on the market. Previous recording meters of this sensitivity were expensive and not readily portable.

Direct electrical measurements can also be made by this new instrument of quantities which formerly required elaborate circuits or amplifying devices. Thermocouple voltages can be indicated. A simple three-element outfit with no battery comprises an electrical temperature indicator.

The Electrynx was primarily designed for measuring the minute currents that flow in photoelectric tube circuits or other light- and sound-sensitive devices.

Silver Purifies Water

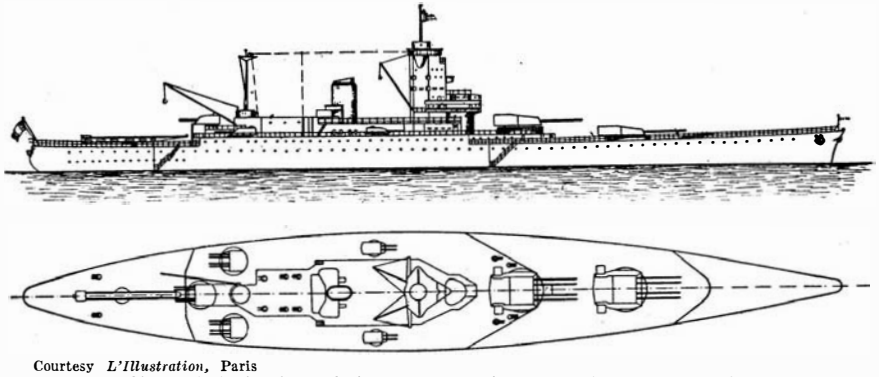
METALLIC silver in an ionic condition appears to exercise a very effective bactericidal action on the germs which are usually present in drinking water. Various means of introducing silver ions into water are described in a recent issue of *Chemical Age*. An electrical method recently proposed involves the passage of the water between silver electrodes through which a very small current is continuously passing. By this method an effective number of silver ions are introduced into the water with the aid of a three to five milliampere current.

One of the earlier methods of purification was based upon the ability of water to take up silver by merely allowing it to trickle over glass beads coated with a very thin layer of the metal. A suitable small-scale plant consists of a 25-quart stoneware jar filled with a quantity of silver-coated glass beads which reduces the capacity to 18 quarts. The water is passed into the jar via a tube filled with silver-coated quartz fibers, and a velocity of flow of half to one quart per minute suffices for thorough disinfection. A curious feature of this catadyne process is that water sterilized in this manner can itself be used as a sterilizing agent for mineral water bottles and the like. It appears that on allowing such silver-charged water to stand in a glass bottle for several hours, a proportion of the ionic silver becomes transferred to the walls of the bottle and serves to sterilize any liquid subsequently poured into it.—*A. E. B.*

French Cruiser "Dunkerque"

THERE have been so many changes in the design of the French armored cruiser *Dunkerque*—which is intended as a counter to Germany's "pocket battleship" *Deutschland* and which was authorized in 1931—that conjectures as what its ultimate appearance will be have been numerous. The design has apparently reached its final state—and even this will be considered more or less tentative—judging from the accompanying drawing of her profile and deck arrangement which was recently published in *L'Illustration* (Paris), through the courtesy of which magazine it is reproduced.

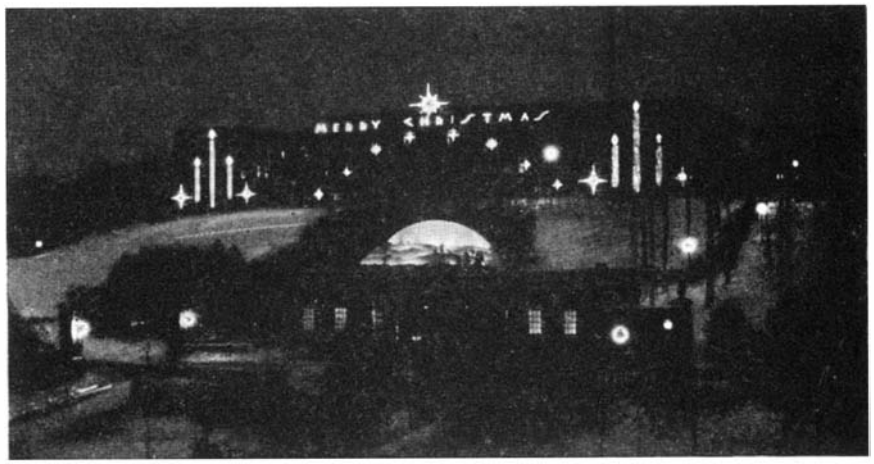
It will be noted that the eight 13-inch



Courtesy *L'Illustration*, Paris

Profile and deck plan of the new French armored cruiser *Dunkerque*

guns are mounted in two quadruple turrets forward on the axis of the cruiser. Medium-sized guns are mounted in three quadruple turrets, one axial and two lateral, and in two double turrets, one on each side ahead of the stack. The smallest guns shown strategically disposed are anti-aircraft guns and quadruple-mounted machine guns. An airplane catapult is shown aft.



Last Christmas, visitors to East Cleveland, Ohio, were greeted by this lighting scheme of challenging beauty and originality at Nela Park, lamp headquarters of the General Electric Company. The crescent is a lighted Christmas scene

Fake Remedies for High Blood Pressure

CONTINUED enforcement of the national pure food and drug law has practically removed from interstate commerce drugs and medicines labeled with remedial claims for high blood pressure and arteriosclerosis, according to Dr. F. J. Cullen, Federal Food and Drug Administration. However, some preparations, inadvisably recommended for these diseases, are manufactured locally and sold intrastate and thus do not come within the jurisdiction of the federal law. Then, too, some products, although legally labeled, are advertised as having curative value for high blood pressure and arteriosclerosis, neither of which is susceptible to effective treatment through the use of drugs. Before purchasing any such article, therefore, it is advisable to compare label statements, controlled by law, with claims made in collateral advertising, and be guided accordingly.

"High blood pressure may be caused by a number of bodily disorders, including Bright's disease, hyper-thyroidism, syphilis, heart disease, diabetes, and sclerosis of the liver," Doctor Cullen says. "The disease may result from hardening of the arteries (arteriosclerosis), or may lead to this serious condition. Blood pressure varies, even in a 'normal' person, from time to time, due to worry, lack of rest, improper diet, or nerve strain. A chronic or aggravated form of high blood pressure is usually fatal or may result in paralysis. One afflicted with the disease should rely upon recognized medical treatments and certainly should not waste money on fake remedies nor endanger his chances of recovery through trusting in claims of medical quacks."

Exaggerations on Telescopic Spectacles

Recent Newspaper Claims Raise False Hopes of Blind

FALSE hope has been created among many of the blind, their families, and their friends throughout the United States by the widespread newspaper publicity given to the announcement in Chicago in December that telescopic spectacles have been perfected which can restore vision to 40 percent of the present classified blind population. In response to the numerous inquiries on this subject which have come to the offices of the American Foundation for the Blind and the National Society for the Prevention of Blindness, respectively, these organizations made the following statement, based on their investigation:

The experience of ophthalmologists who have done much work with telescopic spectacles indicates that the true percentage of those now classified as blind who can be helped by the use of this device—but who cannot be helped by ordinary spectacles—is not 40 percent, but much less than 5 percent. The assumption that practically all cases of low vision are capable of being improved by mere enlargement of the images on the retina is false. The group of the "near-blind" includes a large number of persons whose vision is obstructed by opacities, of persons whose optic nerves or retinas have lost practically all sensitiveness, of persons whose eye diseases would be aggravated and blindness precipitated by excessive use of the eyes, and many others who cannot be helped by any optical device.

Moreover, it happens frequently in the experience of ophthalmologists that a person to whom the physician is able to give improved vision with telescopic lenses is unable actually to make use of them in daily activities. The unfounded claims regarding the extent of their usefulness is particularly unfortunate in that it raises false hopes among the blind. Persons who are helped may find them a great boon, but the number of such persons is relatively small.

There is really no "great discovery" in the use of magnifying glass for spectacles. The first attempts to improve vision by applying the magnifying principle of the telescope to spectacles were made about 300 years ago. For more than 20 years, American ophthalmologists have been using telescopic spectacles in their regular practice.

The only change now proposed is the substitution of cylindrical lenses for the usual spherical lenses—enlarging the vertical dimensions of images by 30 percent, while enlarging their horizontal dimensions 80 percent. This will improve the patient's ability to judge distance and space correctly, it is claimed, and thus make it easier and safer to walk about while wearing the spectacles. Upon examination, this claim does not appear to be justified for several reasons.

In the first place, objects will appear closer than they actually are. Moreover, the use of cylindrical lenses produces distorted or blurred images in which objects appear broader in proportion to height than they actually are. The use of cylindrical lenses in this way is not new and ophthalmologists who have tried it have not found it any improvement.

More important, it is pointed out by ophthalmologists that the use of cylindrical lenses cannot obviate other inherent defects in telescopic spectacles which affect their usefulness, such as the limitation in the field of vision, the apparent movement of objects on turning the head, the necessity for keeping them in adjustment, the impossibility of using the same lenses for both near and distance vision—not to mention the weight and conspicuous appearance of the device. It therefore appears that the "new development" does not constitute any real improvement which would make the spectacles any more widely applicable for improving the vision of persons with low vision than the types of telescopic spectacles now in use.

Novel Use for Carbon Dioxide

IN England, manufacturers and users of ready mixed paints prevent the usual formation of surface skin by filling the can with carbon dioxide gas. Skin formation is thus avoided when the paint has to stand over nights or week-ends. The skin is formed by oxidation of the drying oil. The paint maker simply purges the container of air by substituting a carbon dioxide atmosphere over the paint whenever interruptions occur in the mixing operations.—*A. E. B.*

Pernicious Anemia Patients Should Stick to Treatment

SINCE the discovery of the liver treatment for pernicious anemia, those who die of the disease do so because they fail to keep up the medication ordered, with the result that they may die of anemia or fall into a condition where infectious diseases find them easy prey.

This observation is reported by the Simpson Memorial Institute at the University of Michigan in the Annual Report of President Alexander G. Ruthven for 1931-32. In a group of 290 patients studied by the Institute, 24 deaths occurred. Of these, 12 died of degeneration of the spinal cord, which seems frequently to accompany pernicious anemia, and in a majority of cases the patients had discontinued the advised treatment, often over a long period.

Nine of the 24 died of accidents or diseases wholly unrelated to anemia, while 3 died of bronchopneumonia. The latter and those dying of spinal cord lesions, could have been prevented had these patients co-operated early and sincerely in the prescribed treatment with liver and venticulin, Dr. Cyrus C. Sturgis, Director, stated. The liver extract developed for direct injection into the blood is proving useful, Dr. Sturgis said. It need be given only once a month to keep the average patient normal, and is a valuable emergency method when the extract cannot be taken by mouth.

Ocean Air Transport

THE U. S. Weather Bureau expert in New York City, Dr. Kimball, is not very optimistic about the prospects of any one undertaking a transatlantic flight single handed. While it is true that ocean weather reporting is now very much better than it used to be, as reports come from steamers all over the Atlantic and are rapidly coordinated and analyzed, and the ocean flier can now select the time for his trip with a better chance for success, still the weather forecast may be wrong at least locally, and adverse winds may retard or force the aviator off his course. Another hazard is fog. To fly in fog, blind, is theoretically possible with the aid of modern instruments, but it is a terrific mental strain.

Dr. Kimball recently gave, before the A.S.M.E., a vivid picture of the state of mind of the ocean flier in heavy fog. Blinded in the fog he would seek to fly high, above the clouds. Then unless an expert celestial navigator, he would begin to worry about drift off the course, since being above the clouds he would not be able to check drift by observation of a smoke bomb or the use of some other drift indication method. He would then descend, perhaps rise again, and realize each time that he was losing valuable fuel by so doing. The most brilliant and expert pilot might not be able to stand the protracted mental agony involved. Dr. Kimball also thought that a forced landing even on one of the routes of ocean steamships was a very poor hazard for a small plane, even a seaplane.

That the Department of Commerce is of a similar opinion to that of Dr. Kimball is proved by the latest regulations issued regarding transoceanic flights. The regulations come in the form of an amendment to Air Commerce Regulations and are specifically designed to discourage inexperienced pilots with inadequately equipped aircraft from attempting transoceanic flights. Prior to such a flight, the owner or pilot will have to secure definite authorization from the Department of Commerce. Before securing such authorization he will have to satisfy the following requirements:

1. Ability to fly entirely by instruments or blind. 2. Substantial amount of cross-country night-flying experience. 3. Qualifications as a navigator or the carrying of a competent navigator on board the craft. 4. The aircraft should be one meeting the airworthiness requirements of the Department of Commerce. 5. Certain of the instruments must be in duplicate to guard against failure. 6. Adequate supply of fuel. 7. Ability of the aircraft to carry the strain of the great weight of fuel.

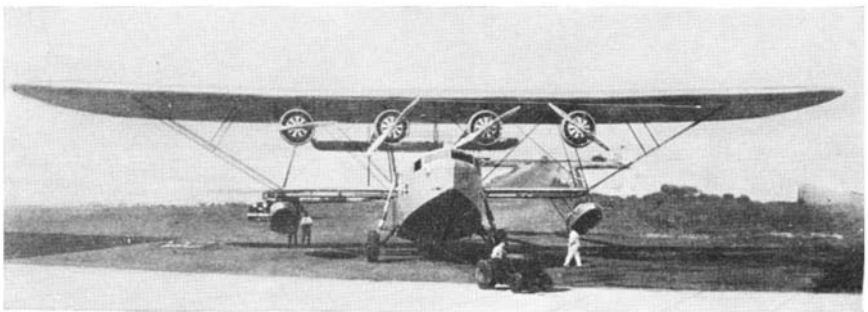
Both Dr. Kimball and the Department of Commerce are undoubtedly right. But, on the other hand, never have the prospects for regular transatlantic service by flying boat looked rosier than they do to-day.

Pan American Airways, which conducts flying operations to Central and South America with such regularity and brilliancy, has just signed two contracts for large flying boats, which are to be used in transoceanic service.

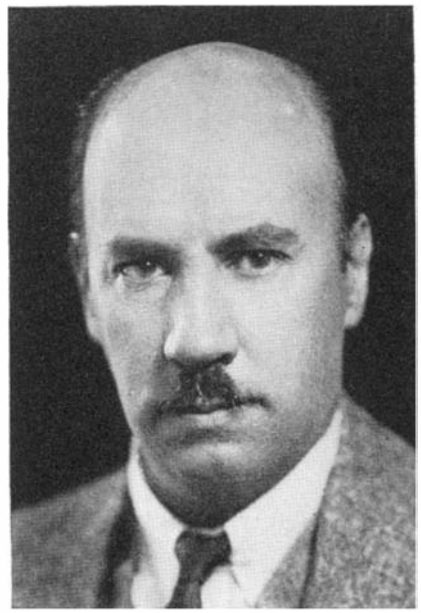
The design specifications and preliminary discussions of these two flying boats have been in progress for some 15 months; Colonel Charles A. Lindbergh, the engineers of Pan American, of the Sikorsky Aviation Corporation, and of the Glenn L. Martin Company (the two fortunate recipients of the contracts) have been hard at work in conference, experiment, and test.

It is unfortunate, but perhaps justifiable, that scarcely any details regarding the new designs have been made public, although we have been fortunate in securing artist's drawings of the new ships, which are reproduced here.

One of our photographs shows a Sikorsky Clipper, which has now been in service for two years in the Central and South



A Sikorsky "Clipper" which has done much transoceanic flying

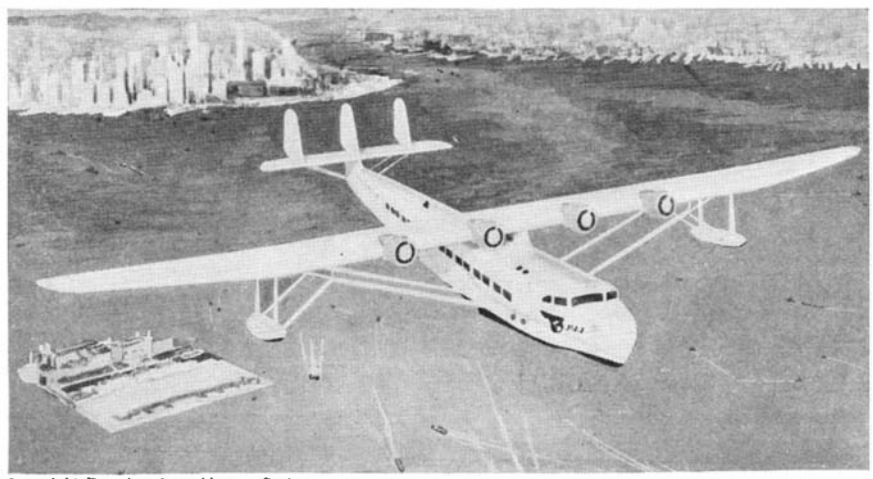


Igor Sikorsky

American airlines, including in its operations a straight water jump of over 500 miles between Miami, Florida, and Baranquilla, Colombia. The Clippers are equipped with four Pratt & Whitney Wasp engines, have a gross weight of 34,000 pounds fully loaded, and are capable of carrying 40 passengers at a cruising speed of 115 to 125 miles per hour.

