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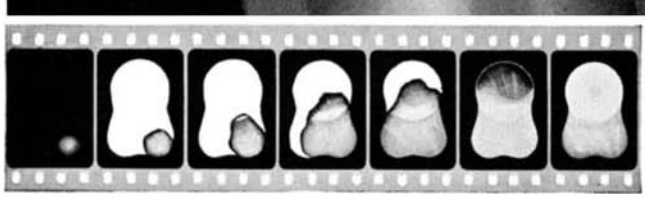
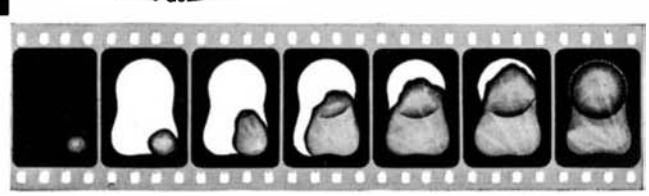


ORDINARY GASOLINE is in the cylinder. You see the spark in the picture at the left. In the next the gasoline vapor starts to burn. More—more—more burns. Then suddenly, in the sixth picture—BANG! The remaining unburned gasoline explodes. That is KNOCK. The last picture shows nothing but afterglow. Knock wasted the gasoline that should be working now.



ETHYL GASOLINE starts from the spark in the same way—as shown in the first three pictures. But Ethyl can burn at only one speed: *the right speed.* See how its flame spreads *evenly* from start to finish. It is not all burned until the last picture—delivering its greatest power when the piston is going down—the time when power counts most in the performance of your car.

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SCIENTIFIC AMERICAN

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EIGHTY-EIGHTH YEAR • **ORSON D. MUNN, Editor**

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CONTENTS · APRIL · 1932

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ACROSS THE EDITOR'S DESK

DO you want us to publish articles dealing with the construction of radio sets? Our mail recently has shown a marked increase in the number of inquiries as to where such data can be obtained. Many of these have been occasioned by the lure of the short waves and by the promise of reception from foreign stations on the higher frequencies. Up to the present we have confined our radio activities to reporting only new developments of wide general interest, but if it is your wish, we will include short, succinct, accurate articles on receivers, and possibly transmitters, of approved design. It's up to you. If you want this kind of material in your magazine, drop us a line and tell us so. The amount of space devoted to it will depend upon your response; the greater the number of readers who say they want it, the more you will get.

●

With the unaided eye you can see between 2000 and 3000 stars on a clear night—no more. The most distant of these are only about 3000 light-years away. But the total number of stars in our galactic system is certainly greater than 100,000,000,000 and the extent of the system is probably something like 200,000 light-years. But this is only the beginning. Out beyond this galactic system of ours are millions of other similar systems. Staggering figures, but striking; indicative of the enormousness of the evolving universe of which we are so small a part. In a two-part article scheduled to start next month, Sir James Jeans gives an absorbing account of these vast groups which occupy outer space. The article is one which fitly follows "What Is It All About?" by Hiram Percy Maxim, in this issue.

●

When you think of the Navy, you naturally think of an efficient fighting machine, geared for the sole purpose of protecting our country, our lives, and our property when the need arises. But this is only a part of its work, and a small part at that. There is scarcely an industry in the nation, large or small, that has not at some time or other felt the influence of the Navy in the conduct of its normal business. It is, of course, well known that the Navy has been of invaluable assistance to the aircraft industry, for example. But in an article to be published soon many things will be told about the linkage between the Navy and your own daily life—things that will surprise you.

●

You have read the newspaper announcements of the X-ray "microscope," and possibly visualized it as some combination of an ordinary microscope and an X-ray tube. If so, you were wrong. This new collection of apparatus which actually reveals electrons in motion within the atom bears not the remotest resemblance to either of these familiar units. One of our contributors, Gaylord Johnson, recently interviewed Dr. Jesse W. M. DuMond, of the California Institute of Technology, who, in collaboration with Dr. Harry Kirkpatrick, conceived and constructed the X-ray "microscope." As a result of this interview, Mr. Johnson has prepared an article, which will appear next month, and which reveals the innermost workings of the instrument; furthermore, it tells just how it is used. A series of explanatory sketches helps to make the article one of the most fascinating and informative that we have ever published in the field of physics.

●

Our "industrial" or "shop" article for next month will tell in detail the various steps in new and improved processes of manufacturing plate, window, and safety glass. A series of special photographs will depict the life history of glass from raw material to finished product.

●

We hear the question reiterated time and again, "Where is television?" There has been so much ballyhoo about "talking pictures by radio" in the home, that many have come to feel that they have been grossly deceived. To a certain extent they have. But it must be remembered that television is as yet a new art and that it involves factors on which there never has been accumulated sufficient knowledge to make rapid progress possible. Television is here, and has been here for some time—but only in the laboratory stage. What is being done to bring it out of the laboratory and into the home, and what we may expect when it gets there, are phases of the subject which will be treated in an article soon to appear.

The Conquest of Space

By DAVID LASSER

Pres. Am. Interplanetary Soc.

AT LAST there is a comprehensive, scientific, sane treatise in English on rockets and rocket flight.

At present rocketry has reached the stage which aviation had reached a generation ago; that is, most "sensible" persons regard it as a little bit crazy, while a few really sensible persons are taking pains to look into it and are meeting with some surprises. Mr. Lasser's very well rounded book of 262 pages treats the subject from all its interesting angles.—$3.20 postpaid.

Scientific Self-Defence

By W. E. FAIRBAIRN

TRAINED for many years in the practice of jiu-jitsu, the author has evolved a means of defence for the nonactive civilian who wishes to be able to protect himself from assault by thugs or other malicious persons. All the holds are fully described and illustrated so that one can readily practice them without further instruction. Douglas Fairbanks, who has somewhat of a reputation for efficiency in jiu-jitsu, writes the preface in which he heartily commends the book as well as the wrestling art of the author.—$3.65 postpaid.

Diesel Reference Guide

By JULIUS ROSBLOOM

A BOOK for reference purposes and instruction on modern Diesel engineering—land, marine, locomotive, aero-service, automotive, and portable duties. Combines also a directory of manufacturers of Diesel engines and products essential in Diesel services. Profusely illustrated, with tables, formulas, and so on. The most comprehensive work on this subject that we have seen. 8 x 10¼, 202 pages of text and 68 pages of appendix.—$4.20 postpaid.

The Art of Learning

By WALTER B. PITKIN

Prof. Journalism, Columbia

REGARDLESS of the extent of the reader's formal education this book explains practical and direct methods for applying himself most effectively in making new knowledge his own. It makes clear just how to use one's mind with greatest economy of time and effort for maximum results. Written expressly to give practical aid to those whose positions or ambitions compel them to learn some new science, profession or business.—$2.65 postpaid.