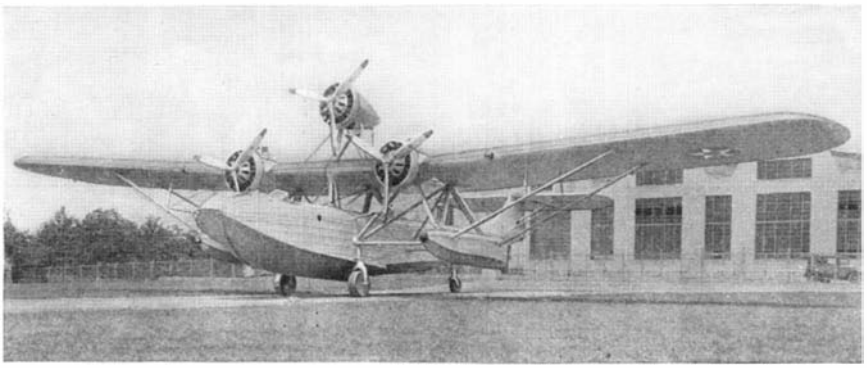
The contract for the new ship calls for a bigger craft than the Sikorsky Clippers, although considerably smaller than the *Do-X*. It is to be powered with more powerful engines of the radial air-cooled type (presumably of 700 horsepower each) and these engines will be streamlined into the wing to decrease head resistance. The new ship will be a high wing monoplane. It will be capable of a range of 2500 miles, with 600 miles as a safety factor. It will carry 50 passengers on South American service, and presumably a smaller number when used on transoceanic flight. The cruising speed is to be in excess of 125 miles per hour. The long outriggers on which the Sikorsky tail surfaces are generally carried, will be placed at the end of a lengthened hull. The span and over-all dimensions will be considerably larger than those of the Clippers.

Another photograph shows a Glenn L. Martin Navy patrol boat. The new plane to be built by this company will be some-



Copyright Pan American Airways System

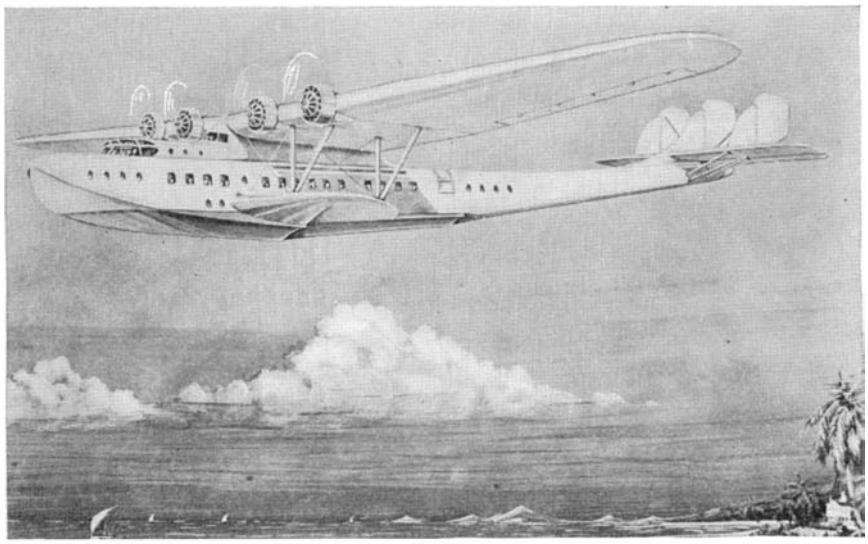
Drawing of Sikorsky S-42, which generally follows the design of the ship above



A Martin patrol which will serve in many respects as the prototype of the Martin transoceanic plane, an artist's drawing of which is illustrated below

what along these lines, except that it also will be provided with four powerful air-cooled engines streamlined into the wing. The Martin design is to have a particularly high prow for its hull, and the tail surfaces will be carried far above the water, both features increasing the seaworthiness of the craft.

No definite date has been set for the completion of these two giant boats, although two years is mentioned. We think this period is too long, and that a year should see one or other of these boats in the air. If these experimental planes prove successful, Pan American will increase its fleet of this type to six.



Left: **Glenn L. Martin**

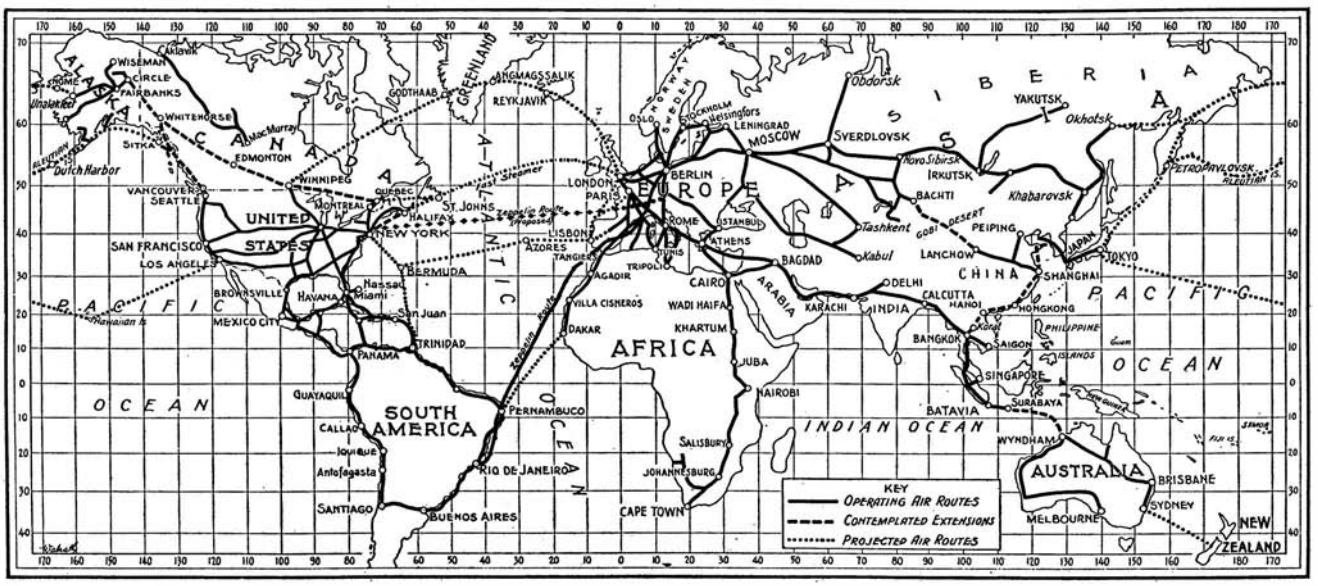
Pan American Airways are equally secretive about the service to which these two boats are to be put. We are indebted to *The New York Times* for a world map of flying routes, operating, under extension, or projected. Will Pan American fly the northerly route via Greenland and Iceland? Or will it essay the southerly route with stops at Bermuda and the Azores, where climatic conditions are of course far better, but where longer non-stop flights are required?

At any rate, it is quite certain that the flying boats will not use the 1900-mile stretch from Newfoundland to Ireland nor the direct route from New York to Paris which is seriously being considered for airship service.

The signing of these two contracts and the speculations regarding the use of the boats, always awakens the controversy of "flying boats versus airships for transatlantic service."

Airships which have been proposed for the direct route will cruise at 73 miles per hour. The flying boats will cruise at 125 miles per hour or more, but they will be penalized because their range, when fully loaded, is apt to be shorter. The flying boats will have to use an indirect and longer route, which to some extent will offset the higher speed.

The airship exponents have the greater pay load capacity, and greater flying range of the airship, as their trump cards, and they make out quite a good case for the contention that airships alone are likely to be employed in transatlantic service. The National Advisory Committee for Aeronautics, in its annual report has gone so far as to say: "For transatlantic air-transport ser-

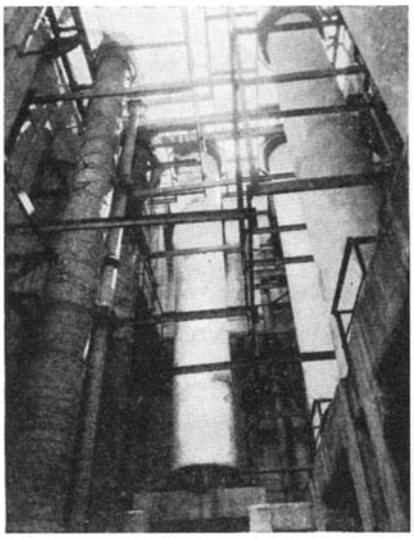


Courtesy *The New York Times*

Operating air routes, contemplated extensions, and projected air routes of the world, for both plane and airship

vice to Europe, greater cruising range and carrying capacity are required than can be efficiently provided in heavier-than-air craft at the present stage of development. Rigid airships at this time offer a prospect for air passenger service to Europe. . . . The Committee believes that the United States should continue to encourage the development and use of rigid airships as a means of ocean transportation."

The flying boat people can probably make the most effective rejoinder to this view by building such flying boats as those



First photograph of stalls where molecules of oil are torn apart and reformed according to specifications

previously described, which, compared with airships, will involve a much smaller initial investment and permit of the use of more units; which will have such reliable engines that, in combination with the multiple power plant, the possibility of forced landings will vanish; and which will have an adequate range while carrying a commercially profitable pay load.

The controversy will never be settled by discussion. It is a matter for experimentation, unfortunately on a very large and costly scale. Is it not possible that both types of aircraft will eventually be put to work in flying across the Atlantic? Perhaps the airships will be more apt to carry passengers in more commodious quarters, and a somewhat heavier amount of cargo, while the flying boats, still a long way from their limit of speed, will become faster and faster, and will be used for the traveler in a real hurry and for first class mail. —*A. K.*

High-Pressure Tricks With Petroleum

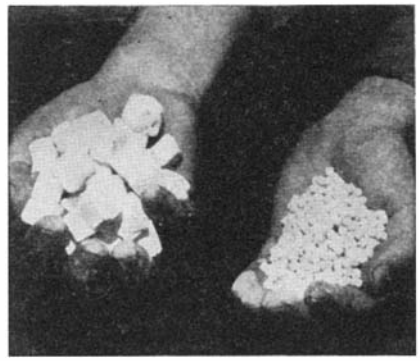
ALTHOUGH the hydrogenation process for producing petroleum products has been in use for about two years, it was only recently that the details of the remarkable plants at which this ultra-modern process is carried out were revealed to the public.

As previously explained in these columns, the hydrogenation process supplements the conventional "refining" of petroleum. While, heretofore, the object of the refining process was to "crack" the crude oil in such a manner as to obtain a maximum of any desired fraction—gasoline, for instance—with the new hydrogenation process it has become possible to convert all of the crude oil into any desired "fraction" simply by varying the degree of hydrogenation. In other words, the chemist tacks hydrogen atoms on to petroleum in any manner or degree desired, thus determining the character of the resulting product. In this way petroleum may be converted entirely into gasoline or entirely into kerosene, or paraffin, or any other petroleum product, depending on the demand.

The heart of the process is the huge nickel-chromium-steel reaction chamber, where the mixture of petroleum and hydrogen gas, heated to 750-1000 degrees, Fahrenheit, and at 3600 pounds per square inch pressure, passes through the catalyst which causes the hydrogen to combine with the oil. By varying the temperature and the pressure, the degree of this combination can be changed.

Two years' full-scale operation of this plant has demonstrated that it is possible to produce hydrogenated products on a price basis at least equal to that of older refining methods. From the standpoint of the public, the company believes its most important hydrogenated product to be a new motor oil marketed under the brand name "Essolube." In this new lubricant are said to be combined the five characteristics generally agreed to describe perfect lubrication. These are: ability to keep its body under engine operating conditions, winter fluidity, low carbon content, low consumption, and long life.

A new line of hydrogenated solvents for



Not pills and lumps of sugar but two forms of the catalyst which boss the high-pressure tower process

use in the paint, varnish, lacquer, soap, and textile industries has been developed and will soon be offered on the market. These will compete with coal-tar products and similar compounds. A hydrogenated safety fuel for aircraft and motor boats, which will not catch fire like gasoline under normal temperature conditions has been developed and is now being sold. A special aviation engine-oil will shortly be offered, while a substitute for benzine for anti-knock blending purposes can readily be made.

Hydrogenation has produced a superior kerosene, the demand for which was so great during the past year that, in addition to its regular refinery output, the company kept the hydrogenation plant on the exclusive manufacture of this product for five months continuously.

It is worthy of note that in case of a national emergency the hydrogenation plant can be converted within one month's time into a plant for the manufacture of synthetic ammonia, or those types of hydrocarbons which become especially important in such times. Thus, a process originally considered of possible future interest has within two years of commercial operation, following a quarter of a century of research and development, become of immediate interest, not only to the petroleum industry, but to the consuming public and to national defense.—*A. E. B.*

Electric Effects in Flying

ONE of our friends tells us that he received a slight electric shock when sitting down in a certain type of airplane. There was evidently an accumulation of static electricity caused by the friction of the rubber tires while taxying. Asphalt runways in particular tend to produce this accumulation of static. A small dragging chain attached near the tail of the airplane would discharge this accumulation into the ground.—*A. K.*

Air Express and Bad Weather

AIR express has great possibilities, but it has not been growing as rapidly as at first expected. Customers naturally expect great speed and perfect regularity, and the regularity is not always available, mainly because of that great enemy of aviation, fog. It will be some time before blind flying and blind landing are so perfected that fog will cease to be an obstacle.

Air Express Corporation, a newly formed organization, plans to circumvent fog and to give 100 percent regularity of service by a radical departure from standard air transport practice.

The new organization handles exclusively "through express" shipments between New York and Los Angeles, with all "way-traffic" eliminated. Terminals are Floyd Bennett Field in New York City, and United Airport at Burbank, California. A fleet of five Lockheed Orions, with retractable landing gears, and remodeled for express duty has been put into service. These ships are capable of a top speed of 194.9 miles per hour; at a commercial cruising speed of 170 miles per hour, they carry a cargo of 1050 pounds. Departures from New York are at 6 P.M. daily with arrival

Before and after. A sample of heavy crude oil and a sample of clear, high-octane gasoline it produces

at Los Angeles at 8:45 A.M. next day. Eastbound planes leave Los Angeles at 12:45 P.M. and reach New York at 8:45 the following morning. Difference in departure time as between the two terminals is accounted for by the spread of three hours in standard time from coast to coast. Actual elapsed time is 17.45 hours westbound, and 17.00 hours eastbound, equivalent to an average speed of 150 miles per hour, which can be readily met. Under normal flying conditions the refueling stops are at Columbus, St. Louis, Wichita, Albuquerque, and Seligman, with change of pilots at Wichita.

Since this cuts the fastest transcontinental service some 25 percent and allows for the carriage of express matter without the loss of any business-day time, a great step forward has been made.

But how about the increase in regularity of service, our readers may ask?

The really brilliant idea underlying the new service is this: With through service only, the airplane is able to demonstrate fully its inherent flexibility of routing. When the air service is bound to certain intermediate stops, this flexibility disappears. With no advertised intermediate stops, flexibility of routing is regained, and all bad weather areas avoided.

Reserve planes are stationed at New York, Wichita, and Los Angeles, and a reserve plane and pilot will always be available within a maximum of 3½ hours at any point on the route. Thus if the westbound pilot is advised at Columbus that Wichita is fog bound, he will be ordered by radio to proceed to Oklahoma City or any other clear point, there to refuel and to be relieved. In the meantime, the reserve pilot at Wichita will be ordered to proceed in the reserve plane to Oklahoma City, and there relieve the west-bound pilot. This procedure is possible because, while practical landings cannot be made in zero visibility as yet, it is entirely feasible to take off in fog.

The above system, combined with the ease with which such high-speed planes can avoid much slower moving storm areas (the speed of travel of which rarely exceeds 30 miles per hour) should bring regularity of operation on a par with that offered by any other form of transportation.

The abandonment of service to intermediate points is also justifiable on economic grounds. Analysis of both railroad and air transportation shows that the overhead due to intermediate stops amounts to about 40 percent of the total costs, while the revenue derived does not exceed 20 percent of the total. Therefore through traffic is more likely to be profitable, if sufficient volume can be secured.

The air express company will operate its own pick-up and delivery service. Rates are the same as by other airlines; namely, $1.75 for the first pound and one dollar for every additional pound.

Once the plane is loaded, the cargo is sealed, and seals are left unbroken until destination is reached. This diminishes chances of damage in handling.

The freight compartment of the plane is so designed that packages are held snugly in position, no matter what volume is carried. This is effected by a system of light hooks, to which are attached canvas belts. These belts are adjustable and can be made to fit any size package that can be passed through the loading hatch. The maximum cargo capacity is 90 cubic feet.

Clyde Pangborn, of world-flight fame, piloted the first cargo plane to leave Floyd Bennett airport. He carried 115 copies of *The New York Sunday Times* for delivery next day in Los Angeles; a shipment of live lobsters for Hollywood; an electric dental furnace; 16 boxes of cigars; a number of orchids; a box of cake from Oscar of the Waldorf-Astoria; and special motor parts for Ralph De Palma, the auto racing driver.

Granted that the first shipment was partly of a stunt character, there should nevertheless be a steady volume of traffic available, granted that exceptional service is maintained.—*A. K.*

The Lockheed Orion used in the fast coast-to-coast express service

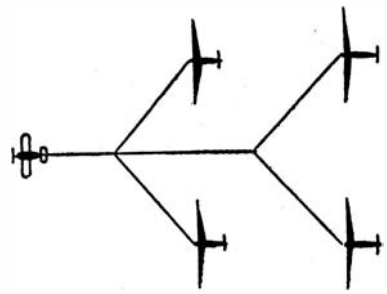
Weather by Teletype

IN air-transport operations, the collection of weather reports must be exceedingly prompt and requires a highly efficient communication system. This need has been met on our airways by the installation of teletype circuits. At the present time about 13,000 miles of airways are provided with teletype service. The circuits consist of leased telephone lines, 500 to 800 miles in length between terminal airports, with "drops" at the intermediate weather-reporting stations, each one of which has a teletype machine. The messages are typed on these machines in sequence, the various stations following one another in rapid succession, and each message is received on tape by all other stations in the circuit. Many of the larger terminal airports, especially those from which several airways radiate, are now provided with equipment for automatic re-transmission of the reports from one circuit to another.

So excellent has this service become, and so expert are the meteorologists in airway service, that when the advice given to pilots is subsequently checked by the pilot's report of weather actually encountered, the score of correctness stands at 98 percent. If we check up the weather forecasts given in the daily paper we will soon find that this average is never equalled.—*A. K.*

Towing Four Gliders At One Time

AT the Halle-Leipzig airdrome in Germany a curious experiment was tried recently. A pilot called Boenig took off in a 120-horsepower airplane and actually towed four gliders and four glider pilots into the air. In the take-off run, it was of course the lightly loaded gliders which took to the air first—the airplane followed. After flying twice round the airdrome, the glider pilots released themselves, and the whole experiment ended successfully. We do not see any great utility to this experiment, but what a thrill such an exploit would give spectators at the next National Air Races!—*A. K.*



The curious hook-up of the gliders which were towed by an airplane

Ice Bombing

AN unusual use which has recently developed for the airplane is that of ice bombing. Frank Wiley, in *Western Flying*, writes of the ice jams in Montana which form during the spring break up of the ice in the rivers. Primarily the jams are due to the fact that most of the Montana rivers run north, and the ice in tributaries breaks up before that in the lower sections of the rivers has started to move.

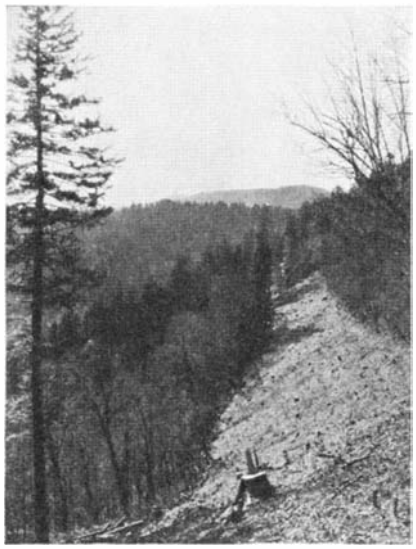
These jams sometimes occur near towns and become a serious menace to life and property. Mr. Wiley has been often called in to break up such a jam.

He first makes a survey from the air, which is much easier to do in this way than in any other. He finds that the usual obstruction of the flow is a sheet of solid ice which refuses to budge under the pressure of the ice cakes carried down by the open stream above.

After locating the obstruction, Mr. Wiley makes his own "bombs," consisting of 15 to 20 sticks of dynamite, bound together with heavy twine, with a cap and a two-minute fuse attached in the usual manner, the whole wrapped in several thicknesses of burlap. The fuse is split to facilitate lighting. An open cockpit plane is employed for this new and fascinating business.

The approach to the ice sheet to be bombed is made in the usual manner, in a normal glide with some throttle used. The pilot's assistant is signaled to light the fuse and pass the bomb back to the pilot.

The pilot then drops the bomb in a carefully selected spot, opens the throttle and goes on his way as quickly as possible. When the bomb explodes, there may only be a small round hole in the ice, and it may be necessary to drop another bomb before this hole is large enough for another operation. Finally a bomb is dropped which either falls or slides into the hole, and when the bomb explodes under the sheet of ice the results are really satisfying.



A swath cut along the side of a mountain marks the beginning of a highway in the Great Smokies Park

Mr. Wiley says: "Don't fly over the spot where the bomb reposes until it has exploded or until you are absolutely certain it is not going to function."—*A. K.*

United States Now Sure of Potash

THE director of the United States Bureau of Mines, in his annual report, states that the federal five-year program of potash exploration was concluded during the fiscal year with the completion of a drill-hole in Lea County, New Mexico. Three definite accomplishments may be credited to this government research: discovery of vast resources of potash ores capable of supplying all domestic requirements in a national emergency, birth of a domestic potash industry which can be expanded in the face of foreign competition, and positive insurance against profiteering by foreign monopolists.—*A. E. B.*

Mile-High Mountain Highway

"THIS is the forest primeval. . . ."

Well might this line from Evangeline start the epic story of the building of highways through the new Great Smoky National Park in North Carolina and Tennessee, for the engineers on that job have had to survey their grades and cut their roads through one of the last stands of virgin timber in this country. Recently this highway has reached a high point in the mountains of nearly a mile above sea level, the exact elevation being 5044 feet.

The accompanying illustrations give an idea of the type of country through which this road has been built and the natural difficulties it was necessary to overcome. Most of the country through which the road runs is above 4000 feet in elevation, with many peaks close to 6500 feet. The heaviest grade on the road is 8 percent and the sharpest curve 52 degrees.

A large percentage of the work already completed has been done by the North Carolina State Highway Commission, but much additional road building is to be done in the park by the United States Bureau of Public Roads for the National Park Service. The Park Service estimates that in the near future, more than 2,000,000 people will visit this area in cars each year. Yellowstone had only 400,000 visitors in 1931.

Cellophane Rolls for Projection Lanterns

CELLOPHANE, the stuff of a thousand uses, has added the thousand-and-first. It can be used instead of glass slides for some kinds of "still" picture projection with stereopticon lanterns. At a meeting of the American Chemical Society, Ross Bonar, Floyd Bonar, and Prof. Earl C. H. Davies of the University of West Virginia, told how.

Ordinary thin commercial wrapping cellophane is used. Drawings can be made on it in ink, or if tables of figures are to be projected, these can be done with a typewriter, using carbon paper. An easily made holder carries the roll, which can be pulled through the carrier as desired. A roll of cellophane over 33 feet long, bearing a whole library of lecture illustrations and notes, has a diameter of less than three quarters of an inch.—*Science Service.*

Hazards of Breathing Dust

AS an antidote for the harmful effects of breathing rock dust, miners are advised to inhale coal dust, according to Dr. J. B. S. Haldane of Cambridge, in a recent address at the University of Michigan. Rock dust by itself, Dr. Haldane admits, is a real danger. It consists of fine particles of silicates, each a little knife that cuts into lung tissue and thus produces the disease known as silicosis. But rock dust mixed with coal dust is no health hazard. According to Dr. Haldane, coal dust stimulates expectoration. As he clears his lungs and throat the miner gets rid of the coal dust as well as the rock dust that may be mixed with it. In fact the irritation produced by coal dust may actually be a benefit in warding off silicosis. Gold miners in the quartz seams of the Rand in South Africa are now being shifted to coal mines in order to test this theory.

Just what constitutes "bad air," the subject of Dr. Haldane's Michigan address, depends on what the viewpoint is. The unquestionably pure air that an aviator breathes at 20,000 feet is "bad" in the sense that there is not sufficient oxygen in it and that it exalts and leads to reckless acts. Air charged with rock dust, particles tossed up in the process of grinding cutlery, sand, and minute bits of cotton "fluff" is bad because, if breathed continually, it may induce tuberculosis and pneumonia. Apparently air charged with limestone and flourmill dust is not "bad" in this sense.—*A. E. B.*

Strong Alloy

THE American Brass Company of Bridgeport, Connecticut, recently attracted much attention with an exhibit of a new copper-beryllium alloy of exceptional strength. Using from 1 to 2¼ percent beryllium the company has developed a range of products with elastic limits up to 170,000 pounds. The alloys are extremely hard, susceptible to heat treatment, nonsparking, of high electrical conductivity and resistant to corrosion.—*A. E. B.*

Engineering in 1932

SO many tremendous engineering projects made progress last year or were completed that it has been virtually impossible to cover them all in the limited space devoted to the subject in SCIENTIFIC AMERICAN. We are, therefore, noting below some of the more important projects, as compiled by *Science Service.*

The *Normandie*, the world's largest ship, 75,000 tons, 1020 feet long and with a beam of 117 feet, was launched at St. Nazaire, France.

The main dyke, 18½ miles long, closing off the Zuider Zee, of Holland, from the North Sea was completed in a project that will add more than half a million acres

The type of road that has been cut in virgin lands of the new eastern park

Men who "know it all" are not invited to read this page

THIS page is not for the wise young man who is perfectly satisfied with himself and his business equipment.

It is a personal message to the man who realizes that business conditions have radically changed in the last few years, and that there is a whole new set of rules to be mastered. He feels that he ought to be earning several thousand dollars more a year, but simply lacks the confidence necessary to lay hold on one of the bigger places in business.

We should like to put into the hands of every such man a copy of a little book that contains the seeds of self-confidence. It is called "What an Executive Should Know" and it will be sent without obligation.

It contains the Announcement of the Institute's new Course and Service for men who want to become independent in the next five years. Among the contributors to this new Course are:

ALFRED P. SLOAN, JR., *President*, General Motors Corporation.

FREDERICK H. ECKER, *President*, Metropolitan Life Insurance Company.

HON. WILL H. HAYS, *President*, Motion Picture Producers and Distributors of America, formerly U. S. Postmaster General.

BRUCE BARTON, *Chairman of the Board*, Batten, Barton, Durstine & Osborn, Inc., Advertising Agents.

DR. JULIUS KLEIN, *The Assistant Secretary*, U. S. Department of Commerce.

JOHN T. MADDEN, *Dean, School of Commerce, Accounts and Finance*, New York University.

HUBERT T. PARSON, *President*, F. W. Woolworth Company.

M. H. AYLESWORTH, *President*, National Broadcasting Company.

THOMAS J. WATSON, *President*, International Business Machines Corporation.

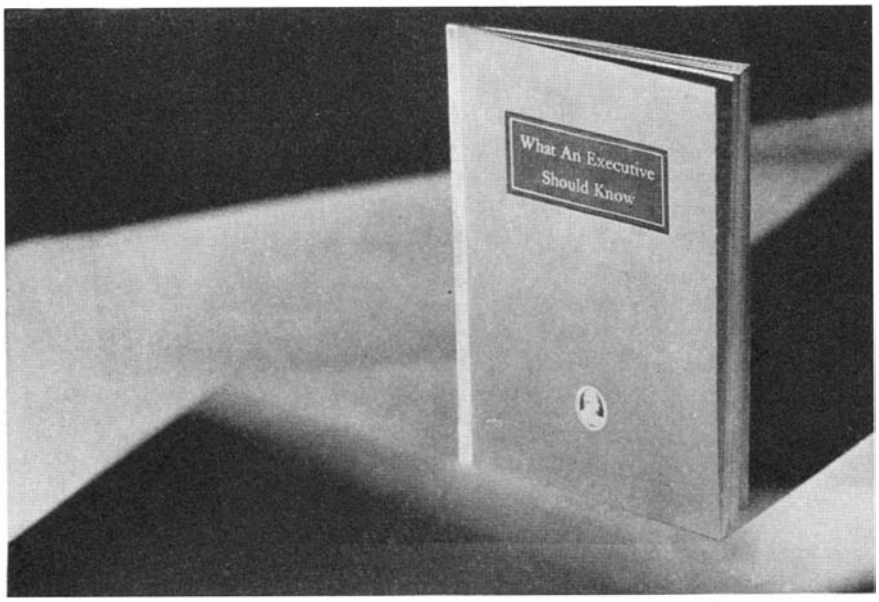
DEXTER S. KIMBALL, *Dean, College of Engineering*, Cornell University.

Can any ambitious man fail to get something of value from contact with minds like these? Here are a few examples, selected from many hundreds, showing how this organized knowledge is translated into added earning power:

CASE 1. Works Engineer, salary $6,000; now Vice-President and General Manager, salary $18,000.

CASE 2. Local Manager at $5,200; now Regional Manager, salary $15,000.

CASE 3. Production Manager, salary $6,000; now President, salary $21,600.



For the Man who wants to be Independent in the next 5 years

THE little book pictured above should be read by every man who expects to win a secure place for himself in the next five years. It explains some of the changes which are taking place in the business world today. It tells how you can equip yourself to take your place in the new business structure with confidence and increased earning power. It contains the condensed results of 20 years' experience in helping men to forge ahead financially.

Send for this Booklet

For the man who is perfectly content with himself and his job, the Alexander Hamilton Institute can do nothing. But there are thousands of men who could double their incomes if they believed in themselves and had the solid business knowledge to back up their belief.

Why not investigate *now?* The booklet pictured at the left costs nothing and places you under no obligation.

To the Alexander Hamilton Institute, 696 Astor Place, New York City. (In Canada, address Alexander Hamilton Institute, Ltd., C. P. R. Building, Toronto.)

Send me "What an Executive Should Know," which I may keep without charge.

NAME.....

.....

BUSINESS ADDRESS.....

.....

BUSINESS POSITION.....

to Dutch farming land and reduce the Zuider Zee to a fresh water lake one fourth its original size.

A new definition of the inch, 25.4 millimeters instead of 25.40005 millimeters, was adopted by the American Standards Association and industries of the United States.

Reclamation of about 200,000 acres of Pontine marshes, near Rome, neared completion so that farmers began to occupy fertile land which had been abandoned to the malarial mosquito for 2500 years.

The world's largest Diesel engine, 22,500 brake horsepower, was built for a Copenhagen power station.

Two 20,000-kilowatt power plants using mercury vapor instead of steam neared completion at Kearny, New Jersey, and Schenectady, New York.

The largest radio tube ever constructed, made of iron and steel and having an input of 500 kilowatts, was built in the laboratories of the Metropolitan-Vickers Company, Manchester, England.

Dneprostroy, a large power plant, was put in operation at Kichkas on the Dnieper River, in Russia. Incidentally, this project is practically all "American-made."

Ten-million-volt artificial lightning was produced with a new generator in the Lynn, Massachusetts, General Electric Laboratories.

A huge commercial explosion in Michigan, setting off 430,000 pounds of dynamite and similar explosives, and bringing down more than 1,250,000 tons of quarry limestone, allowed scientists to make seismological observations of the structure of the earth's crust.

Welding Water Tunnel Liner

AS construction progresses at record speed on the 21-mile long New York City tunnel No. 2, engineers are watching with interest the various methods employed. Arc welding of the steel liner plates to insure water-tightness was one of the time-saving devices utilized.

This 43,000,000-dollar tunnel extends from the Hillview Reservoir in Yonkers to Brooklyn, and is part of the Board of Water Supply's system for delivering water to the boroughs of Bronx, Queens, and Brooklyn. Specifications called for special steel liner construction with arc welded caulked joints near and under the East River where seepage might be encountered.

The steel liner is made up of one-inch plate fabricated in sections above the ground. Three sections form a 20-foot circle. A total of 13,920 feet of 3/16-inch fillet welds were laid above ground along four by four by one half-inch angles which were riveted to the liner segments.

The photograph shows welding operators at work laying the caulking welds after the sections had been assembled in the tunnel. Each ring required 102 feet of continuous welding where two angles butt together. Operators averaged 31 lineal feet of welding per man per hour using the Shielded Arc method of welding and equipment.

Courtesy Lincoln Electric Company

Laying caulking welds in assembled sections of new water tunnel liner

A Library on Wheels

A TRAVELING library, unique in size and design, has been acquired by The New York Public Library, to give improved service to the outlying districts of the Bronx.

This book-truck, built by the Expando Company of Chicago, has unusual features. Mounted on a Dodge heavy-duty chassis, with dual rear tires, the body contains three compartments. In the front compartment, besides the driver's seat, there are facilities for charging books to borrowers and for registering applicants. The rear compartment contains facilities for discharging books. There are two doors on the curb side for the use of the public—the one in the rear compartment being the entrance, that in the front compartment the exit. The middle compartment is composed of the expanding section, a feature of construction developed and controlled by the Expando Company. This section is 10 feet long and on each side contains double book shelves, four tiers of which face the outer or street side and six tiers of which face the interior. There are about 200 feet of book shelves, with a capacity of 2000 volumes. This book-truck is designed for operation by a staff of from two to six, as needed.

The unit has an over-all length, from bumper to bumper, of 29 feet, a width of seven feet, and a height of over nine feet. The body alone is almost 22 feet long and over six feet wide. In outward appearance, The Bronx Traveling Library resembles a commercial vehicle except for the glass panels on the sides, behind which the colorful bindings of books on the outer shelves may be seen.

When circulating books to the public, the side walls of the middle section are expanded 13 inches on each side through a mechanical device attached to the batteries. At the same time the roof of this section is raised 11 inches. Besides the light supplied through a skylight, additional light and ventilation are obtained from the side panels which are exposed when the roof is raised. When expanded, the space on the inside available to the public for the selection of books is about six feet by 10 feet, sufficient room for at least 15 adults. In bad weather the work will be conducted entirely on the inside, with about 1200 books available, while in good weather, both the inside and outside book shelves will be used.

Dry-Cleaning Acetate Silk

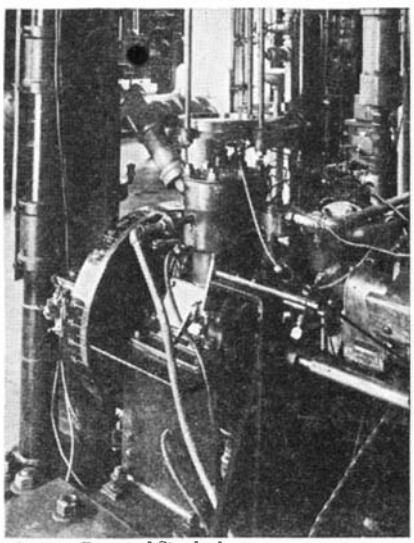
LADIES, if you do your own dry-cleaning, be careful of your rayon garments, for if they are made from the so-called "acetate silk" they may dissolve in the cleaning solvent. Acetate silk differs characteristically in chemical and physical properties from all the other types of natural or artificial fibers and must be handled with due regard to these special properties if the goods are not to suffer in either luster or tensile strength, says *American Dyestuffs Reporter*.

Contrary to some impressions which still prevail, acetate silk is decidedly resistant toward the action of many common and cheap dry-cleaning agents. Many of the special dyestuffs now used for the dyeing of acetate silk are also resistant toward such cleaning agents, which was not the case a few years back, when the commoner dyestuffs, in use and satisfactory for other fibers, were giving acetate silk a bad rep-

Exterior and interior views of the library on wheels, described above

utation. Gasoline and other liquids of the same sort, hydro-carbon mixtures of the paraffin and benzene series—benzene, toluene, xylene—are good, as well as the more common and in many ways more desirable carbon tetrachloride. All such solvents should be used cold.