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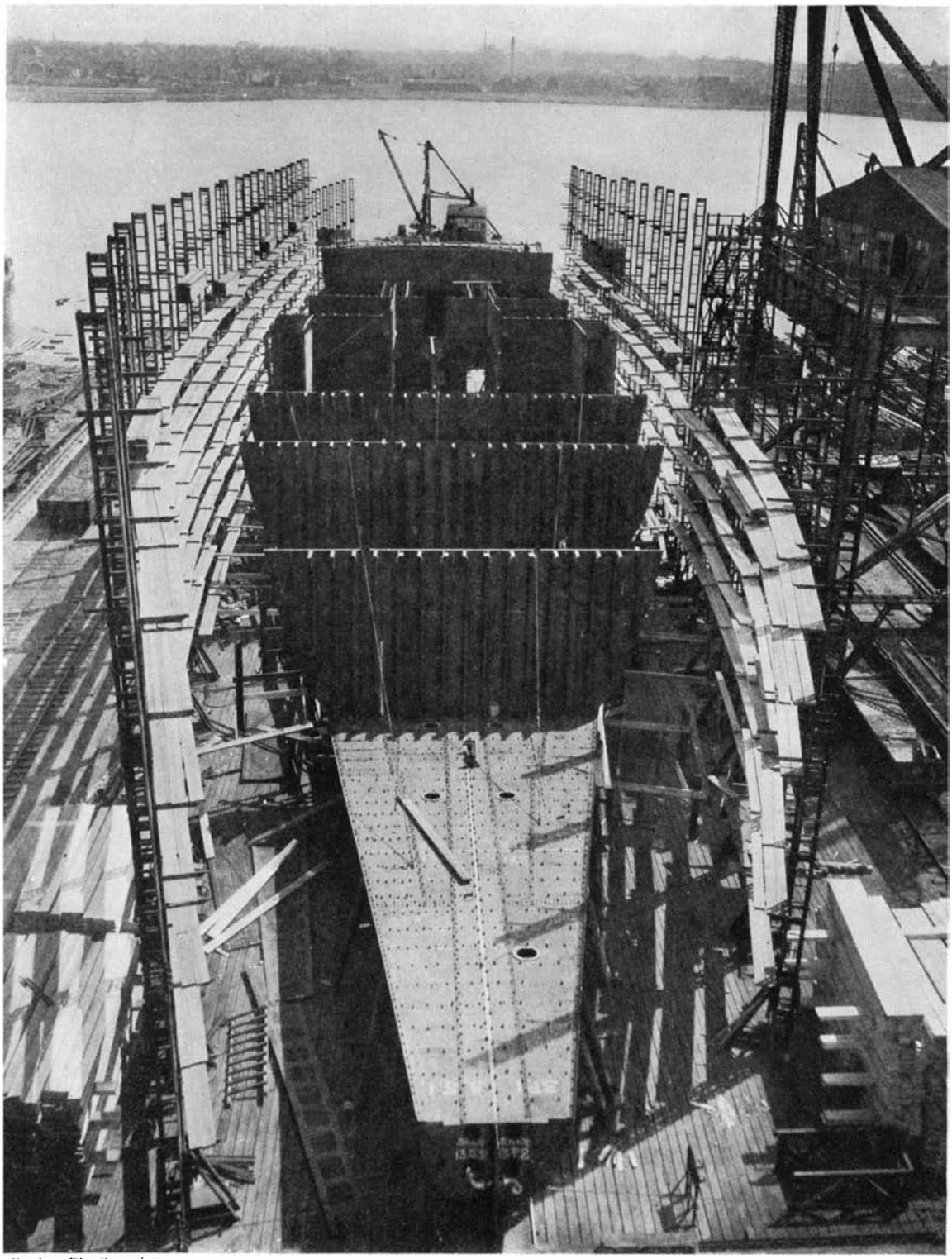
Photograph by Clyde Fisher, courtesy of the *Amateur Astronomer*

CHARLES P. OLIVIER JOHN A. KINGSBURY

OBSERVING meteoric showers is a form of outdoor sport in which hundreds of amateur scientists are co-operating with professional astronomers. In the flashlight photograph shown above Mr. John A. Kingsbury (right) of Wall Street, New York, is assisting Professor Charles P. Olivier (left), director of the Flower Observatory at the University of Pennsylvania and president of the American Meteor Society, in the observation of the Leonids, one of the great annual showers of meteors. Dr. Olivier is a leading authority on this phase of astronomy and is the author of the book "Meteors," also of "Comets." He holds in his hand a ruler used for lining up the meteor with the background of stars the moment it appears, a method which adds to the accuracy of plotting and simplifies the work.

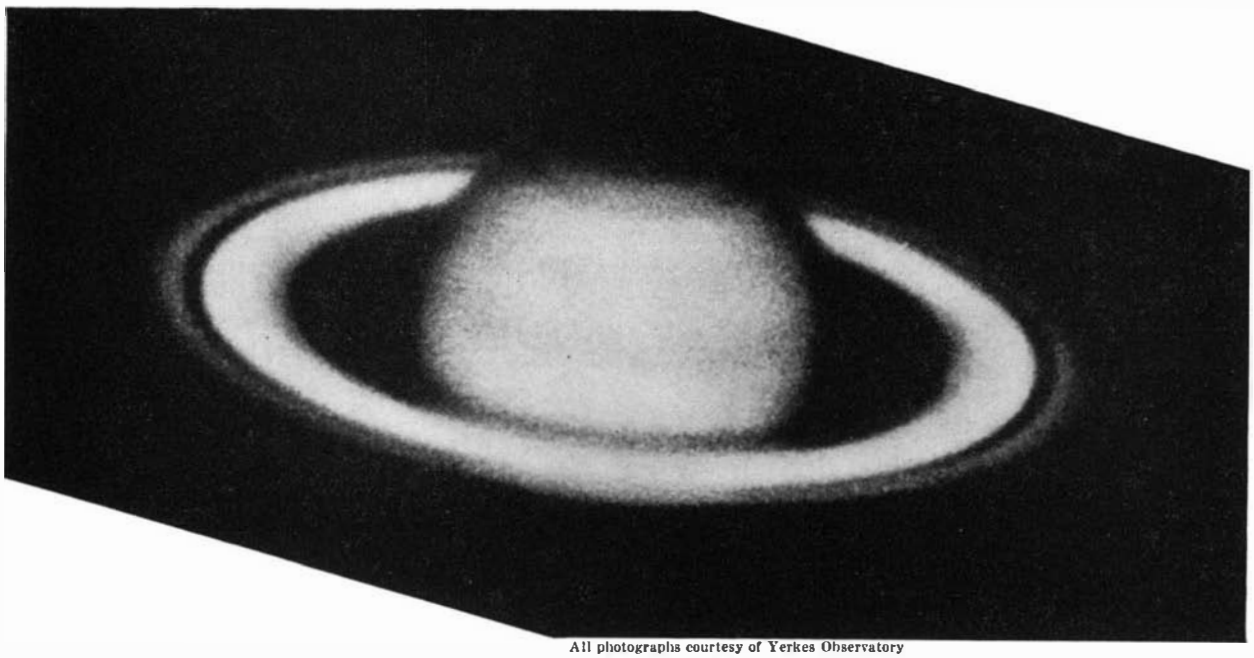
In an account of a night's observation, published in the *Amateur Astronomer*, official organ of the Amateur Astronomer's Association (New York), of which he is secretary, Mr. Kingsbury says: "I am sure you will be amazed to learn that the total count of meteors observed was 2586. The record for the largest individual total is 485, and the largest number seen in any one half hour period was 96. I don't remember how many fireballs we saw, but there must have been fifteen or twenty."