Care must be exercised, however, with some of the solvents which have proved themselves very valuable with other fibers. Acetone, chloroform, tetrachlorethane, and so on, attack acetate silk very vigorously, speedily swelling and actually dissolving the fiber, and so hopelessly ruining the weave.—*A. E. B.*



Courtesy Bureau of Standards

Special engine for studying effects of gasoline combustion. The cylinder head is provided with heavy quartz windows through which the interior can be viewed. Any desired period of the cycle may be watched by means of a stroboscope

American Iodine

WITH iodine tincture in a foremost position on every household medicine shelf, it is interesting news that this halogen chemical element is produced on a commercial scale from the same oil wells that give gasoline and lubricants for autos. Because the oil wells are in the United States, this country has made sure of having enough of another essential chemical in the event of future war or blockade of this country.

Up until a few months ago when iodine was extracted from the briny waters of the oil wells, Chile had a virtual monopoly of the chemical, producing it as a by-product of its nitrate industry. Small amounts of iodate are contained in the "caliche" or nitrate ore which once furnished the world with nitrogen essential to fertilizers, explosives, nitric acid, and other basic chemical products. The Germans just before the World War learned how to "fix" or capture in chemical compound the nitrogen that comprises three quarters of the weight of the air around us. Thus was broken the Chilean nitrate monopoly based on the existence of large deposits of nitrate salts in its arid territory.

Now this other Chilean monopoly is being broken. The standard price of iodine has been four dollars and already it has

—Read It
In the March
HYGEIA

"Quelling the Quacks"

How medical quacks impose on the credulity of human nature and capitalize on the hope of the sick, is told by Dr. Solon R. Barber who is in charge of the information service for the Food and Drug Administration of the U. S. Department of Agriculture. In this article—the second of a series—he gives a few highly illuminating cases of medical quackery which illustrate the ingenuity of the fakers and the necessity for eternal vigilance on the part of government officers who run them down.

"The Dividends of Health"

"Everything from a man's ability to digest raw onions to his ability to accept disagreeable facts and to get along with disagreeable people depends largely upon the precise kind of health he has," writes Walter B. Pitkin. Read his attributes of health—and then check up on your own!

"Progress in Preventive Medicine"

This enlightening series of articles tells the story of the progress made in preventive medicine, beginning with inoculation for smallpox little more than a century ago. Dr. P. M. Ashburn, who is librarian of the U. S. War Department's Army Medical Library, gives an excellent historical background for this absorbing study.

Why Jump Out the Window?

Some who lose their money do it. Others remain calm or even indifferent in the face of adversity. In a timely article, Dr. Franz Alexander, director of the Institute of Psychoanalysis, shows how different types of people react to the economic depression—and why.

Meeting Emotional Depression

In some cases of emotional depression which seem to be caused by economic depression, a fundamental cause lies much deeper within the patient's personality. Dr. Thomas M. French, also of the Institute for Psychoanalysis, discusses the physical health of such patients in relation to psychotherapy.

These are only a few of the entertaining and enlightening articles to appear in the March HYGEIA. Every month HYGEIA, The Health Magazine of the American Medical Association, is filled with *authentic* information on practically every phase of health. If you are not already a subscriber, get acquainted with HYGEIA now. The coupon below will bring it to you.

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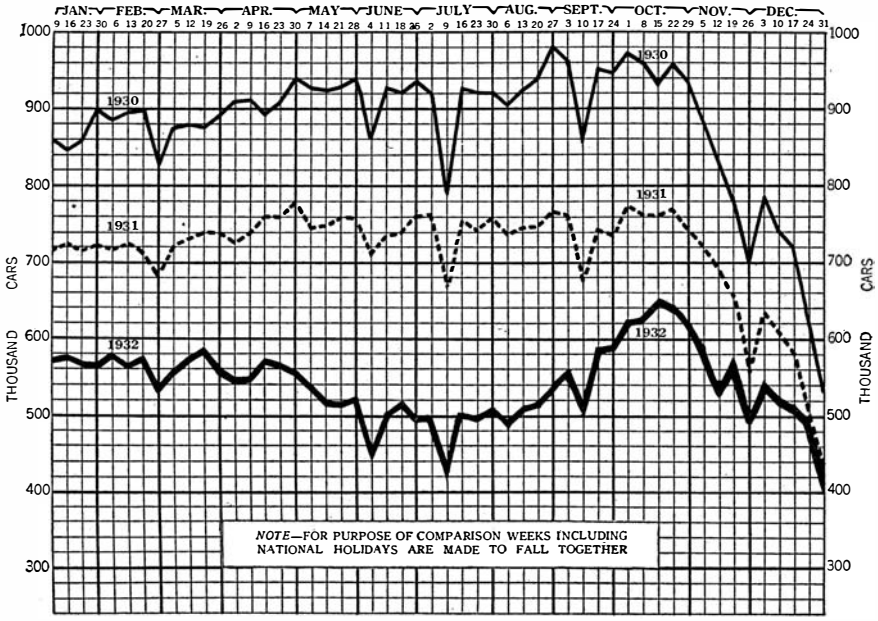

A barometer of business conditions since it shows the movement of goods of all kinds throughout the country: freight car loadings for the past three years. Although car loadings for 1932 were considerably lower than in 1931, there was a tendency toward the last of the year to approach 1931. This indicates a slight revival of business. A slump this year has been followed by a rise

been dropped to three dollars by the Chilean interests in recognition of the iodine production in American oil fields. P. F. Holstein, New York chemical engineer, writing in *Chemical and Metallurgical Engineering*, estimates that Chile may eventually be able to produce iodine at 25 cents a pound while present costs are little more than twice that figure. If Chile sells iodine for a dollar a pound, this will stop the American producers who need a price of three and a half to four dollars a pound to produce.

Russia, too, is making ready to supply its own iodine from oil wells and seaweed, a source that was most important before iodine was obtained from natural nitrate deposits. Europe, Japan, Java, the United States, and Russia, without Chile, if given price incentive could produce 2,200,000 pounds a year, more than the whole world now uses.

With cheaper iodine in the offing, more uses may be found for it. At present most of it is used in medicine, largely as the brown antiseptic solution used for painting cuts, or in iodoform, the yellow antiseptic powder with the disagreeable odor.—Watson Davis. All rights reserved by *Science Service*.

High-Alloyed Cast Irons

AS a result of the depression there is a demand for inexpensive metals that are corrosion-resistant. In response to this demand, the metallurgists are developing a series of alloyed cast irons. The newest members of the group are the high chrome cast irons ranging from 15 to 30 percent chromium, developed by the Union Carbide and Carbon Corporation. The quantities of the other elements are in general similar to those of cast iron, but are regulated according to the service requirements.

These cast irons are suitable for casting in intricate forms and have considerable resistance to oxidation, high temperatures, and some forms of corrosion. Owing to their high carbon content, they are relatively hard, and in physical properties are nearer to cast iron than to steel. They are not recommended for the replacement of stainless and heat-resisting steels under conditions of stress, but rather of cast and malleable irons which have a tendency to deteriorate at high temperatures and under corrosive influences.—*A. E. B.*

Tropical Aquarium for Tropical Fish

FAMILY arguments as to who left the door or window open and chilled *Pterophyllum scalare* (angel fish) are no longer necessary. Recent engineering progress has made it possible through the installation of a heating element controlled by the built-in watchman thermostat, for the fish to enjoy the comforts and temperature of tropical water. The water of an aquarium must be kept at a fairly constant temperature at some point above 72 degrees, Fahrenheit, and below 87 degrees, Fahrenheit; otherwise tropical fish get the dreaded disease Ichthyophtherius, sometimes shortened to "Ick."

The Tropic-Arium Company of Cleveland, Ohio, are now building an aquarium that conceals the water heating element. A Westinghouse built-in watchman thermostat insures that the water will be kept at an even temperature. Now, automatically heated aquaria can be left for several days without attention. The heating element is located below the bottom of the aquarium; no heaters, unsightly and awkward cords, rods or tubes are visible.

An attractive green signal glows when the thermostat has the heat turned on so that a double check can be kept on the fish's welfare.

Octane Rating Not Wholly Dependable?

THE much-advertised "octane" rating of gasoline is not wholly dependable in the selection of automobile fuel, according to Dr. Arthur Lachman, petroleum research expert, addressing the American Chemical Society.

Since motor-car manufacturers have taken to building high-compression engines, old-fashioned, straight-distilled gasoline is just not so good. Such fuel was made by simple methods much like the old process of turning out moonshine whisky. It was about the only kind of "gas" the public knew 10 years ago.

Dr. Lachman points out that a gasoline which has passed the anti-knock engine test with a high score does not necessarily give superior results in an engine working at a different temperature. For example, an air-cooled motor, working at a high cylinder temperature, will often not recognize a high-octane gasoline as a superior fuel. On the other hand a low-temperature water-cooled motor may accept the fuel in question to great advantage. The moral for the consumer is simple: Try out the different brands on your motor and make your own scientific decision.

Rumors have gained credence that "high octane" is just another form of commercial buncombe originating in the advertising

An electric heating unit keeps the water warm in this tropical fish aquarium

departments. Critics voicing these rumors base their conclusions on the fact that the oil companies do not advertise the actual octane numbers of their several motor fuels. Dr. Lachman comes to the defense of the oil company. As long as one cannot with certainty predict from octane number just how good performance will be, just so long would it be misleading to coax a purchaser into line by quoting numbers.

Incidentally, experiments show that gasoline which attains good anti-knock quality from addition of suitable chemicals, is more steady at different temperatures than gas which is naturally of high octane rating from its intrinsic content.—*Science Service.*

Peculiar Properties of Pure Boron

BORON, an element which occurs in borax and which gives the latter its name, has recently been manufactured in an extremely pure form by the high-temperature treatment of boron tribromide vapor in the presence of a tungsten filament and mercury, the latter functioning as a reducing agent. Remarkable properties are exhibited by the pure element which is capable of cutting glass and undergoes the most extraordinary change in electrical properties with rising temperature. Although possessing an electrical conductivity not much greater than zero at room temperature, it undergoes a million-fold increase in conducting power when heated to 1000 degrees, Centigrade.—*A. E. B.*

Should a Fever be Stopped?

REPORTS of the abnormally high temperatures with which a young Mexican girl in Los Angeles has been worrying her doctors, recall the epidemics of high fever deceptions that have occurred. The highest temperature authentically reported which the patient survived was 110.6 degrees, Fahrenheit. This was reported by Dr. Harold M. F. Behneman, assistant in the University of California Medical School.

Dr. Behneman's patient, soon after the terrific period of fever, began to recover from the skin disease from which he was suffering, and Dr. Behneman believed that the excessive heat of the body aided in controlling the bacteria causing his ailment.—*Science Service.*

Water-proof Glue in Sheet Form

A NEW sheeted, water-proof adhesive or bond called Tego Gluefilm, for building up plywoods and laminated panels, and for applying veneers, has recently been placed on the market by Tego Gluefilm, Inc. Besides its use with woods, it makes an equally effective bond with such substances as artificial building boards and asbestos base materials, and permits gluing veneers to metal. Furnished in rolls for easy stocking, it can be cut and applied as required. The sheet is uniformly .005 inch thick, and therefore, the same glue-spread is always obtained over the entire surface.

The bond is completed in a hot plate press under heat and pressure with no added water or moisture.

The bond is water- and moisture-proof and is not affected by termites, molds, atmospheric moisture, or decay. No reactionary

No more overhead on your HEADGEAR

Restaurant Check Room Tips Abolished

AGAIN THE STATLER HOTELS PIONEER

Buying a hat is the only installment purchase you never complete. You buy it once from the store and a thousand times from check room attendants. It may be *your* hat, but it's *their* meal ticket.

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HOTELS STATLER

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HOTEL PENNSYLVANIA IS THE STATLER IN NEW YORK

stresses are set up,—no checking or warping, and thin light veneers may be used with no chance of staining. The strength of the bond is limited only by the strength of the materials laminated, all tests—wet and dry—showing 100 percent failure in the wood. One interesting feat made possible by Tego Gluefilm is the bending of panels into various forms. Placing the panel in hot water and steaming does not injure the bond.

An Institute for Health and Efficiency

THE well-known Bremen industrialist and philanthropist, Dr. Ludwig Roselius, who created for his home city the unique Böttcherstrasse, which has been called "Crazy Street" because of its unique and modernistic designs, has added a new attraction to it. This is an "Institut für Gesundheit und Leistung"—institute for health and efficiency—which he has established in the Atlantis House built by Professor Hoetger. It really consists of two institutes, one for efficiency tests, with all sorts of equipment for psycho-technical and physiological tests, and one for physical culture.

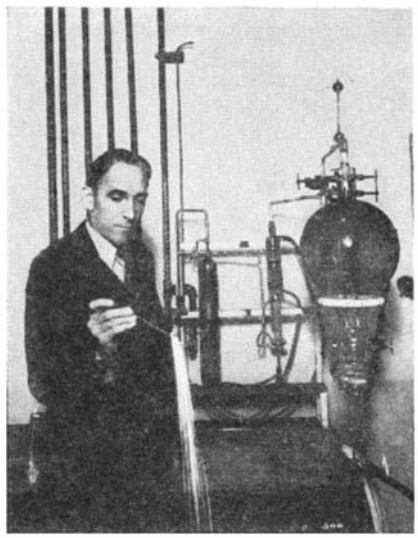
The equipment of the institute for efficiency tests makes it possible to apply some hundred different tests. The various kinds of apparatus, which were created by Dr. R. W. Schulte, are all made along new lines. They indicate immediately the results of every test, and thus make it possible for the person taking them to control and estimate his own efficiency and adaptability. Moreover, the methods used are so interesting that they do away with all nervousness on the part of the person being examined. They measure the speed of mental reactions, excitability, adaptability, keenness of vision, hearing, and so on. The amount of work performed can also be ascertained in terms of horsepower. One interesting apparatus amplifies the human heart-beat 15,000 times and records the sound-waves graphically on a rotating disk.

The institute for physical culture has a gymnasium for 20 persons, with shower baths and pool, a special hall for women called the "Himmelssaal," and a massage room along the lines of the Greco-Roman baths.

The main gymnasium is fully ventilated, and special lamps give the effect of the sun's rays. A large circular massage room adjoins this gymnasium. Exercising wheels, the resistance of which can be raised to 40 pounds, also stand here; hot-air baths and needle-baths complete the equipment. There are tub baths for carbonic acid and pine-needle baths in adjoining rooms, and also a steam inhaler, with the spray of which any desired remedies can be mixed.

Produce Rare Metals in Pure State

A NEW method of electrolysis for obtaining such rare metals as uranium, thorium, and tantalum in the pure state has been developed by Dr. Frank H. Driggs and his associates in the metallurgical research laboratories of the Westinghouse Lamp Company. Being continuous and therefore cheaper, this new process is expected to make rare metals available in larger quantities and at cheaper prices, thereby extending their industrial uses either separately or as alloys.



Dr. Driggs, whose work with rare metals is described above, emptying a small tube of uranium dust into the air, where it ignites spontaneously. The large glass globe at the right is a vacuum induction furnace where rare metal dusts are heated until they become molten

In this new process, a cathode is inserted in a liquid bath containing equal parts of sodium and potassium chloride to which has been added a quantity of potassium thorium fluoride when the metal thorium is desired. After powdered thorium has collected to a thickness of about one inch on the cathode, it is removed and replaced immediately with another cathode, the feature which makes this process continuous. It is not necessary to destroy the entire bath in order to obtain the metal deposits as in other processes.

Rare metals in the powdered state oxidize so rapidly at room temperature that extreme care must be exercised in this process else the powdered metal will "go up in smoke."

As the cathode is removed from the liquid bath, the salty solution clinging to it temporarily protects it from oxidation. When the solution is washed away, however, the powder must be preserved in an atmosphere of ether or in a vacuum. After it is pressed into bars, the rare metal does not oxidize at room temperature and can be handled freely.

To get these bars of rare metals in the molten or ductile state they are placed inside induction coils of vacuum induction furnaces and subjected to high temperatures until they are suitable for drawing and working into alloys.

Now that rare metals are more readily available, their field of application in industry is broadened considerably, according to Dr. Driggs. Already these rare metals are used for the cathodes of certain photo-electric cells.

Uranium, for example, is light sensitive only at short wavelengths and is used in the photo-electric cells of meters which measure the strength of ultra-violet radiations. X-ray tubes will operate more efficiently with plates and cathodes of pure thorium or uranium, but since these metals melt at low temperatures, they have not yet proved as practical as the tungsten now used under the intense operating heat.

Some of the equipment for measuring human efficiency and adaptability in "Institute for Health and Efficiency"

A modernistic gymnasium in the Institute. In the vaulted roof is set blue and white glass. Sun lamps are also used

Perhaps the most practical application of rare metals to date is in gaseous tubes such as those used in electric signs, radio tubes, and for some applications of interior illumination.

Charcoal Fuel for Motor Trucks

TRUCK drivers in China may be pulling up to the "filling station" and saying "Gimme five gallons of charcoal" if recent tests in that country presage the general adoption of the new fuel. The use of charcoal gas for operating motor trucks and buses was demonstrated at a conference held in China, according to information made available by the United States Department of Commerce.

The conference was attended mainly by engineers and highway commissioners from 14 Chinese provinces. These men are reported to have been favorably impressed with the possibility of materially reducing motor truck and bus operating costs through the adoption of the new fuel. The demonstrations were made with buses constructed on American light truck chassis.

The cost of the new fuel is said to be considerably less than the prevailing price of other motor fuels. Any considerable expansion of modern transportation in the interior of China depends upon cheap fuel, especially in sections where motor fuel costs are prohibitive because of high transportation charges and tax impositions. Hunan Province is already operating 200 motor buses, including eight which are powered with charcoal gas, over 700 miles of well-constructed roads, and plans have been made for the construction of 500 miles of additional roads with provisions for connection with adjoining provinces. The vehicles using charcoal gas in the demonstration had to stop for refueling every 20 or 25 miles. The refueling required but a few minutes, and about five gallons of charcoal on each stop. In certain parts of interior China there is a plentiful supply of charcoal.—*A. E. B.*

Rickets Still Too Prevalent

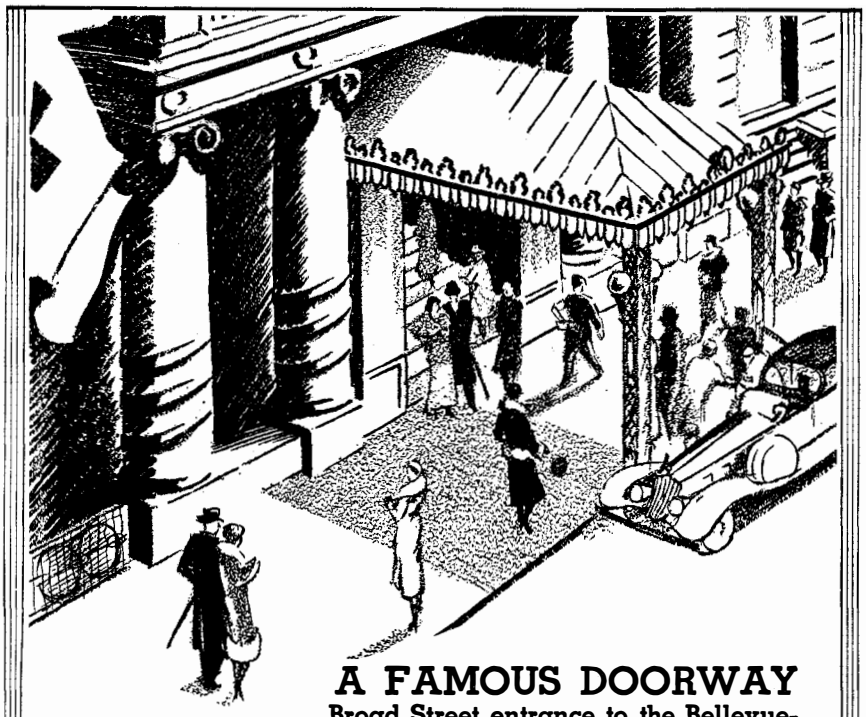
RICKETS is still far too prevalent in many communities, the American Medical Association finds. This serious childhood disease continues in spite of the fact that a means of preventing it is known and has been broadcast for years by welfare organizations and advertisers of curative and preventive products.

Rickets is caused by lack of an essential diet factor, vitamin D. This is found in various natural products, notably cod-liver oil, and is formed in the body when the skin is exposed to ultra-violet light from the sun or certain other light sources. When these facts were discovered, it was expected that rickets would be eliminated as a serious health menace, just as scurvy was when the cause of that disease was discovered to be lack of vitamin C and the scurvy-preventing foods that contained the vitamin were recognized.

Commenting on rickets, the American Medical Association states that the situation is frankly disappointing.

Besides cod-liver oil and cod-liver oil concentrates, this association calls attention to such other available anti-rachitic agents as viosterol (which is irradiated

(*Please turn to page* 181)



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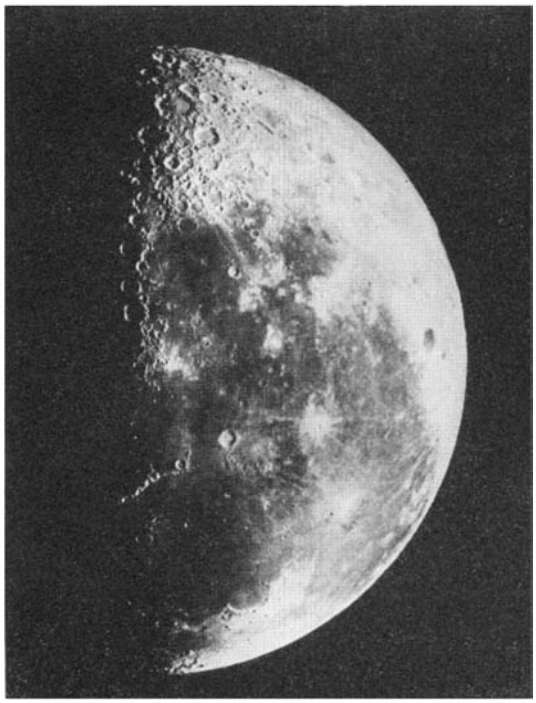
THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

AT the end of a nine-month gestation period, a third edition of "Amateur Telescope Making" is finally born into the world, and the infant and "mother" are reported as doing well. It has just 500 pages and a tough, red, waterproof epidermis. We promised it for mid-December and too glibly offered to permit those who so patiently awaited it to hang a curse on us for every day's delay thereafter. Something over 12,000 curses must have been tossed at us, for the infant ran two months over term.



Taken with Cook's 28½-inch reflector

No matter how hard you try to eliminate all mistakes at the time of the proof stages of a technical book, you may be morally certain that some mistake will "hide out." The previous edition of "Amateur Telescope Making" was in use four years before some of its mistakes were discovered and reported to us. In the new book we corrected the 25 or 30 of these we knew of, by patching the plates. Readers who find further mistakes in the new edition are asked to report them early, so that an erratum sheet may be prepared.

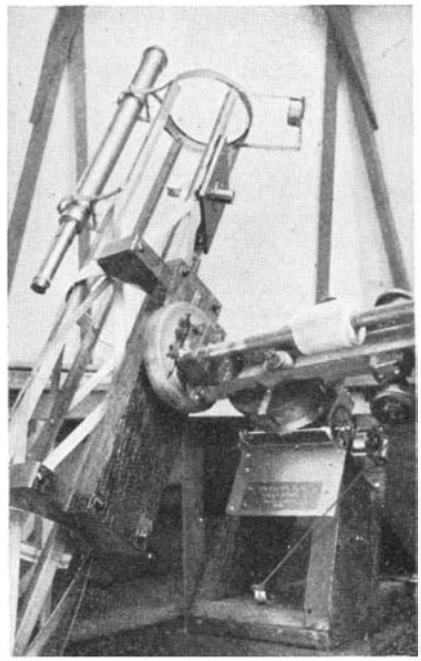
"Amateur Telescope Making" should have contained a chapter on clock drives, mainly electric. An amateur specialist in that corner of the game promised us one but did not come through. Who therefore will contribute a compact, concise chapter on this subject, written for the man who knows nothing about it, and full of practical, concrete, not merely general, facts? The best one will be published in this department, with credit to its author. Payment in the form of "glory." About 1000 words—no more. Also, who is in a position to contribute equally practical instructions on designing setting circles for various types of telescopes and on making them? This telescope making hobby is becoming so ramified that we lean more and more on those who have worked up exhaustively some one special corner of it. The chief trouble is to locate these modest shrinking violets who are working out new information, yet who omit to transmit it to us and through us, to the others.

AS a Christmas card, Gustavus Wynne Cook of Wynnewood, Pennsylvania sent us a 10-by-13-inch photograph of the moon, made with his new 28½-inch Fecker reflector, and we now reproduce this "card" here. Another photograph shows his 40-foot focus photoheliograph. This consists of an 8-inch heliostat inspired by II and III, Figure 36, Part I, of "A.T.M." and made by himself, with a five-inch lens photographically corrected. The eight-inch Pyrex flat is unsilvered and is wedge-shaped so that the rear-surface reflections are deviated about two degrees. The focal plane shutter at the rear of the house (through small window and a "tunnel") is operated electrically from the pier. Other pictures of Mr. Cook's equipment were published in the August 1932 number, page 74. (See also the new "A.T.M." page 139.)

FRANKLIN B. WRIGHT, 155 Bret Harte Road, Berkeley, Calif., sends a photograph which we reproduce, and states that "this is the mounting of the 6½-inch telescope I used as the basis for the article I sent you a short time ago." (Now chapter VI, "Accuracy in Parabolizing a Mirror," Part X, "Contributions by Advanced Amateurs," of the new "A.T.M."—*Ed.*)

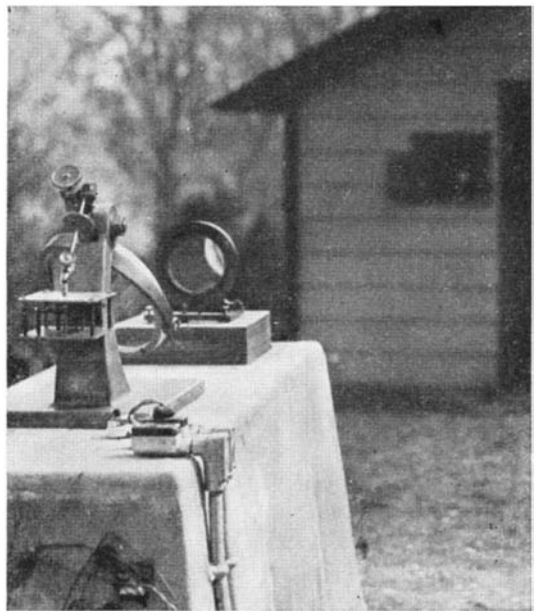
"A four-watt Telechron motor geared for sun time is used for clock drive to 100-tooth worm gear below Ford brake drum, which carries a right ascension sidereal time circle. to be set on a known star at the beginning of an evening's work. The simplicity of the gearing arrangement more than compensates for the error of the clock (four minutes a day).

"The telescope tube rotates in its cradle to get the eyepiece into a convenient position. With a ½-inch eyepiece, giving 125 power, the mirror plainly shows Cassini's Division in Saturn's rings, the shadow cast by the disk on the rings, several belts on the disk, and at least four of the satellites."

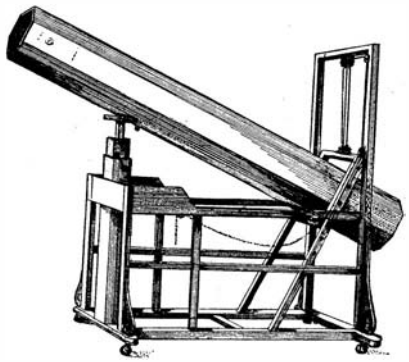


Wright's 6½-inch reflector

ALONG time ago we harped a bit on the superiority of wooden tubes over metal tubes. Since then a few have been made, and there seems to be a fairly general agreement that the amateur observers in Great Britain are right in preferring wood, because that material tends to diminish temperature troubles. One type of wooden tube—octagonal—was used long ago by Sir William Herschel. Oswald Hardy Evans, Casilla 48, Valparaiso, Chile, has copied an old drawing of one by that maker, now preserved in the Radcliffe Observatory, at Oxford and this is reproduced here. The drawing is self-explanatory, though it is doubtful whether the mounting itself is as



Cook's 40-foot photoheliograph



Herschel telescope—wooden tube

efficient as a modern equatorial would be.

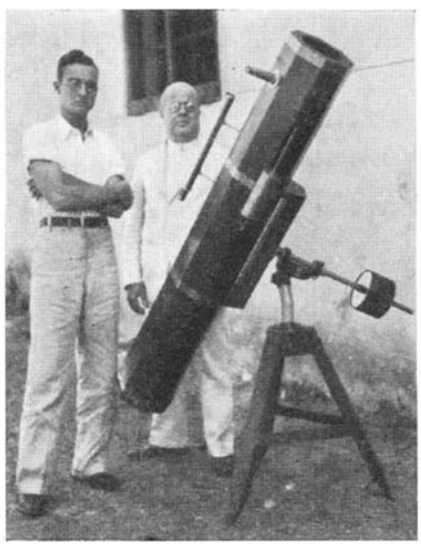
Miguel Angel Mendoza, Jr. and his father, Dr. Miguel Angel Mendoza, San Lazaro 305, Havana, Cuba, have made a telescope with an octagonal tube of oak. It is a six-inch of f/10. Now the junior Mendoza is at work on a 10-inch. He wishes to get in touch with other Cuban amateurs.

Winston Juengst of the University of Rochester states that boiling lump rouge vigorously for an hour or so will reduce it to fine particles. This is done in professionals' shops, he adds. Try it.

Another interesting item is that a club named "The Detroit Amateur Astronomical Society" has been formed, with 25 members. Eight telescopes have been finished. The secretary is Howard Morehouse, 4336 Dickerson Ave., Detroit, Michigan.

Frederick E. Ward, Box 25, Calumet, Massachusetts, states that he checked a synchronous electric clock in New Jersey against Arlington time and found that the errors ran up to 13 seconds. Has anyone any further sidelights on such scandalous performances of supposedly synchronized time?

Dr. H. Page Bailey of Riverside, California, protests our description of his mounting (January number, page 51) as a "Porter type." It is always hard to say just exactly what a design is, because one type so often shades off into another. Bailey's mounting uses a double yoke in connection with the Porter split ring, and so it's a Porter type if you accent the ring and a Bailey type if you accent the yoke. As Porter has not contested it, let's accent the yoke and all stay happy.



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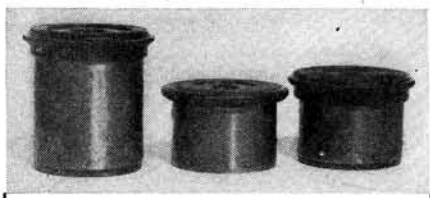

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CURRENT BULLETIN BRIEFS

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

USING PAINT AS LIGHT is a "write down" of a highly technical paper by D. L. Gamble of the research division of the New Jersey Zinc Company. The measurements were made on a laboratory scale but they were made under conditions which closely simulate actual practice. The simplicity of the charts and the definitions of lighting terms in the back of the pamphlet should enable anyone faced with a lighting problem to make a decision as intelligently as though a great deal of time and study have been given to the problem. *The New Jersey Zinc Company, 160 Front Street, New York City.—Gratis.*

ELECTRIC SERVICE FOR THE IOWA FARM (Report No. 7, Official Publication of the Iowa State College), by Frank D. Paine and Frank J. Zink, gives in succinct form the operating cost of the individual farm electric plant. The Iowa project on rural electrification was started in 1924 for the purpose of determining the uses of electricity in bettering farm living and working conditions and studying its adaptability to Iowa farming processes. *Director Engineering Experiment Station, Iowa State College, Ames, Iowa.—Gratis.*

STANDARDS YEAR BOOK (Bureau of Standards, Miscellaneous Publication No. 133) is a bound book of 394 pages and gives in great detail the very interesting work carried on by the government's great research laboratory. *Superintendent of Documents, Washington, D. C.—$1.00 (money order).*

PETROLEUM PRODUCTS IN THE TEXTILE INDUSTRY (*Lubrication*, Vol. XVIII, No. 10, October, 1932) deals with the chemical aspects of oil stain elimination. This is an important part of successful textile manufacture. *The Texas Company, 135 East 42nd Street, New York City.—Gratis.*

DOMESTIC AND INDUSTRIAL FUEL OILS (Commercial Standard, CS12-29, Bureau of Standards) gives the findings of a conference which resulted in the specifications here published. *Superintendent of Documents, Washington, D. C.—five cents (coin).*

REGISTER STUDIES IN OFFSET LITHOGRAPHY (Research Paper No. 480, Bureau of Standards), while a very special treatise on a portion of a highly specialized trade, is well worth noting. A serious economic waste in offset lithography results from lack of knowledge of the optimum printing properties of lithographic papers. An accurate rule of special design for measuring prints, and a sword type of hygroscope for determining the hygrometric state of paper were found valuable in the plant studies. *Superintendent of Documents, Washington, D. C.—five cents (coin).*

REPORT OF OXY-ACETYLENE COMMITTEE, presented at the Annual Meeting at Philadelphia, November, 1932, is filled with useful information not found elsewhere. *International Acetylene Association, 30 East 42nd Street, New York City.—Gratis.*

THE GOLDEN GRAINS, by Louise Boynton and Georgie Boynton Child, is devoted to a study of the use of cereals as a basis in menu planning, supplemented by other inexpensive foods and dairy products. The Golden Grains awakens the interest of home-makers to the practical use which can be made of this abundant vegetable resource. The numerous recipes are based on common sense. *Clark-Sprague Company, 1901 Locust Street, St. Louis, Mo.—$2.25.*

WHO PAYS FOR HIGHWAYS IN NEW YORK STATE?, by Dr. C. S. Duncan, gives an analysis of highway expenditures and sources of revenue. The question is answered as to whether land owners or vehicle owners are paying more than their share. *Associated Railways of New York State, 390 Seventh Ave., New York City.—Gratis.*

THE AMERICAN ENAMELER (Vol. V, No. 6, Sept.-Nov., 1932). This particular issue is rather unusual as it covers new and distinctive materials. There is a beautiful colored folding plate. *The American Enameler, Baltimore, Maryland.—$2.50 a year, 25 cents per copy.*

LUMBER (Simplified Practice Recommendations R16-29, Bureau of Standards) gives recognized classifications, nomenclature, basic grades, seasoning standards, sizes, uniform working, measurement, tally, shipping provisions, grade marking, and details of inspection. This is the fourth edition and is one of the pamphlets on elimination of waste through simplified commercial practice. *Superintendent of Documents, Washington, D. C.—30 cents (coins or money order).*

AIRWAY MAP OF THE UNITED STATES (Aeronautics Bulletin No. 8, Aeronautics Branch, U. S. Department of Commerce) shows federally lighted airways, federal airways equipped for day operations, federal airways under construction for night operation, and other airways. *Aeronautics Branch, U. S. Department of Commerce, Washington, D. C.—Gratis.*

THE HISTORY OF EVOLUTION, by John B. Sparks, is a large multicolored chart (22 by 58 inches) graphically showing earth history, animal evolution, and human history and ethnography from world origin to date. It is based on authoritative science and is very detailed. There is also an accompanying bibliography. *Histomap, Inc., 43 East Ohio Street, Chicago, Illinois.—$1.00.*

DESCRIPTION OF AIRPORTS AND LANDING FIELDS IN THE UNITED STATES (Airway Bulletin No. 2) is a 183-page pamphlet setting forth descriptions of all airports and landing fields of the United States which are on record with the Aeronautics Branch of the Department of Commerce. The data is presented alphabetically by states. *Aeronautics Branch, Department of Commerce, Washington, D. C.—Gratis.*

A PRIMER OF SIMPLIFIED PRACTICE (Issued by the Bureau of Standards), by Ernest L. Priest, gives answers to typical questions on the all important subject of simplifying practice to do away with industrial waste. *Superintendent of Documents, Washington, D. C.—15 cents (coins).*

SOLUTION OF SPECIAL PROBLEMS IN PIPE FLOW BY GRAPHICAL ANALYSIS (Engineering and Science Series No. 37), by Grant K. Palsgrove, M. E., is an advanced study of the subject. *Rensselaer Polytechnic Institute, Troy, N. Y.—Gratis.*

STATISTICAL ABSTRACT OF THE UNITED STATES annually compiles, clarifies, and compares detailed figures for practically every important commercial, economic, and social development and enterprise in the United States. It deals with foreign commerce, finance, transportation, and communications and gives hundreds of tables which contain a vast amount of information. There are 826 pages and the book is bound in buckram. *Superintendent of Documents, Washington, D. C.—$1.25.*

OXWELD WELDING ROD FOR BRONZE WELDING describes a welding rod for bronze welding steel, bronze, brass, cast iron, malleable iron, wrought iron, galvanized iron, copper, nickel, and mold metal. This rod can also be used for building up wearing surfaces. The technique is given in detail. *The Linde Air Products Company, 205 East 42nd Street, New York City.—Gratis.*

CORROSION OF NON-FERROUS METALS AND ALLOYS (Report of Committee B-3, American Society for Testing Materials) describes additional tests besides those described in former issues. *American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.—25 cents.*

THE NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (*Transactions*, Volume X, 1929-1930) is an English society with an American branch. It is very influential and solves many historical puzzles relating to the history of inventions. The papers are freely illustrated where necessary. *Newcomen Society, Science Museum, South Kensington, London, S. W. 7, England.—20 shillings.*

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 177)

ergosterol), irradiated products of various kinds, foods fortified with viosterol, and direct ultra-violet irradiation.