Courtesy *The Grace Log*

FORTY PERCENT COMPLETED BEFORE THE KEEL IS LAID

PERHAPS nothing is more indicative of the advance in the art of shipbuilding than the fact that months before the keel is laid, the parts of a new ship are formed and equipment built so that there will be no delay after the essential "backbone" is laid down. Craftsmen of the foundry, the plate and angle shop, the machine shop, lumber yard, and of numerous other nationally important industries are the unsung creators of the pre-formed 40 percent of the structure of the throbbing monsters of the ocean travel lanes. The photograph shows assembled bulkheads in position on a new Grace liner now being built for Panama mail service.



All photographs courtesy of Yerkes Observatory

Like all of the outer planets Saturn is not thought to be a likely place for life to exist, because it is altogether too cold for it

By HIRAM PERCY MAXIM

WHAT IS IT ALL ABOUT?

ONE of the questions that occasionally come to all of us is: What is this great scheme of nature all about? In thinking about it, we picture ourselves standing upon our little earth, peering out into surrounding space, marveling at the great central sun—speculating as to our brother and sister satellites of the sun—wondering about the distant fixed stars, their incredible distances and numbers—awed at the vastness of it all and at the perfect system and order that prevail—wondering what it possibly can signify.

What could have been the beginnings of such a stupendous mechanism? How is it going to end? Where does the phenomenon of life fit into the great picture? What is to be the future influence of intelligence on it all? We humans have been asking ourselves these and many other basic questions for centuries. Let us see how far we are able at present to go in answering some of them.

We have come to classify living organisms as the organic. We classify the rocks and minerals as inorganic. Looking out into space we find an inorganic universe, for we have never discovered a single bit of positive evidence of the organic in all our searchings through interstellar space. Here on earth it is entirely different. We see the earth literally teeming with all kinds of the organic, each example of which is able to reproduce its kind. One of these examples has developed, after thousands upon thousands of generations, an intelligence, something unique in the entire universe, at least as far as we have been able to find out. We humans are of course the ones which possess this intelligence, and possessing it we make use of it to reach out into space, and to wonder what is the explanation of all the things we notice.

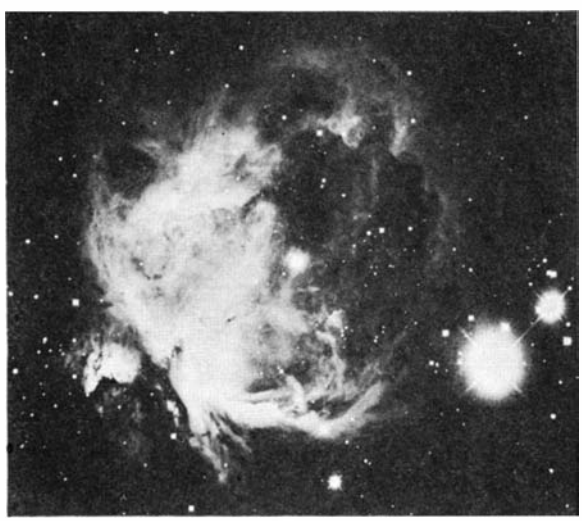
WE must realize that this intelligence of ours is something quite recently acquired. None of our thousands of fellow creatures on earth have any of it, at least in the sense that we are considering. But, notwithstanding the fact that we are able to build railroads and airplanes and telescopes, and understand many of the complex laws of nature, we probably are only at the dawn of things. We are prone to think we are well informed, but we are only just beginning to uncover nature's mechanisms. We do not yet know whether we are alone in the great cosmos. We have no idea at all whether in the whole domain of space—whether among all the billions of celestial bodies—this insignificant little earth of ours is the sole abode of an intelligence. We are like a little tribe of bushmen in the wilds of Africa, with no knowledge that there are any other human beings besides themselves in all the world.

Men have been asking themselves about these matters for centuries. As long ago as Ptolemy's time the latter was asked where man stood in the universe. Ptolemy's answer was, "At the center." Galileo, only 300 years ago, came to the conclusion that this answer could not be right. He believed it should be, "Man lives on one of the smaller bodies which revolve about a great central sun." Two centuries later scientists showed that Galileo was not wholly right in believing the sun was the real center. They believed that there were millions of suns, each surrounded by planets, and that life might be expected to exist upon some of them, just as life exists on at least one of the planets of our sun. Today's astronomer now modifies the answer again, to the effect that "life appears to be a great rarity in the cosmos, for we know of no type of astronomical body in which the conditions can be favorable to life, except planets like those surrounding our sun, and planets are rare." Sir James Jeans is the author of this answer.

From this we begin to see that in all probability we intelligent beings on earth are terribly alone and adrift in a transcendently vast ocean of time, space, and energy. The evidence is that we have been thus adrift for a very, very long time, as we measure time—far longer than we have been taught to believe by our forebears. When we wish to refer to long stretches of time we humans speak in terms of centuries, but our human standards are pitiably small ones. We must think in terms of mil-

lions of centuries when we consider astronomical time. For example, our earth has been revolving around the sun for some twenty millions of centuries. Geological records and radioactive deposits assure us of this. Man himself has been the upstanding creature we see him today for five thousand centuries.

The evidence indicates that the creature that eventually became man passed out of the ape stage about five hundred thousand years ago. Century after century passed, during which he was forced to develop an intelligence in order to feed himself and escape his enemies. On this basis, something like 4970 centuries had to pass before he had acquired a mentality that enabled him to suspect that he was adrift in space on some kind of satellite revolving around the sun. This was only 3000 years ago. It was only 440 years ago that a man named Columbus lived, who had quite a time of it making his fellow creatures believe that the earth was round. It was only 299 years ago that Galileo was cast into prison because he preached that the earth was not the center of the universe. Thus we see how recently this creature man has acquired his present fund of knowledge.



The Great Nebula in Orion, a "diffuse" nebula. These have nothing in common with spiral nebulae

THIS earth on which we find ourselves adrift as we awaken intellectually, accompanies its parent sun on some kind of journey through space of which we know almost nothing. Where we are going, and why, fills us with an immense wonder. Our parent sun is quite an average star. There is nothing at all unusual about it if we compare it with the 30,000 million stars which form a galaxy which we call the Milky Way. Thirty thousand millions of suns is a lot of suns, at least as we poor little earthians view numbers and regard suns. To be an inhabitant of one of nine planets of a single sun among this vast horde leads us to wonder whether we are as important as we thought we were.

But this is not the worst of it, as we found when we continued to develop new apparatus with which to explore the depths of space. The trouble began when one of us made the discovery of the "island universes," the spiral or extra-galactic nebulae. Up to that time we thought that our incredibly enormous Milky Way was the entire universe. While we were busy trying to readjust things, the news came from the big observatories that a large number of new galaxies had been photographed. Where was the thing to end?

The largest telescope we have today is the 100-inch reflector at Mount Wilson. It has disclosed the disconcerting fact that there are hundreds of thousands of galaxies, more or less like our Milky Way, and some astounding facts have also been discovered about the details of these "island universes." We are building a 200-inch telescope and we have reasons to believe that it will disclose that there are millions of galaxies. How far into the depths of space this manifestation of unthinkable numbers of stars goes fills us again with a great awe. This is what Einstein is trying to figure out at the present time. When one thinks about it he realizes that probably we of today know just about as much about cosmic geography as the early Egyptians knew about the geography of the earth.

As we look into these matters we behold ourselves just awakening to our surroundings. On the face of things we occupy a position of the most magnificent insignificance. We organic creatures appear to be living in a universe that takes almost no cognizance of life. We seem to be a sort of by-product. As will be shown later, this universe is not only indifferent to organic life, but seems actually hostile to it. If humility is good for our souls, then we should have extraordinary souls, for as we look out from our little speck of cosmic dust and realize the facts, we cannot but become superlatively humble.

What do we find about the beginnings of this earth of ours? This is a very important question, one that has been given much study. The evidence leads to the belief that all of the satellites of the sun were flung off from the latter when some great stranger star wandered in from outer space in the long ago. This huge wanderer must have passed close to the ancestral sun. The gravitational pull created such an enormous tide on the surface of the sun that stupendous masses of incandescent material were pulled out and flung off from the parent body. These masses followed natural laws and coalesced, became spherical in shape and gradually cooled down to the condition in which we see them today, the nine known satellites of the sun. We know with considerable exactness their diameters, densities, periods of rotation, orbits, temperatures, composition—and their names. Ascertaining their names was of course a most difficult determination.

It will help us judge the other evidence if we run through what we know about the other planets. Starting from the parent sun we find Mercury, which has been known from remote antiquity. It is very much smaller than our earth. It probably keeps the same face always toward the sun, so that it is eternally hot enough to melt lead on one side and eternally dark and intensely cold on the other side. Life might exist there in the border lands between killing heat and killing cold, but as yet we have no evidence at all of such life.

Venus is next. It is about the size of the earth. Its days and nights are probably several of our weeks long. Whether life and intelligence in any form reside there we have no idea, for we have never seen its actual surface. What we see is the top of its clouds.

Except in the polar regions of our earth, the temperatures run from 125 degrees to about 40 degrees below zero, Fahrenheit. We have an atmosphere and an unlimited amount of water. Man has evolved under these conditions, and he finds them generally very pleasant, for unless he abuses his privileges this old earth is a fine place in which to live.

NEXT beyond the earth comes Mars, which is smaller than the earth. Being farther from the sun it receives less heat. Its day is 24 hours, 37 minutes long. On its equator the temperature may rise to an average of 50 degrees in the day time. At night the temperature probably goes close to zero, Fahrenheit. A small amount of moisture appears to remain upon Mars, and the kind of life we know on earth could exist there. If vegetation of some sort lives there, as Lowell thought, then it can be argued that animal life must also exist.

The late Percival Lowell, whom I suspect may have had an abnormally acute vision, used to insist that the straight lines which he saw on the surface of Mars must be the work of intelligent beings. Straight great-circle lines are not the lines that nature would

make. We have not been able to photograph these lines, and by some their existence is questioned. The inability to photograph them, however, need not prove that they do not exist, since the limitations of astronomical photography are such that they would hardly show if actually present. Lowell was steadfast in insisting that the lines were there, and he believed the evidence was good that they were irrigation canals which brought water down from the melting snow at the poles. This water made vegetation possible, in his opinion, and it was this vegetation, extending back 20 or more miles on either side of a canal, that gave the difference in color that made a line visible from the earth.

This is all the evidence that we possess as to the existence of life anywhere else in the whole universe than on earth. It must be recognized that we have not been able to do very much searching of the universe for living substance, because if life and intelligence of a high order were present elsewhere than on our earth, we should not be able to communicate with it because of our own backward state. An intelligence located in outer space could, indeed, have been sending out signals for centuries, yet we would have been too backward to detect them. The only means of interstellar communication of which we have any knowledge is radio, and as that has only just appeared on earth it is in a very primitive state.

Next beyond Mars are the asteroids, the largest of these being Ceres which is about 480 miles in diameter. We have found four other asteroids of comparable size, each about 100 miles in diameter. There are countless smaller ones.

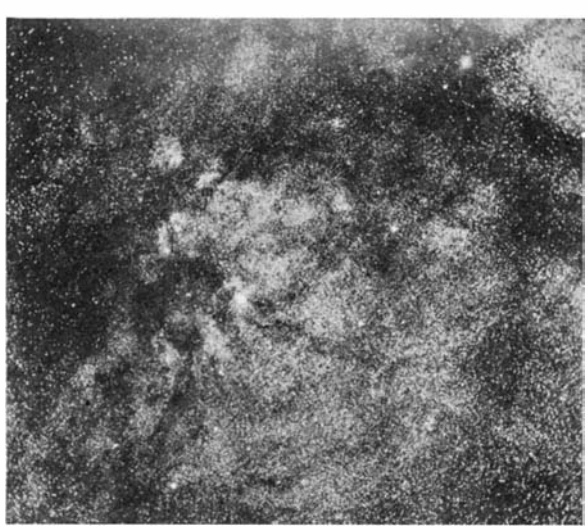
NEXT beyond the asteroids comes Jupiter, the largest of all the sun's children. Jupiter is 11 times the diameter of the earth, and 1400 bodies the size of the earth could be packed into the space occupied by it, with plenty of room to spare. Jupiter's density is only one and one-third times that of water. Its year is almost 12 of our years. The temperature on the part which is visible is probably about 250 degrees below zero, Fahrenheit. If an intelligence exists there it must be built into a different kind of physical body than we know anything about. We know very little about Jupiter beneath the dense banks of clouds we see.

Next comes Saturn, the planet with the unique ring. Its density is less than that of water. Its year is 29½ of our years. It has nine moons and a remarkable ring which puzzled us earthians for a long time. We now have deduced that it must consist of countless small stones, pebbles, and grains. We know very little about conditions on the surface of Saturn. It is perpetually cloudy, so we have never seen the surface. The temperature on the surface of the planet, if there is a real surface, must be around 300 degrees below zero, Fahrenheit, owing to the great distance from the sun.

Next comes Uranus. He is four times larger than our earth. His density is so much less than that of water that we suspect that he is some kind of gas. His year is about 84 of our years. Uranus is a long, long way out from the sun and consequently receives only a fraction of the heat that we do. The temperature must be away down in the hundreds of degrees below zero, Fahrenheit, and if beings live there we are very sorry for them.

NEXT comes Neptune, 30 times as far out in space from the sun as we are. The sun is 30 times smaller to an observer on Neptune than it is to us earthians. The temperature must be near absolute zero, 400 degrees or more below the Fahrenheit zero. We cannot imagine life existing in such a place.

We thought that Neptune was the outer member of the family until a few months ago, but we now find that we have another member, Pluto, who roams away out in cold space even beyond Neptune. We know almost nothing about him, as yet, beyond the fact that he is small and probably a thoroughly dead and frozen world.