Efforts to give rickets-preventing properties to two such widely used foods as milk and bread are of particular interest, in the opinion of the association.

One of the most recent developments along this line is the successful irradiation of liquid milk at almost insignificant cost, which is reported by Dr. A. F. Hess and J. M. Lewis of New York City. By means of carbon-arc rays, these investigators were able to give milk anti-rachitic potency which was retained when the milk was dried.

Milk is particularly suitable for such irradiation and subsequent use in preventing rickets because it contains so much calcium and phosphorus, both important in treatment or prevention of rickets.

The use of irradiated liquid milk will probably be restricted to cities, in the opinion of Drs. Hess and Lewis.—*Science Service.*

Danger in Shipping Ferro-Silicon

FERRO-SILICON, an alloy of iron and silicon, would never be suspected of being a dangerous substance to handle, and ordinarily it is not. But in 1929, a bargeman died on board a lighter in Holland in consequence of breathing poisonous gases evolved from a cargo of ferro-silicon.

Induced to investigate the cause of this fatality, W. Schut and J. D. Jansen state that poisoning was due to phosphine and arsine, which are evolved when ferro-silicon is in contact with water or moist air. Unless the alloy contains other metals, such as manganese or aluminum, these gases are evolved only from samples containing more than 25 percent of silicon. Alloys containing 40 to 60 percent of silicon have the property of disintegrating spontaneously. The reason for this is not clear, but as the evolution of gas is increased considerably, alloys of these compositions are very dangerous during transport or storage.—*A. E. B.*

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The sequins have been the subject of much discussion ever since they were first discovered. Some scientists have claimed that the Egyptians knew an art for coloring gold surfaces purple, while others have believed that the purple sheen was a kind of patina due to the great age of the ornaments. Dr. Wood, using the methods of a physicist, has shown the color to be due merely to the presence of iron in gold which has been first hammered and then

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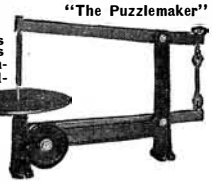

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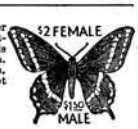

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heated. He even made duplicates of the sequins by hammering out a gold-iron alloy into thin flakes and heating the latter over a flame. One of his modern purple-gold sequins has been sent to the Cairo Museum, to be displayed along with the originals.

A modern beauty aid helped in the solution of the riddle of the purple film. Dr. Wood found he could remove the film by coating the gold ornaments with varnish such as is used in fingernail polish, and then peeling off the varnish, leaving the underlying gold of a bright yellow color. There was no sign of the film on the peeled-off varnish layer, but the film could be made to reappear by redepositing gold on the side to which the film was attached by vaporizing gold in a vacuum. Then the purple could again be seen by reflected light. The problem in physical optics presented by this phenomenon is still under examination, Dr. Wood stated.

Subjected to spectroscopic examination, the stripped-off film proved to be principally iron, probably an iron oxide. Dr. Wood then suspended one of the sequins from which the purple film had been removed between the poles of a strong electromagnet. It was attracted toward one of the poles, demonstrating the presence of iron in the gold.

Etching the surface of the gold with acid showed a very marked crystalline structure, such as is found only when rolled or hammered sheet gold is subsequently heated to nearly a red heat. Microscopic examination showed on the surface numerous small globules of gold standing out in high relief, conclusive evidence that the sequins had been heated to a high temperature after having been hammered into shape. It was after having learned these facts that Dr. Wood took gold and iron and duplicated the product of the "lost art" of the ancient Egyptian court jewelers.—*Science Service.*

Pure Manganese Dioxide Made Electrolytically

THE production of manganese dioxide of 92 to 100 percent purity by electrolysis of manganese nitrate is of interest in connection with the growing demand for the pure substance in the manufacture of dry cells. Using platinum electrodes and a bath temperature of 40 degrees, Centigrade, Japanese chemists have obtained the most favorable results when a current of 10 amperes per square centimeter was passed through a solution of manganese nitrate containing a 3 percent manganese ion concentration and a 2 to 3 percent acidity (nitric acid). The manganese dioxide, which settles to the bottom of the vessel, is finally dried at 200 to 300 degrees, Centigrade.—*A. E. B.*

Green and Ripe Olives Have Vitamin A

IF you have always looked on olives primarily as a table accessory, it is time to revise your ideas, and give both green and ripe olives a place in your menus as a food of real value. There was a time when a careful mother snatched an olive away from a child who was experimenting with its taste. Now the United States Department of Agriculture can assure her that there is nothing about olives to hurt children and much to benefit them.

Both ripe and green olives contain abundant quantities of vitamin A, the Bureau of Home Economics reports after completing a series of laboratory feeding tests. Vitamin A is particularly important to our nutritive well-being, for it protects the body against a number of troublesome bacterial infections.

Foods having a yellow or green color are usually rich sources of this vitamin. About seven medium-sized olives will supply as much vitamin A as an eighth of a cup of whole milk, or as a serving of the bleached lettuce leaves that usually appears in a salad.

Tests of one of the varieties of ripe olives for vitamins B, C, D, and G indicated that the olives were unimportant as a source of vitamin B and did not contain any of the others in detectable amounts. Because they are a rich source of vitamin A, however, the bureau recommends that both green and ripe olives be used more, not only as an appetizer, but in cooked dishes, salads, sandwiches, and sauces.

Prevents Oxidation of Lubricating Oil

ANILINE has been found to be an effective preventive of oxidization of lubricating oil in aircraft engines. Recent research reported to the Institution of Chemical Engineers has shown that the addition of a small quantity of aniline completely stopped oxidation under certain conditions and also that the presence of iron was useful.—*A. E. B.*

Submerged Cutting Machine

AT the recent Power Show in New York there was exhibited a new machine which, with remarkable ease and efficiency, cut and machined many materials on which, formerly, these operations were carried out at great expense, and others which could not be cut or machined at all by older methods. This machine, called the Campbell Hudorkut submerged cutting machine, will work on practically any material used in industry, whether it is hard or soft, including metals, glass, ceramic ware, Bakelite or other chemical or fibrous molded products, stone, and rubber.

New cutting machine in which the work is kept submerged in a bath

Examples of materials cut by the machine shown on opposite page

This machine was examined while cutting disks from the ends of glass rods, large and small, and it was noted that the cut was always clean and smooth, there being no chipping or burning of the piece. As the work is immersed in a bath during the cutting process, the cut may be made very rapidly without heating. The bath eliminates the need for an exhaust fan, as there is no dust, and also increases the life of the cutting wheel.

The machine is semi-automatic in operation and is suited for rapid production work. Cutting speeds, which are very high, depend in part on the type of material cut and on the grade of finish required. Loss of material in cutting is held to a minimum because the cutting wheel is extremely thin. Close tolerances can be held and square cuts are made as there is practically no side pressure exerted on the wheel. The wheel is well inclosed and guarded so that there is little spattering of the bath on the operator.

Rubber Chemist Honored

AS the "American scientist who has most distinguished himself by his services in applied chemistry," George Oenslager of the B. F. Goodrich Company of Akron received the Perkin medal of the Society of Chemical Industry at a national gathering of members of chemical societies.

The award was made for Mr. Oenslager's contributions to the rubber industry, especially his development of organic accelerators for rubber vulcanization and the carbon-black tread for tires. As a direct result of his efforts the rubber industry has been revolutionized and there have come about economies of manufacture, increase in service, and savings to consumers which run into the hundreds of millions of dollars annually.

Diesel-Bus Cross-Country Run

THAT a bus-load of nearly three dozen passengers could be transported across the nation, from coast to coast, at a total fuel cost of less than 30 dollars and at record speed, if desired, has just been demonstrated by two nationally-known figures in American automotive circles—Dave Evans, veteran A.A.A. race driver and C. L. Cummins, designer and manufacturer of American Diesel motors for heavy duty automotive equipment.

Cummins and Evans have just finished driving a 32-passenger bus, with a loaded weight of more than 10 tons, from New York to Los Angeles in the elapsed time of 91 hours and 10 minutes, their actual running time being 78 hours and 10 minutes.

The Diesel oil-burning motor is a new development in bus transportation although Cummins' company is now supplying motors of this type to a dozen or more American truck building corporations.

When the results of the run were checked by Cummins and Evans at Los Angeles, the following facts were disclosed: Previous coast-to-coast heavy-duty speed record, held by a Cummins-Diesel motored truck, was broken by 36 hours. Best coast-to-coast time made by truck powered with gasoline motor was beaten by 46 hours.

Attempt to Roll Lead-Zinc Mixture Kills Worker

A LONDON metal firm recently received an order for some rods containing 55 percent of zinc and 45 percent of lead. When the ingot was passed through an extrusion machine, the two metals separated, the zinc coming out as rods while the lead shot forth practically in the form of shrapnel bullets with fatal results to one of the workers.—*A. E. B.*

'Phones Songs Overseas

WHOEVER declares this to be the age of speed may also note that not even the leisurely art of humming a tune is the exception. Recently the transatlantic telephone was used for this purpose, when the London representative of an American phonograph company called up its New York office and hummed two of the latest English song "hits" into the transmitter.

It seems that Arthur Tracy, the "Street Singer" on the Columbia Broadcasting Company's hook-ups, makes records which are quite popular in the English metropolis. So as soon as the two new English songs, "Wonder" and "Dreamy," were released in London, the phonograph company's representative got on the job, realizing that it would take speed to beat the competing English companies in making records of the songs. He telephoned to Victor Young, New York orchestra leader, and hummed the tunes to him, Young speedily jotting down the melodies on a sheet of paper.

The orchestration was arranged and that night the recording took place. Within 24 hours after the humming episode, the records had been completed and were on a fast liner bound for Britain.

Wood No Longer An Essential Raw Material

WE are using up our forests at an alarming rate. Reforestation can not keep pace with the consumption of wood, not only for lumber but particularly for the manufacture of paper. A single Sunday issue of one of our large metropolitan newspapers gobbles up from five to seven acres of virgin timberland. Is the end of our wood supply in sight? If so, is it of far-reaching importance?

The fact of the matter is that wood has ceased long since to be a necessity either as a fuel or a construction material, for furniture, or for charcoal. Its chemical use

INAUGURATE

The Taking of Omens

When we speak of the *inauguration* of a president we use a word that carries us back to ancient times when people believed in omens and looked for them on every important occasion. Latin *augur* meant a member of the highest class of official diviners of ancient Rome, whose duty it was to observe and interpret the omens, such as the flight of birds, at the time of any important event. *Inaugurare* meant "to take omens" before entering upon a critical undertaking, such as the proclamation of an Emperor. From this is derived English *inaugurate*. There are thousands of such stories about the origins of English words in

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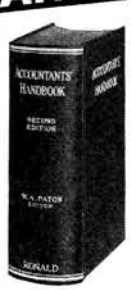

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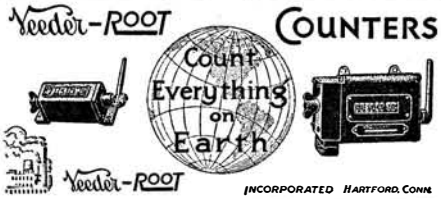

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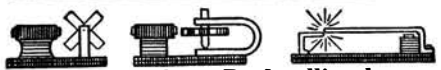

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as a source of methanol, acetic acid, and acetone has already been largely replaced by synthesis and could be entirely replaced without the least inconvenience to chemical operations. Its use as raw material for making newsprint paper and near-silk garments would present a more serious difficulty, and these industries would be forced to use annual instead of perennial cellulose. Such a switch might be a bother, but it is not an impossibility. The late Dr. John E. Teeple once remarked: "Just one industry I can find where the disappearance of wood might be a horrible calamity and might cause a considerable change in the trend of our modern civilization. I cannot see how the manufacture of antique furniture could continue without wood."—*A. E. B.*

Not All Carbon Black From U. S.

IT appears that the item in our November, 1932, issue, stating that the United States supplies the world with carbon black was based upon incomplete data. The Godfrey L. Cabot Company, of Boston, manufacturers of that important product, have informed us that "within the past two years, carbon black factories have been erected in Turkey and Formosa."

Test Grasses for Airports

TO find the best grasses or other plants for planting on airplane landing fields, the United States Department of Agriculture has planted 34 different grasses and combinations of grasses on an acre test plot on the Washington-Hoover Airport near Washington, D. C.

The experiment is the first of its kind made by the department. The department expects to find some of the plants suitable for covering landing-field areas except the actual runways. The test plot is at one side of the present field, but this year the field will be enlarged and the test grasses will be near the center of the field, where the effect of landing and departing planes may be observed.

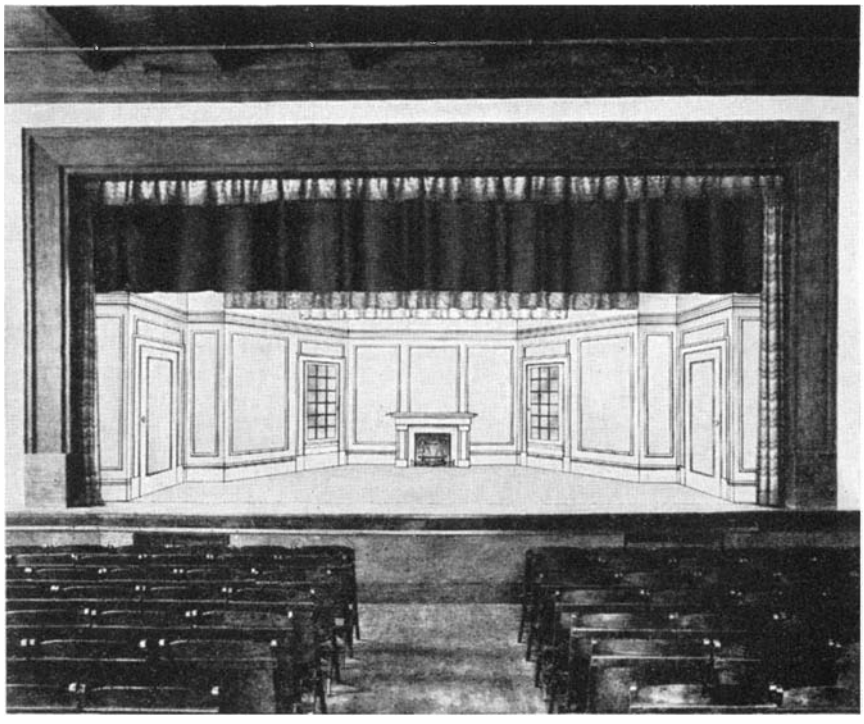
The department receives many requests for information and aid on growing grass for airports. Some of the chief reasons for planting grass on landing fields are to avoid dust, mud, standing pools of water after rains, and washing away of the soil.

The 34 grasses and combinations include some which the department hopes will prove especially suitable. Among these are several fescues, Bermuda grass, reed canary grass, alfalfa, zigzag clover, quack grass, and a perennial lespedeza which grows close to the ground and forms a matted covering, and crown vetch. An interesting compromise between a weed and a grass will be tried in combinations of crabgrass with *Poa annua* and *Poa bulbosa*. In these the crabgrass will do best during the hot weather and the other grasses will grow to best advantage at other periods of the year.

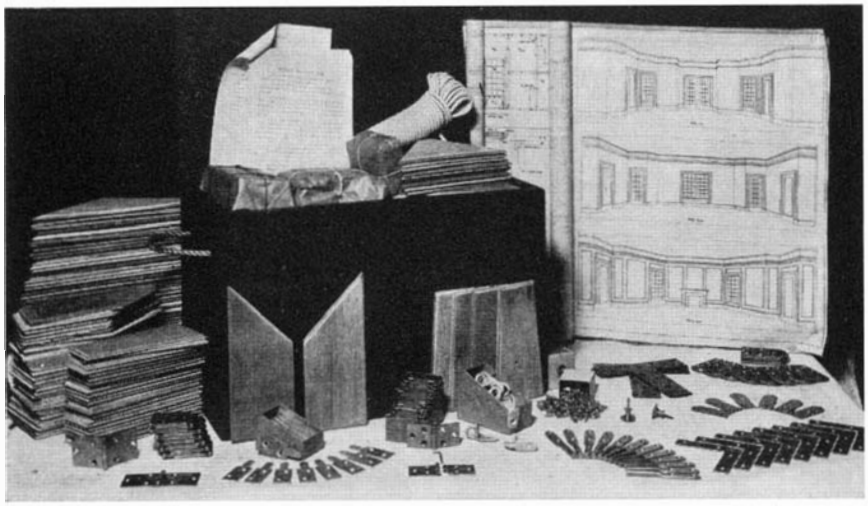
Relief for the Amateur Stage Carpenter

MANY of our high schools, parochial schools, and libraries in recent years have gone in for dramatics. These have found it so hard to get theatrical hardware and other equipment that the work of the well-intentioned amateurs has been hampered both by inexperience and lack of technical material. How often a stage is built with an ample floor which may be all right for dancing, but when an attempt is made to put in a screw clamp, the result is a ruined floor and a botched job.

The builders of the two great stages of Radio City, Peter Clark Inc., of New York City, have taken pity on the amateurs and have provided a complete scenery "kit," costing less than 50 dollars, which embraces all the hardware, clamps, et cetera, together with blue prints and full instructions for building and painting the scenery for a set for a proscenium opening 35 feet wide and a stage depth of 20 feet. Everything is included except lumber, lines, and



An example of an amateur stage set made with the kit described above



The materials and plans included in the amateur stage kit

paint. Three entirely different arrangements of scenery are provided for. The kit weighs 77 pounds and is packed in a wooden chest with rope handles which gives the outfit a professional air.

Eliminate Poison Hazard in Lead Soldering

LEAD monoxide in the form of a very fine mist is produced during lead soldering operations, the risk of inhalation by the workers being intensified by the slow rate at which the oxide settles to the ground. It has recently been shown that oxide formation takes place on a far smaller scale if carbon-containing flames are used in place of the oxy-hydrogen flame, so far as practicable. Oxy-acetylene and oxy-coal-gas are suggested as convenient substitutes. It has elsewhere been suggested that a readily volatile lead hydride might be produced during soldering operations, but no trace of such a compound could be detected during the investigation.—*A. E. B.*

The Oil Lamp's Birthday

WE moderns who nightly obtain our illumination from incandescent bulbs are inclined to forget that the oil lamp in its day was an important improvement over older methods of illumination. Poland, however, has not forgotten, for it is to a Pole, I. Lukasiewicz, a chemist from Lemberg, to whom they give the credit for the production of the first modern oil lamp.

Poland celebrated last November the fiftieth anniversary of the death of this benefactor of mankind and the eightieth anniversary of his development of the oil lamp. According to Dr. Kazimierz Maslankiewicz, who supplied this information, Mr. Lukasiewicz also was the discoverer of means of purifying and distilling petroleum.

Express Train Speeds

IN a recent letter to *The New York Times*, Paul F. Laning of Norwalk, Ohio, cited statistics he has gathered giving a most interesting comparison of scheduled miles run daily by European and American railroad trains at more than 55 miles an hour. Americans who boast of the quality and comfort of our trains may be rather surprised, upon inspection of Mr. Laning's figures, which are quoted below, to learn that, despite our much greater track mileage, we do not excel in train-miles at the higher speeds. North America is eclipsed not only by Europe in proportion to track-miles but also by the tight little British Isles in actual figures.

	Daily Scheduled Total Mileage	No. of Runs Making Total Mileage
London, Midland & Scottish	7,899	103
Great Western	5,642	71
London & North Eastern	3,909	66
Southern	705	10
Great Northern of Ireland	573	20
Total, British Isles	18,728	270
Nord	5,828	66
Est	5,194	46
Paris-Orleans	1,429	20
État	1,172	16
Alsace-Lorraine	1,137	19
Midi	524	6
Paris-Lyons-Mediterranean	23	1
Total, France	15,307	174
German State Railways	2,076	19
Italian State Railways	286	4
Total, Continental Europe	17,669	197
New York Central Lines	7,278	80
Pennsylvania System	5,656	104
Reading	1,535	54
Baltimore & Ohio	1,093	17
Canadian Pacific	786	9
Chicago, Mil., St. P. and P.	674	15
Canadian National	537	11
Chicago & North Western	182	7
Alton	91	1
Illinois Central	79	3
Wabash	65	2
Lehigh Valley	49	2
Total, No. Amer. Continent	18,025	305

Mr. Laning also says: "It may be of interest that the fastest start-stop run scheduled is the Cheltenham Flier of the Great Western Railway, Swindon to Paddington Station, 77.3 miles in 65 minutes, average speed 71.4 miles an hour. On this side of the Atlantic the Canadian Pacific appears to hold the palm, 124 miles in 108 minutes between Smith's Falls and Montreal West, 68.9 miles an hour."

Zinc Rust

THE formation of white zinc rust on zinc or zinc-coated metals may be accomplished by immersing them in a solution of chromic acid, then washing and drying. A treatment by immersion for five seconds in a 0.5 percent solution of chromic acid is said to be sufficient. If the zinc articles are stained with a film of oxide, hydroxide,

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or carbonate this film may first be removed by pickling, or the treatment in the chromic acid solution prolonged until a visible film of zinc chromate is formed.—*A. E. B.*

Identify Substance Causing Coal Tar Cancer

THE exact chemical nature of the substance in coal tar which produces cancer has been discovered. The substance itself has been produced synthetically in the laboratory. This important success, following many years of failure, has just been reported to the British scientific journal, *Nature*, by Dr. J. W. Cook, I. Hieger, and Hewett of the Cancer Hospital Research Institute in London.

One type of cancer, which often afflicts chimney sweeps and workers in the coal tar industries, is due to irritation with coal tar, scientists found some time ago. The same type of cancer occurs in mice that have had coal tar painted on the skin. Now the British investigators have found that the cancer-producing constituent of the coal tar is a previously unknown compound of hydrogen and carbon, 1.2 benzpyrene.—*Science Service.*

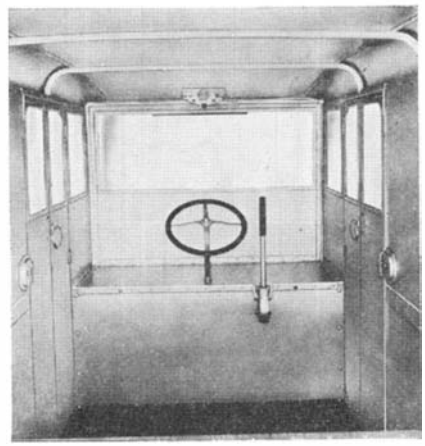
A "Mechanical-Horse" Car

A LIGHT delivery vehicle called the Pak-Age-Car, to compete with the horse and wagon in house-to-house delivery, has been announced by the Stutz Motor Car Company. It is designed to sell for approximately the same price as a horse, wagon, and set of harness and is more economical in maintenance and operation. It is virtually a one-horse wagon with the horsepower installed at the rear in the form of a gasoline engine.

The novel system of control permits the driver to advance the vehicle with no more delay nor inconvenience than is required to grasp the reins and cluck to his horse. At the same time the design permits the driver to perform his duties with the use of less personal energy than any other vehicle now on the market, because of the very low floor onto which the driver steps from the ground.

The power unit is one of the most interesting developments of automotive engineering in recent years. This "mechanical horse" consists of the engine and all of its accessories—the clutch, the transmission, and final drive—all assembled as a unit in conjunction with the rear springs, hubs, wheels, service brakes, and tires. This engine is a four-cyclinder unit of conventional design, rated at seven horsepower and capable, it is claimed, of driving the car at 18 miles an hour. Fuel consumption, in regular delivery service, is said to be one quart an hour, oil consumption negligible.

In case of emergency, the Pak-Age-Car



Clean and roomy interior of the car equipped with a "mechanical horse"

does not have to be hauled in to a service station or garage. The entire power plant unit can be replaced on the street within 15 minutes without the necessity of the mechanic entering the vehicle or disturbing the load.

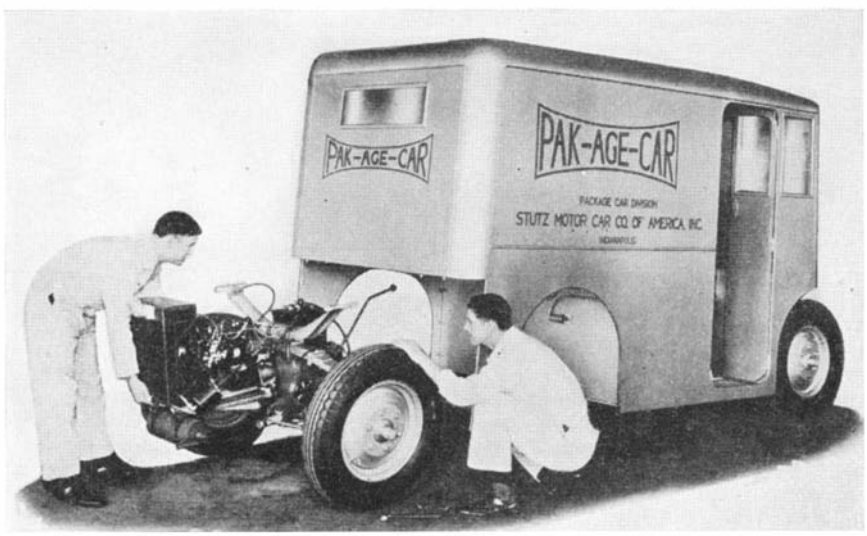
Pak-Age-Car has no axles of conventional form either at the front or at the rear. From the first experimental designs, these cars have used independent springing for all wheels.

Hoggish Hog Costs Most to Make Pork

KEEP a hog from making a hog of himself and he will turn feed into pork more economically.

This is the seemingly paradoxical conclusion the United States Department of Agriculture reaches after experiments at its Beltsville, Maryland, farm.

Three lots of pigs were used in the test. One lot got four pounds of feed daily



Removing the "mechanical horse" from the chassis

for each 100 pounds of live weight. Another lot got three pounds and the third lot two pounds. The feed was corn, tankage, alfalfa meal, and mineral mixture. The pigs weighed approximately 68 pounds each when the test began and they were slaughtered at 200 pounds.

The pigs on the four-pound basis reached the 200-pound goal first. It took them only 119 days to do it, but they required more feed than the others. Those on the three-pound ration took 128 days. The lot which got only two pounds of feed daily for 100 pounds live weight took 166 days, but made the most economical gains. The three groups used 559 pounds, 458 pounds, and 395 pounds of feed respectively per pig to reach the slaughter weights.

The tests showed that 100 pounds of feed produced 24, 29, and 32 pounds of pork when fed at the four, three, and two-pound levels. In other words, the most restricted ration produced a third more pork on an equal amount of feed, but in a 40 percent longer feeding period than the full-fed lot. The leanest pork was produced on the lowest feeding level.

The Truth About High-Altitude Flight

(*Continued from page* 155)

taking for the average pilot and passenger. Only men with exceptionally strong hearts and lungs and special training are able to climb to and live for a while in altitudes of 40,000 feet and over. A height of about 50,000 feet is considered to be the absolute limit at which a human being can survive no matter how strong he may be.

Just as a human being requires air for breathing, the airplane engine needs air to furnish the necessary oxygen for combustion. The lung of the engine is the carbureter where fuel and air mix before entering the cylinders. The amount of air required is governed by the fuel consumption of the engine. For each gallon of gasoline consumed approximately 102 pounds of air are required or about 1350 cubic feet at sea level density. With increasing altitude and thinness, the weight of the air, and correspondingly the amount of oxygen drawn into the engine becomes less and less, although the volume, determined by cylinder displacement, remains constant. The air-gas mixture becomes too rich; and from experiment we have learned that the power output decreases at a somewhat greater rate than the weight or density of air decreases with altitude. A one horsepower engine will deliver about .57 horsepower at 15,000 feet and only .31 horsepower at 30,000 feet, whereas the values of density and weight of air decrease from 1.0 at sea level to .63 and to .374 respectively.

To increase performance at high altitudes, most of the present day airplane engines have been equipped with superchargers, which maintain sea-level horsepower up to certain altitudes depending upon the size and efficiency of the supercharger. Above this level the decrease in power is the same as with conventional engines. This decrease in power is responsible for the loss of speed and other reduced performances of conventional planes with increase in height. No real effort has been made up to the present time to improve engine performance above a limited altitude because there has been no demand from the air-line operators. Therefore, constant engine power at all levels, to utilize fully the possibilities of high speed in the thin air of the stratosphere, is another interesting problem of high-altitude flight.

There is still another gain to be expected when the stratosphere is conquered, and that is the freedom from sea-level weather, with all its hazards to aerial navigation and unpleasantness to passengers. On long cross country flights, different kinds of atmospheric disturbances are often encountered. We may have rain in New York, fog in Ohio, thunderstorms with hail in Kansas. In between may be changing head and cross winds, with sun squalls or bumps as a very disagreeable addition. Bad weather conditions at sea level probably have been the reason for the failure of a number of ocean flights in the past. Treacherous weather conditions with disturbances of great magnitude and suddenness generally exist in tropical and polar districts. Here is one reason why an air line to Europe by way of Labrador, Greenland, and Iceland is not considered practical, and "floating islands" have been considered to serve as bases for refueling in mid-Atlantic.

The foregoing shows clearly that weather means more to the ultimate success of air transport as a paying business, than to any kind of surface transportation. Not only can weather be very annoying to passengers but it is also responsible for interruptions of flying schedules. However, these atmospheric disturbances, caused by the thermic influence of the earth, can develop only in the lower belt of the atmosphere. The ideal lanes for flying, therefore, are above these levels in the cloudless region of the stratosphere. Here, far above the earth, where weather disturbances cannot form, with a clear sky above at all times, navigating by sun or stars becomes an easy matter. There are no sun squalls or bumps to annoy the passengers and make them air sick. Fog, clouds, rain, snow, and thunderstorms far below may be encountered only for short periods after starting and before landing.

Although the air in the stratosphere is always clear, it is not motionless, but flows smoothly in a horizontal direction without gusts or bumps. Observations and measurements indicate that this air-flow sometimes reaches a velocity of about 60 miles per hour at 40,000 feet altitude, but decreases to approximately 35 miles per hour at 50,000 feet. The direction of air-flow frequently changes in different levels and it should therefore be possible to find a level or lane for every flight route at which the altitude plane can make use of a tail wind for additional speed. Nevertheless, there are still some uncertainties about these velocities and directions which probably can be cleared only by actual flights in the stratosphere.

●

In the second and concluding part of this article, to be published next month, Mr. Evers tells in detail of an American stratosphere plane that was designed several years ago. He also deals with speeds that may be expected with high-altitude planes, exploding some of the exaggerated figures that have been published in the past.

IF YOU ARE PAST 40

You May Recognize These Symptoms

But Do You Know What They Often Mean?

Millions of men past 40 suffer from night rising—so-called "bladder trouble," constipation, piles, pains in back and legs, like rheumatism, and from weakness and low vitality. They think often that these are just signs of age—never dreaming the true cause.

In fact, doctors say, these troubles include the surest sign of degeneration of a vital male gland—the prostate. High authority says after a certain age 65% of men have some prostate weakness, which may lead to surgery, or miserable old age!

FREE BOOK TELLS ALL

Now an amazing FREE book, "Why Many Men Are Old at 40," tells facts about prostate weakness. It explains a marvelous home treatment called Thermalaid, using the same principle recently tested with amazing success by a prominent New York hospital. Thermalaid is now sold with the understanding that if you do not seem to feel ten years younger in one week, your money will be refunded!

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COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY
Member of the New York Bar

Radio Anti-Trust Case Settled

A CONSENT decree of injunction, granted recently by the United States District Court of Wilmington, Delaware, closed an anti-trust case that has created wide-spread interest. Because of the vital importance of this decree, and of the far-reaching results that may be expected to arise therefrom, we feel justified in devoting the entire space of this department this month to the publication of the full text of the decree.

The decree was entered in a suit entitled Equity No. 793, United States of America against Radio Corporation of America, General Electric Co., International General Electric Co., Westinghouse Electric & Manufacturing Co., Westinghouse Electric International Co., National Broadcasting Co., Inc., R. C. A. Communications, Inc., R. C. A. Photophone, Inc., R. C. A. Radiotron Co., Inc., R. C. A. Victor Co., Inc., American Telephone and Telegraph Co., Western Electric Co., Inc., General Motors Corporation and General Motors Radio Corporation.