A small section of the Milky Way, which is probably our spiral nebula, with billions of suns

This ends our family, which we call the solar system. These are the nearest bodies to us in space. From what we have reviewed of our knowledge concerning them we are led to infer that only in a very narrow zone can a kind of life exist that we are able to imagine. Those satellites of a star that are too near it are too hot, and those that are too far away are too cold for life.

The matter of communication across interstellar space becomes of interest at this point. Radio waves represent our first tool with which it may prove possible to carry a signal across the great reaches of astronomical space. If among the billions of stars there are some which have a family of satellites such as our own sun has, then it is reasonable to expect that some of these satellites would be in a zone of temperatures where life could exist. If life does exist somewhere else, and it is reasonable to expect that it does, then some day someone is likely to encounter, by means of radio, an extra-terrestrial intelligence. What a sublimely dramatic moment it will be for those concerned when this first interstellar contact is made! Will it not dwarf every other dramatic incident that ever happened upon this earth? How will a language be worked out? When a rudimentary language has been agreed upon, think of asking this extra-terrestrial intelligent being what sort of creature he, she, or it, is. Comparisons will be out of the question, as it would mean nothing to the other party to ask him whether he looks like a man or a crab or a chestnut burr. And think of asking "it" where "it" resides! On what celestial body is "it" located? And what if "it" were to turn out to be an intelligent insect sort of thing, or an intellectual vegetable. It might easily be. For illustration, we are what we are physically purely because of fortuitous environment in the dim past.

THERE are factors which have to do with interstellar communication which must not be overlooked. Were it to be our next door neighbor Mars with whom we were to make contact, it would take about two minutes for the signal to travel across the intervening distance between earth and Mars. Radio waves are a kind of light, and the velocity of light is 186,000 miles per second. Mars is very close by, astronomically speaking. However, were our communicant to be an intelligent being located on one of the planets of one of the stars of the Hercules Cluster, for example, it would take the radio wave 40,000 years to cross the space between the earth and that planet. Likewise, it would take another 40,000 years for the signal from the planet in Hercules to come back—that is, 80,000 years for a message to go to Hercules and for the answer to get back to earth! This may cramp the style of those who in future centuries endeavor to carry on a correspondence with somebody in Hercules. The service will be poor.

This point is elaborated in order to emphasize the sublime distances we become concerned with when we get into astronomical matters. Before we become involved and confused by such inconceivable distances, let us look at some of the things that are nearer home.

The celestial cataclysm which caused the birth of the family of planets of which our earth is one seems to have occurred about 2000 millions, possibly 4000 millions, of years ago. It required all the intervening time between this time and 1500 millions of years ago for

How the moon originated is unknown; some think from the earth

conditions to come about which would permit life to appear. This first bit of life probably was a very simple protoplasmic cell. It is thought of as the simplest living organism. Whether it was originated on earth, or whether it crossed interstellar space to reach earth, we are not sure. Some maintain that it originated here from a combination of chemical reactions. Scientific men have worked at it for years, but they have never been able to repeat this combination. In other words, we cannot seem to create life. If life were carried here from some other heavenly body—and this might be possible since we receive daily many tons of cosmic matter—then it would follow that life exists elsewhere in the universe. Certain forms of life, such as seeds, are able to withstand extremely cold temperatures, and germinate when returned to favorable conditions of temperature and moisture. This lends credibility to the cosmic origin of life.

WHATEVER its origin, which is almost wholly a matter of speculation, we know that life exists in a microscopic bit of transparent, gelatin-like material. It is a thoroughly unimpressive speck of matter. It contains no hint of its tremendous potentialities. Yet its potentialities are tremendous, for a similar mite probably was your and my ancestor. Viewed in some ways this is unfortunate, because some of us are very proud of our ancestry. To have sprung from a lowly origin is something that some of us are prone to gloss over. Old families are also very proud of the fact that they are old. This again is a matter that does not bear too much investigation, for there are any number of beetles, lizards, and crawling things whose immediate family is many times older than ours.

The most primitive and simple life cell is composed of oxygen, nitrogen, hydrogen, and carbon. There is nothing else in it, because the total weight of all of these elements equals the weight of the cell. The difficulty comes when we realize that those cells have the amazing power of spontaneous motion, assimilation, and reproduction. No combination of these chemical elements that we have been able to make has these spontaneous powers. The great question is, why not? It appears to be another rule of this mysterious game that living organisms are so adjusted, or something is so adjusted, that they are enabled to make themselves suit their environment. The offspring always are slightly different from the parents, and when these differences do not fit in with the environment that the cells happen to find themselves in, the cells die. But some of the cells have differences that suit the environment. These cells survive, and produce their offspring, which possess still other differences, and we have what Darwin called natural selection. This is one theory of the cause or method of evolution.

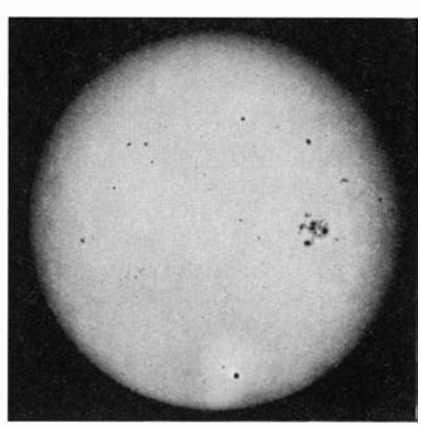
IT looks as if the first living cell appeared here on earth some 1500 millions of years ago. So far we have not decided how it got here, but it did get here, and you and I are the proof. It took, on this basis, 1499½ millions of years for evolution to develop from the first protoplasm a creature that we can call man. This means that man appeared only some five hundred thousand years ago. That is very recent. He evolved from an ape-like creature, so the evidence indicates, gradually assuming the erect posture on account of being left by climatic changes in an open country where there were few trees, and where he was compelled to depend upon his fleetness and his wits to escape being eaten by his enemies, and for his own food supply.

When he came down out of the trees this creature, who eventually was to become man, was a pretty rough specimen. I suspect that he was very hairy and that his table manners were not quite what we should like to have in one of our ancestors. But he had the makings of a real man in him. It took about 497,000 years for him to learn in the school of adversity that he must discard superstition, and accept only ascertained fact. It was only 3000 years ago that man reached the stage of intellectual development where he began to suspect that the earth revolved around the sun, instead of the sun and everything else revolving around the earth. It required another 2700 years to develop a man who could invent and build a telescope. This was Galileo, who lived only 300 years ago, and it required until two years ago for us to discover that there was a ninth planet in our own solar system.

So it becomes quite evident that we proud rulers of the earth, with all our big cities and our railroads and other accomplishments, are only just emerging from animalism. Since the first of us came down out of the trees, until today, only six one-hundredths of one percent of the time have we had telescopes, knives and forks, and any real knowledge of what we are looking at when we gaze into the sky at night. We human beings have only just awakened, intellectually. We are at the threshold of things. Thus it is that we know so little about life and whether or not it exists anywhere else in the great cosmos than on our earth.

WE who live today will be regarded by our descendants of a million years hence as creatures who groped about in the darkness before dawn, in the misty gloom of the morning of understanding, when ignorance, superstition, and animal instinct combated attempts to understand nature's truths.

There is no better way to illustrate how little we know than to point to



The sun is simply the nearest star, one of many millions in our galaxy

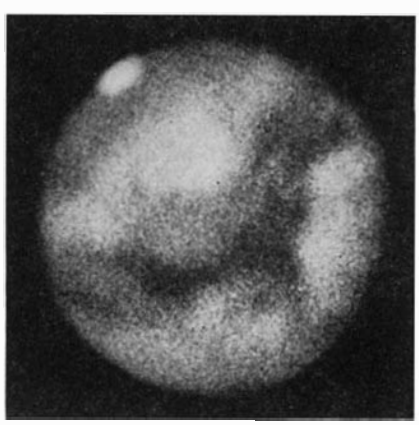
recent astronomical photographs. A few of these are reproduced with this article. These pictures are profoundly impressive. They show many things about which we know nothing. They fill us with a great awe. No eye, even when assisted by the most powerful telescope, may see what most of these photographs disclose, for the eye is not cumulative in its action. The photographic plate is cumulative. Many of these celestial pictures are the results of several hours' exposure, while the eye

can see no more after five hours than after five seconds. But the photographic plate accumulates the light and an object utterly below visibility to the eye may, after several hours, create a very distinct effect in the sensitive emulsion of a photographic plate. Thus it is that an area of space, which is vacant to the eye, is found to be filled with all manner of strange and wonderful things.[1]

It will be observed that in one of the photographs there are large and small dark areas. It seems likely that these dark areas are not "holes" through which we look out into empty space, but instead are enormous clouds of some sort of opaque matter. We are able to examine only objects which radiate or reflect light. Since this opaque material offers us no way to investigate its nature we can only surmise what it is. Some day we may unravel the mystery.

It is inspiring to realize that the light that effected the chemical change in the silver salts of the plates from which these photographs were printed actually crossed the great, mysterious interstellar space, a place that we shall never visit. In the case of the more remote extra-galactic nebulae this light started on its journey long before a creature that could be called a man appeared upon earth, and during all the vast stretches of time that it took to develop a civilization out of a herd of animals, this light has been traveling at a velocity of 186,000 miles per second. Sublimely great, indeed, must be the distance.

In a number of years we shall have



The best photographs of Mars do not equal our visual observations

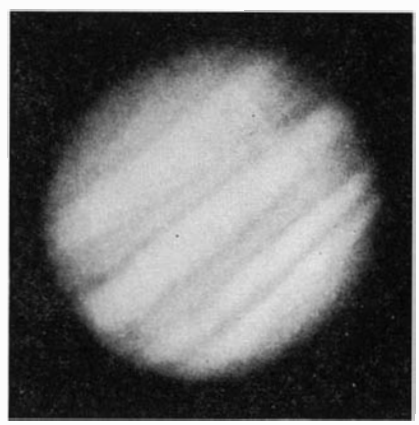
the new 200-inch telescope. This telescope will carry us three times farther into the depths of space than human investigations have penetrated. A celestial domain 30 times the volume of what we know today will be opened to us. Supplemented by the work of our mathematicians, of whom Einstein is the outstanding figure, the observations that will be made will advance our knowledge of cosmic geography more than Columbus advanced our knowledge of terrestrial geography by his discovery of America in 1492.

TO complete our picture, let us glance at what we may estimate as the probable time that human life may be expected to endure on the surface of the earth. It depends upon our sun. The sun must continue to supply us with that very exact amount of radiation which will not run temperatures above 150 degrees Fahrenheit, nor below 100 degrees below zero. This is a range of only 250 degrees. When we realize that we can see billions of examples of temperatures as high as millions of degrees, and other examples of temperatures several hundred degrees below zero, we become conscious of the fact that our existence hangs upon the very slender thread of a maximum variation of only 250 degrees Fahrenheit.

But temperatures on earth have been relatively steady for many millions of years and the chances are that they will continue to be so for more millions. As we have seen, the age of life on earth is about 1500 million years. The radiation from the sun is at the expense of its mass. No less than 360,000 million tons of matter is destroyed every day in order to maintain the present radiation of the sun. Poor old Sol weighs 360,000 million tons less today than he weighed at this time yesterday! By our human standards this prodigal expenditure cannot keep up for very long, but our human standards are not astronomical standards. Computation shows that the sun is not very much different today than it was when the planets were born. The weight of the sun is so inconceivably great that in order to show any material change in weight or radiation we must go back, not 2000 million years, but five million million years. The sun weighed about twice as much then as it does now, and was correspondingly brighter and hotter.

NOW let us look in the other direction. The sun is unquestionably a dying star. It loses some of its weight every year, and this means a loss of gravitational pull and a loss of radiation intensity. In other words, we may expect the earth to draw gradually farther away from the sun, and we may also expect the sun gradually to cool off as millions of years roll around. This means one thing only—death by cold. Just as sure as we can be of anything, are we sure that life will eventually be frozen off the earth. Temperatures need drop only 100 degrees below where they are now in order to kill a great many of us. Some probably would survive, and of these some of their ultimate offspring would have characteristics favorable to very cold weather. If time enough elapsed men and women would evolve into Eskimo types. Even this ignores the question of our food supply, which would be affected much earlier. In any case, in the end even these descendents of ours must perish.