The decree follows in full text:

CONSENT DECREE

This cause coming on to be heard this 21st day of November, 1932, and the several defendants having accepted service of process and having appeared and filed their answers to the petition and to the amended and supplemental petition herein, which latter has superseded the original petition and is hereinafter referred to as the petition, and the cause having heretofore this day been dismissed as to the General Motors Corporation, General Motors Radio Corporation, American Telephone and Telegraph Company and Western Electric Company, Inc.;

* * *

And the petitioner and the remaining defendants (hereinafter in this decree referred to as the defendants) having filed a stipulation with the clerk of the court wherein and whereby the defendants consent to the making and entering of this decree;

And the petitioner by its counsel having represented to the court that this decree will provide suitable relief concerning the matters which the petitioner charges in said petition, and having requested that this decree be made and entered;

And it appearing that by reason of the consents of the defendants to this decree and the acceptance of the same by the petitioner it is unnecessary to proceed with the trial of the cause or to take testimony therein or that any adjudication be made by the court of the issues presented by the pleadings herein, other than those hereinafter specially reserved in Section VI hereof;

Now, therefore, without taking any testimony or evidence and without making any adjudication, it is, upon and in accordance with such stipulation and consent, hereby ordered and decreed as follows:

I

The court has jurisdiction of the subject matter hereof and of all the parties hereto and has full power and authority to enter this decree and the allegations of the petition state a cause of action against the defendants under the provisions of the Act of Congress of July 2, 1890, entitled "An Act to protect trade and commerce against unlawful restraints and monopolies" and acts amendatory thereof and supplemental or additional thereto, known as the Federal anti-trust laws.

General Electric Company and Westinghouse Electric & Manufacturing Company, respectively, shall divest themselves of the holdings of themselves and their respective subsidiaries of shares of stock of the Radio Corporation of America. This shall be done as follows:

* * *

General Electric Company shall within three months from the date hereof divest itself of substantially one-half of all of the holdings of itself and its subsidiaries of the shares of common stock of Radio Corporation of America by distributing such shares ratably to its own common stockholders, or causing them to be so distributed.

The balance of such common stock and the shares of preferred stock of Radio Corporation of America held by General Electric Company and its subsidiaries shall be disposed of within three years from the date hereof, by distributing such shares ratably to its own common stockholders, or causing them to be so distributed, or otherwise disposed of.

Westinghouse Electric & Manufacturing Company shall within three months from the date hereof divest itself of substantially one-half of all of the holdings of itself and its subsidiaries of the shares of common stock of Radio Corporation of America, by distributing such shares ratably to its own stockholders, or causing them to be so distributed.

The balance of such common stock and the shares of preferred stock of Radio Corporation of America held by Westinghouse Electric & Manufacturing Company and its subsidiaries shall be disposed of within three years from the date hereof by distributing such shares ratably to the shareholders of Westinghouse Electric & Manufacturing Company, or causing them to be so distributed, or otherwise disposed of.

II

The distribution of shares of Radio Corporation of America to shareholders of General Electric Company and of Westinghouse Electric & Manufacturing Company, herein provided for, shall be without any restriction on the full rights of ownership of the several distributees, including the right to dispose of the same as they see fit.

In any disposition of shares of common stock hereby required to be made by General Electric Company and Westinghouse Electric & Manufacturing Company, or its or their subsidiaries (other than for the purpose of distribution to stockholders), they shall not knowingly sell or transfer to any one interest shares of such common stock to an aggregate in excess of 150,000 shares of the present common stock, or stock which at the time may be equivalent to 150,000 shares of the present common stock in respect to the then existing voting rights.

Pending the disposition of such stock, General Electric Company and Westinghouse Electric & Manufacturing Company and their respective subsidiaries (other than G. E. Employees Securities Corporation) shall be enjoined from exercising any voting rights with respect to such stock, except that they shall from time to time, as requested by the executive committee of the board of directors of Radio Corporation of America, as such executive committee may then be constituted, give to it or to such person or persons as such executive committee may designate, proxies, with power of substitution, to vote such stock for the election of directors of Radio Corporation of America or for the transaction of ordinary business at any annual or special meeting of stockholders; and as to all other matters as to which the stockholders' action is required, such holders may, at their election, give proxies to such executive committee or, in case any of them fails to do so within 10 days before the date set for any such meeting, it shall give such proxies as may be directed by an order of this Court on the application of the defendant Radio Corporation of America or the holder of such stock.

* * *

General Electric Company and Westinghouse Electric & Manufacturing Company shall report to the court at the ends of the aforesaid periods of three months and three years, respectively, with regard to their compliance with the foregoing provisions of this Section II.

Except as aforesaid, General Electric Company and Westinghouse Electric & Manufacturing Company, and each of them, are enjoined after the expiration of such period of three months from acquiring or holding, directly or indirectly, any shares of stock of Radio Corporation of America or any of its subsidiaries, present or future; provided, however, that nothing herein contained shall be construed to prevent G. E. Employees Securities Corporation from con-

tinuing to hold, and from exercising all rights with respect to, not more than 50,000 shares of A Preferred and 10,000 shares of B Preferred stock of Radio Corporation of America now held by it.

III

General Electric Company and Westinghouse Electric & Manufacturing Company, respectively, shall cause all of their officers, directors, employees or agents, who are now members of the board of directors, or other boards or committees of Radio Corporation of America, or of any of its subsidiaries, to resign, within 10 days from the date hereof, from such boards and committees, and are hereby enjoined and restrained from thereafter permitting any such officer, director, employee or agent to act as a member of any such board or committee; and Radio Corporation of America and its subsidiaries are likewise enjoined and restrained from thereafter permitting any officer, director, employee or agent of General Electric Company or Westinghouse Electric & Manufacturing Company to become or to act as a member of any such board or committee; provided, however, that for a period of not longer than five months from the date hereof, Owen D. Young and Andrew W. Robertson may continue to serve, at the pleasure of the Radio Corporation of America, as members of the boards and committees of Radio Corporation of America and its subsidiaries, provided, that the Advisory Council of National Broadcasting Company, Inc., so long as its functions shall continue to be merely advisory, shall not be deemed to be a board or committee within the meaning of the foregoing provision.

* * *

IV

The defendants are hereby enjoined and restrained from recognizing as exclusive or asserting to be exclusive any license for the enjoyment of patents or patent rights in the following agreements, referred to in the petition:

1. The agreement between the Radio Corporation of America and the General Electric Company, dated Nov. 20, 1919, and referred to as Agreement A;

2. The agreement between General Electric Company and American Telephone and Telegraph Company, dated July 1, 1920, and referred to as Agreement B;

* * *

3. The agreement between the Radio Corporation of America and United Fruit Company, dated March 7, 1921;

4. The agreement between the Westinghouse Electric & Manufacturing Company and the International Radio Telegraph Company, dated June 29, 1921, and referred to as Agreement D;

5. The Agreement between the General Electric Company, Radio Corporation of America and Westinghouse Electric & Manufacturing Company, dated June 30, 1921, and referred to as Agreement E;

6. The Agreement between General Electric Company and American Telephone & Telegraph Company, dated July 1, 1926, and referred to as Modified Agreement B;

7. The Agreement between General Electric Company, Radio Corporation of America and Westinghouse Electric & Manufacturing Company, dated June 11, 1929, and referred to as Agreement L;

8. The Agreement between General Electric Company, Radio Corporation of America and Westinghouse Electric & Manufacturing Company, dated Jan. 1, 1930, and referred to as Agreement M; and are likewise enjoined and restrained from recognizing or asserting the continued existence or the continued obligation of any provision of any of said agreements restricting or limiting the right of a party thereto freely to engage in such business or activities as it may desire or to make such use of its patents or patent rights as it may desire.

MR. LIDDY will be pleased to answer the inquiries of our readers who may desire information relative to the various subjects reported in his department. —*The Editor.*

V

The defendants are and each of them is further enjoined and restrained from making or entering into any combination, agreement, understanding or joint endeavor between them or any two or more of them (except between any one defendant and its subsidiaries or between subsidiaries of any one defendant) or between them or any one of them and third persons, in restraint of interstate or foreign commerce of the United States in violation of the anti-trust laws of the United States by:

(a) limiting or restricting the freedom of any defendant to grant licenses under its own patents or patent rights in the fields of radio purposes as defined in agreement attached to the stipulation consenting to this decree, or in the application in fields other than of radio purposes, of radio tubes or tubes having the functional characteristics of radio tubes or of other radio devices or circuits;

(b) limiting or restricting the freedom of any defendant or any party to such combination, agreement, understanding or joint endeavor to engage in trade and commerce in said fields and in said applications either by exchange of exclusive licenses under patents, by agreements restricting or burdening the right of an owner of a patent or patent right to enjoy the same or to grant licenses thereunder, by agreements for division of fields or territory, or by other similar means or devices;

provided, however, that nothing herein contained shall be deemed or construed to prevent any defendant from acquiring or assigning or agreeing to acquire or assign patents or other property or granting or agreeing to grant, or continuing to act under, exclusive rights thereunder or in connection therewith, or taking any other action, if not done to restrict liberty of action as part of a plan or purpose to restrain interstate or foreign commerce of the United States as prohibited by the anti-trust laws of the United States, it being recognized that patents and patent rights may be bought, sold and transferred as may other kinds of property and subject only to like limitations.

* * *

VI

The issues presented by the petition and the amendment thereto this day filed, with reference to contracts and arrangements and understandings between the defendants or any of them and foreign companies and governments, are specially reserved for trial and determination if that becomes necessary, for a period of two and one-half years from the date hereof, such period being allowed for the reason stated in the stipulation consenting to this decree. Said contracts, arrangements and understandings now existing are not affected by and do not come within the provisions of the previous Sections of this decree. The defendants affected hereby shall at the end of one year from the date hereof render to the Attorney General a written report as to what has been and what is being done with reference to the matters covered by the foregoing portion of this Section VI, and on the request of the Attorney General shall at any time irrespective of the rendering of said report give to him full information respecting such matters. If prior to the expiration of said period of two and one-half years the defendants have succeeded in securing modifications or changes of said contracts, arrangements and understandings, to meet the objections of the petitioner, the cause shall be dismissed as to the issues so reserved, but otherwise upon the expiration of said period (unless it be shown to the Court at that time that defendants have used due diligence to secure the modification or change of said contracts, arrangements or understandings and that no reason of public interest exists why such trial should not be further continued, in which case the trial may be postponed to such time as the Court deems advisable) the cause shall forthwith be placed upon the trial calendar next following and shall be set for trial on the reserved issues at the earliest convenience of the Court. If said issues are to be tried the defendants may file their answers to the amendment to the petition on or before the expiration of said period, but a failure to do so shall not prevent the cause from being placed on the calendar and set for trial as hereinbefore provided. At any time after the said one year from the date hereof the petitioner may, on notice to the defendants affected thereby, apply to the Court to have said period of two and one-half years shortened upon showing to the satisfaction of the Court that the defendants have not been diligent in dealing with said foreign contracts, arrangements and understandings by negotiation or otherwise, or that there appears no likelihood of their being satisfactorily adjusted.

VII

The term subsidiary as used in this decree means a corporation the majority of the voting stock of which is owned by any of the named defendants.

VIII

Jurisdiction is hereby expressly reserved for the purpose of enforcing or modifying this decree on application of any of the parties hereto. Jurisdiction is further reserved to permit any of the defendants, after the expiration of three years from the date hereof, to apply to the court for permission to acquire stock in any other of the defendant corporations, or their subsidiaries, which permission may be granted upon proof to the satisfaction of the court that such acquisition of stock will not tend to defeat the purpose of this decree or violate the anti-trust laws or operate in any manner otherwise inimical to the public interest.

John P. Nields, Judge.

Books SELECTED BY THE EDITORS

THE RADIO ENGINEERING HANDBOOK

By a Staff of 22 Specialists. Keith Henney, Editor-in-Chief

IF there is one thing about a reference book that endears it to this reviewer, it is a well-ordered arrangement of the text. In the present case, a system is used that is very nearly the ultimate in book make-up. Each phase of radio is dealt with by an author who is a specialist in his own particular field, and is allotted a section all to itself. Thus if one wishes to review, for example, resistance, he turns to the section on that subject, and there it is—all the information in one compact group. There are 23 such sections in this book. The first is a compilation of mathematical and electrical tables that will prove to be invaluable; the following 22 are by the various experts and are described fully in the table of contents. A complete index serves to locate branches of the sections with little lost motion. Altogether one of the finest references for the radio engineer and advanced amateur that we have ever seen. The finish of the book is admirable; limp covers and burnished edges that make a good appearance and should wear well.—$5.20 postpaid. —*A. P. P.*

THE MECHANISM OF CREATIVE EVOLUTION

By C. C. Hurst, Ph.D., Cambridge University

WHILE other branches of biology have been theorizing and debating, one small group, the geneticists, have been observing and experimenting with actual things, and they have found the thing in the inheritance cells of man and animals and plants which is the actual mechanism of evolution—the thing which "makes it go." This is the sub-microscopic gene or determiner, and it is one of the most interesting things in all science—something scarcely, if any, larger than a molecule. The genes make us what we are. Readers who wish a clearer view of this remarkably promising corner of science than any book has hitherto afforded will find it here, written in popular (though hardly in tabloid) style by a noted geneticist. They will get a glimpse, too, of what it is that plant breeders really do when they burbank new species. In this superbly illustrated book of 350 large pages we see the actual machinery of evolution in motion—not the mere outside of the box, as heretofore. Readers will do well to keep their eye on genetics, which is cutting rings clear around other sciences and is really getting hold of something solid, instead of debatable theories.—$6.20 postpaid. —*A. G. I.*

THEORY OF ELECTRICITY AND MAGNETISM

By Max Planck, Prof. Theo. Phys., Univ. Berlin

THIS is a translation of Volume III of the famous Max Planck's "Introduction to Theoretical Physics" and it is suitable for the advanced student. —$2.65 postpaid.—*A. G. I.*

THE FORM AND PROPERTIES OF CRYSTALS

By A. B. Dale, Tutor, Cambridge Univ.

AN introduction to the study of minerals and the use of the petrological microscope, being a conventional textbook of crystallography.—$1.80 postpaid.—*A. G. I.*

ELECTRICITY AND MAGNETISM

By Norman E. Gilbert, Prof. Physics, Dartmouth College

A VERY well rounded 533-page conventional but modern textbook treatment of electricity and magnetism, covering basic principles, galvanometers, generators, meters, transformers, communication, electron tubes, etc. The reader must be capable of handling elementary calculus.—$4.75 postpaid. —*A. G. I.*

THE RELATIVITY THEORY SIMPLIFIED

By Max Talmey

MAX TALMEY, the author, knew Einstein when he was a youngster of ten, and continued to know him intimately until he was 15 years old. He lent books to the young prodigy and gave much advice and counsel. How did he know that this boy would some day be recognized by science as the most profound thinker living? Dr. Talmey now explains the Einstein theory in a semi-popular book. Whether this will emerge as *the* popular attempt at explanation of relativity or not, is something we dare not predict. Many have tried the same thing. The title of the book might mislead some. The theory is simplified—speaking relatively—but the reader must at least remember some of his algebra. We mention this because many ask for a still simpler explanation of relativity. The author's 20-page account of Einstein as a lad makes interesting reading.—$1.65 postpaid.— *A. G. I.*

WHERE IS SCIENCE GOING?

By Max Planck, Prof. Physics, Univ. Berlin

THIS book, by the famous "author" of the quantum theory, who is now one of the deans of physical science, deals very largely with the more philosophical aspects of modern science– the very aspects, however, which are engaging the best interests of all the other great physicists today, that is, metaphysics; the law of causality; freedom of the will; and epistemology, (study of the very roots of knowledge) which goes behind all our knowledge. These are the kind of fundamental things which largely occupy the minds of men like the great Max Planck. The reader will gain an insight into the mental processes by which scientists guide their investigations and make their deductions.—$2.90 postpaid.— *A. G. I.*

ATOM AND COSMOS

By Hans Reichenbach, Prof. Phys., Univ. Berlin

THE general scope of the newer physics is here covered—space, time, radiation, and matter—in a supposedly very elementary manner, being based on a series of radio addresses delivered at Berlin. "My presentation," the author states in his preface, "does not presuppose any knowledge of the kind taught in schools, nor does it desire to furnish any such knowledge. It aims to give insight into the physicist's way of thinking, and a general view of the results of his research; and it wishes to show how the physical theories of to-day have united in a picture of the world." If this is the kind of material an *average* radio audience in Germany can and will absorb, it speaks badly for average

radio audiences in America. This book is elementary, as its author infers, but not so much so as to insult the intelligence of the average American reader who has considerable above the ears. It would be just nice comfortable reading for the average human being and it does painlessly impart a lot of knowledge of the newer physics. Of course, if you are a physicist, don't get it. But it is not a book for the "happy moron," either. 294 pages.—$2.15 postpaid.—*A. G. I.*

EVOLUTION, FACTS AND THEORY

By Wells, Huxley and Wells

SOME months ago Mr. H. G. Wells, his son G. P. Wells, and the biologist, Julian Huxley, published a large two-volume work covering all of the life sciences under the title "The Science of Life." The present little book is a reprint of pages 314 to 643 of that famous, authoritative, and at the same time *readable* work, evolution being one of the more popular high lights of it. This reprint covers paleontology, variation, evolution of man, controversies about evolution and, in short, the general facts which the average person who is interested in evolution would wish to know. —$1.15 postpaid.

REPRODUCTION, GENETICS AND THE DEVELOPMENT OF SEX

By Wells, Huxley and Wells

ANOTHER of the small reprints mentioned above. How individuals originate, the actual mechanism of inheritance, what determines sex, and so forth—this is the scope of this volume. All well-informed persons wish to know these things and Mr. Wells knows how to tell them in such a way that readers who are not already professors of biology can understand them. Such writing has always been his forte. The volumes are neatly bound and may be purchased separately.—$1.15 postpaid.

THE DEVELOPMENT OF AMERICAN INDUSTRIES

By Glover and Cornell

EDITED by two Professors of Business Management in New York University, this work of 932 pages consists of 41 chapters each contributed by an authority who reviews the industry with which he is most familiar. It goes to the bone of each, analyzing the factors that have produced present conditions and points out what must be done or along what line effort must be made to rehabilitate each to healthy, normal activity. The selection of authors has been most happy—each seems to have the gift of ample, succinct, interesting depiction, through a wide range which seems to omit no industry of any particular importance. This is both a reference and a guide.—$6.25 postpaid.

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By Graham A. Laing, Prof. Economics, Cal. Tech.

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