This is a gloomy outlook. It has one consolation, and that is that it will be



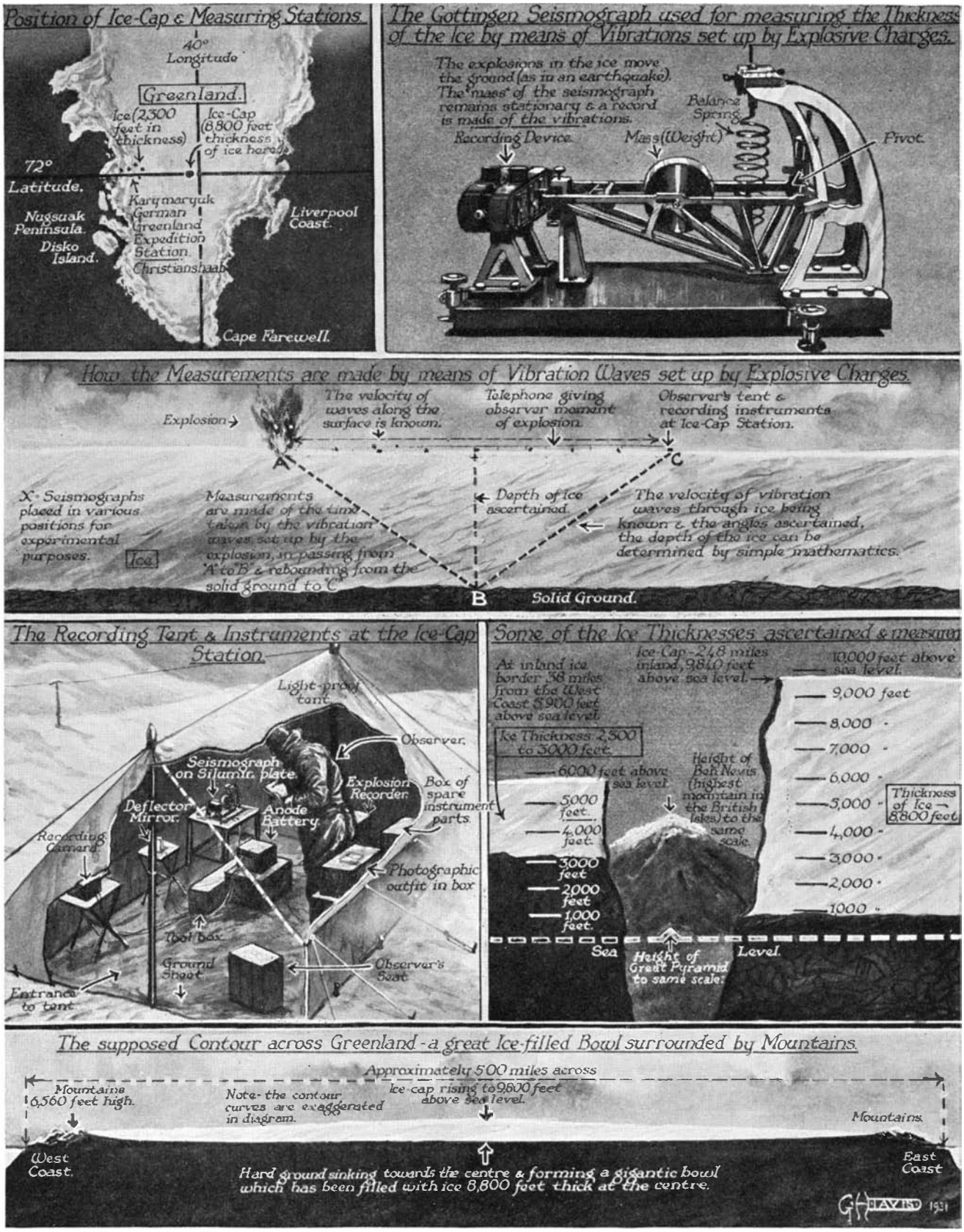
Jupiter's actual surface is probably concealed by banded clouds

a long time before all this happens. It works out to be something of the order of a million million years. As we have been here only half of one million, it becomes evident that things have just begun, and that there is a long time ahead in which to build and plan and enjoy.

What sort of beings shall we be even one million years hence? If we go on advancing in accumulated knowledge as we have advanced since the time of Columbus, our future condition will be impossible to imagine. This leads us to the next and last question. If no accident happens, and if human beings go on developing and advancing in knowledge ever faster and faster, what is to be the influence of intelligence on the cosmos? Is it possible that intelligence is the big aim and object of creation? Will intelligence dominate the universe ultimately, controlling the orbits of celestial bodies and directing evolution?

WE are inhabitants of the universe and as we gaze into the sky on a clear night we are filled with a great feeling of reverence, for we realize that we are looking at the Great Machine in operation. We see ourselves standing upon our little insignificant speck of cosmic dust, awed and inspired at the great picture, conscious of our own unimportance, understanding our probable beginnings, realizing our inevitable end, and wondering and wondering what it is all about.

[1] In the case of the planets it is just the reverse—the eye, in the brief occasional snatches of a fraction of a second at a time during which atmospheric refraction permits undistorted seeing, glimpses details which are actually blurred in photographs because of this very same cumulative effect, the distorted images as well as the others overlapping on the plate. The subject is too involved to explain here. It would demand an article in itself.—*The Editor.*



Courtesy *The Illustrated London News*

MAN-MADE EARTHQUAKES PLUMB DEPTHS OF GREENLAND'S ICE

BY the use of one of the geophysical methods of prospecting for large bodies of ore, a German expedition has sounded the depths of Greenland's ice. As a result of their work, it appears that Greenland is a gigantic bowl filled with ice and surrounded by high mountains. In the seismic method used by the Germans, soundings are made by detonating an explosive charge in a hole in the ice at a measured distance from an observer's station. By telephone, the observer is given the exact moment of the explosion. The explosion waves strike solid earth beneath the ice and are reflected to the observer's instruments. Knowing the speed of such vibrations through ice and the actual lapse of time between the moment of the explosion and the receipt of the reflected waves the depth of the ice may be calculated.

OUR POINT OF VIEW

War Declarations

WITH one world power "passively" protecting its investments and its nationals in its nearest neighbor country, and many other parts of the world seething and ready to flare up at a moment's notice, Alanson B. Houghton, our former Ambassador to Great Britain, treads dangerous ground in stating that the right to declare war should be vested in the people of a democratic state rather than in their elected executives. The argument for this is that those who govern us are elected on domestic issues and their judgement may not be at all representative of the people's will when confronted with a situation involving war or peace. They can declare war, the argument continues, but they can not suddenly declare an armistice; and once war is declared, the people have to see it through although the majority may favor peace.

There is commendable idealism in this argument but, with due respect to Mr. Houghton, it is believed that he looks too far into the future. Man has thoroughly proved his ineptitude in governmental affairs; and if his elected representatives may not be counted on to decide wisely in a question of war, how much chance has he to do so! Given the opportunity to vote for peace or war, the individual *will* perhaps have time to think over the question calmly, but the chances are that he will listen to jingoists, politicians, pacifists, parlor pinks, reds, and other detestable propagandists until he's in a hopeless muddle. Furthermore, elections take time while war crises develop overnight, and an aggressor nation might launch such an offensive that the hesitant one would have no need for an election; it might be conquered and occupied by the enemy long before all the soap box propagandists have finished their varied exhortations. Give us peace but not peace at any price.

Another False Alarm

WITHIN the past year or two there has been a vast amount of comment in the press and from the pulpit concerning the new rapprochement of religion and science. To all appearances there has been a veritable love feast between these two, which were previously more or less at war. Many have said, "See, I told you it would happen; the scientists are at last coming around to our position with regard to the question. They now admit that the universe is not run merely on a cold cause-and-effect basis. They must now admit that man, the most important thing in it, has free will."

What started all this?

Something very small, when the amount of notice given it is considered. The brilliant German physicist Heisenberg discovered a short time ago that it was utterly impossible to determine both the position and the speed of a given electron. This has become the "principle of indeterminacy," and it has been construed to mean that, as Sir James Jeans puts it, "nature abhors accuracy and precision above all things." Not only Jeans but A. H. Compton and Millikan and Eddington and others of great fame—men who have a "big public"—have given encouragement to this idea and the clergy have not been slow to seize hold of their encouragement. It would mean—this principle newly discovered—that there was, after all, no required order in the events of the universe, since the tangible universe is made up of electrons. It would mean the end of the old cause and effect principle, so dearly beloved of the hated materialists—if it were thus construed.

But is it so? Many physicists seriously question this. What they question, to be exact, is not Heisenberg's principle of indeterminacy, but the interpretation that has been given it—and hence the inferences concerning religion and free will to be made from that interpretation. All the principle of indeterminacy means is that man has no way of determining both the position and speed of a given electron, not that there is no determinacy in each. In other words, these fundamental facts are indetermin*able* but not indetermin*ate*.

It makes a lot of difference.

Pessimism or Prosperity

IT would seem that we have become a nation of cowards. Our pessimism seems to have beclouded our vision and dulled our reason. Businesses become more fearful for their continued existence, retrench, cut salaries, lay off employees. Seeing these things, those fortunate ones with work, retrench, cut expenditures, wear worn-out clothes, drive rattly old cars, do without necessities. Demand is lowered and production decreases further. Companies retrench further, lay off more employees. Thus are forged the links of a chain of fear that is binding us down. Like Sisyphus rolling his stone uphill only to have it roll down again, businesses and individuals retrench in the effort to assure their economic security only to find that they have lessened the economic security of the country at large.

Banks that are solvent close their doors because of their depositors' fears. For fear of such bank "failures," people hoard their money, keep it in some hiding place about their homes. Government figures show that hoarded currency totals something over a billion and a quarter dollars, that sum being the amount outstanding which is not in active circulation in the regular channels of trade. At the same time, savings banks show a larger total of deposits than ever before in the history of the country. Most of this deposited money is at work but much of it is not; an amazingly large percentage lies in the vaults and is simply hoarded cash, because banks are lending so little. The assets of several banks of which we recently heard are over 90 percent liquid! Whether or not fear put any of this hoarded money in these banks, fear certainly keeps it there.

With the initiation of the American Legion's campaign, in February, to coax business and industry to make 1,000,000 jobs for the jobless, a bright ray of hope for the near future shines through the murk of fear and pessimism. Thousands of Legionnaires will, during this campaign, endeavor to obtain the pledges of 1,000,000 employers each to take on at least one additional employee. With the present hopeful signs of better business in the offing, and with the Administration's several plans to alleviate existing sorry conditions working parallel to it, the Legion's plan is a glorious portent of better days soon to come!

We join the country's leaders in urging the unqualified co-operation of each and every one in the splendid campaign of this great non-political, patriotic organization. You employers: Take on at least one more employee. You manufacturers and business men and bankers: Put your idle money to work. You individuals: Get out your hoarded currency and put it into a safe institution where it will add to the credit structure of the country, or invest it in some sound security such as government bonds. That hoarded billion and a quarter dollars, if properly circulated, would form the basis of more than 10 billions of dollars of credit!

A striking view of our two great aircraft carriers, the U. S. S. *Saratoga* and the U. S. S. *Lexington,* and of our floating airship dock, the U. S. S. *Patoka,* during maneuvers near Panama, from the U. S. S. *Los Angeles*

AIRCRAFT AND NAVY TREATY STRENGTH*

By CHARLES L. LAWRANCE
President, Aeronautical Chamber of Commerce of America, Inc.

COMMAND of the air, so essential to the successful prosecution of a military campaign, is of equal importance in naval warfare.

From the beginnings of aviation, naval officers have watched and aided the development of aviation. Unwilling to concede what was yet undemonstrated, they have consistently tried to appraise aviation at its true and practical value in sea warfare and have, step by step, added to the air arm of the fleet.

At first it was demonstrated that aircraft were of value only in controlling gunfire and scouting. Then it was demonstrated that they can be used to deliver major attacks with torpedoes and bombs, to protect surface vessels from enemy aircraft, and to perform a myriad of other services closely paralleling the functions of the various arms of the fleet. It now appears that probably nothing else has increased the striking power of navies to such an extent as the development of naval aviation. The fleet without aircraft in large numbers will find itself seriously handicapped in future engagements. Many concede that the fleet which is victorious in the future will be the one that is superior in air power.

*Through the courtesy of *U. S. Air Services.*

The United States has never been the aggressor in past wars. As a nation we are not interested in the conquest of other lands, only in the protection of our own territory. As has often been said, however, the best defense is an offense. We must have a fleet powerful enough to assume the offensive immediately upon the outbreak of hostilities. For that purpose we must have aircraft in sufficient numbers to take command of the air in the various theaters of the war. This means that our naval air forces must be large enough to defeat, not only the craft of an opposing fleet, but enemy aircraft that may be sent out from shore bases.

AVIATION has been growing in importance ever since the World War. Should another war occur, which is always a possibility, we will need aircraft of the most advanced military types in great numbers, and we must depend upon the aircraft industry for replacement and expansion without delay. The revenue obtained from the sales of commercial craft to transport lines, aerial service operators, private individuals, and industrial concerns is not sufficient at present to support the aircraft industry that we have in this country today, yet maintenance of this industry is essential to national defense. Without it we would find ourselves in a hopeless position in the event of a national emergency. The industry needs further support, in the shape of a continuing procurement program, from the Government services; in fact, its very existence will depend for a number of years to come largely upon the support it receives from the military departments.

I have pointed out elsewhere the fact that the Army could use more planes to advantage. So can the Navy. Like the Army Air Corps, the aviation branch of the Navy may be said to be as efficient for its size as any similar organization in the world; but it is far from being large enough to assume and maintain the command of the air so necessary in time of war. We need more planes, more pilots to fly them, and more surface vessels to transport them to the scene of operations. So far no limitation has been placed on the number of naval aircraft a nation may possess, and I believe that if we are wise we will seize the opportunity while it exists of building up our air strength.

Our battleships and cruisers now in commission are well supplied with heavier-than-air craft. The five-year construction program, entered into by the

Navy in 1926 providing for 1000 airplanes and completed one year ahead of schedule, has made it possible for war vessels equipped with catapults to carry from two to four observation and fighting planes, the latter to protect the former. But it is now found that the 1000 useful airplanes provided for in the procurement program are not sufficient to go around after furnishing craft needed by the training station at Pensacola, the United States Naval Academy, and two new cruisers.

A fighting airplane gliding in for a landing on the old experimental aircraft carrier, the U. S. S. *Langley*

WITH regard to personnel, the Navy on June 30, 1931 had 737 qualified naval aviators, 330 enlisted pilots, 3136 enlisted men holding aviation ratings, and 9503 enlisted men on aviation duty. The Marine Corps has 98 naval aviators, 33 aviation pilots, and a ground force proportional in size. It is apparent that more pilots are needed, and this situation is being rectified as rapidly as possible. An aviation construction course has been included in the Naval Academy curriculum, and indoctrinal flight courses are given all ensigns, at either Hampton Roads or San Diego, shortly after they receive their commissions. In addition, the two years' sea duty formerly required is being waived in the case of Academy graduates desiring to enter aviation. The latter is a concession of great value in strengthening our air defenses.

Classes of 15 students each are commencing flight training at Pensacola every month with the exception of the months of June and December. Included in these classes are a number of reserve student aviators, who are sent to sea for one year upon graduation. The Navy Department has recognized the value of a large and active reserve, and is attempting to build up this branch of the service. To maintain the efficiency of the reserve pilots, 13 naval reserve aviation bases and two marine reserve aviation bases have been established throughout the country where the reserve aviators may obtain "flight time" in both training and service type planes.

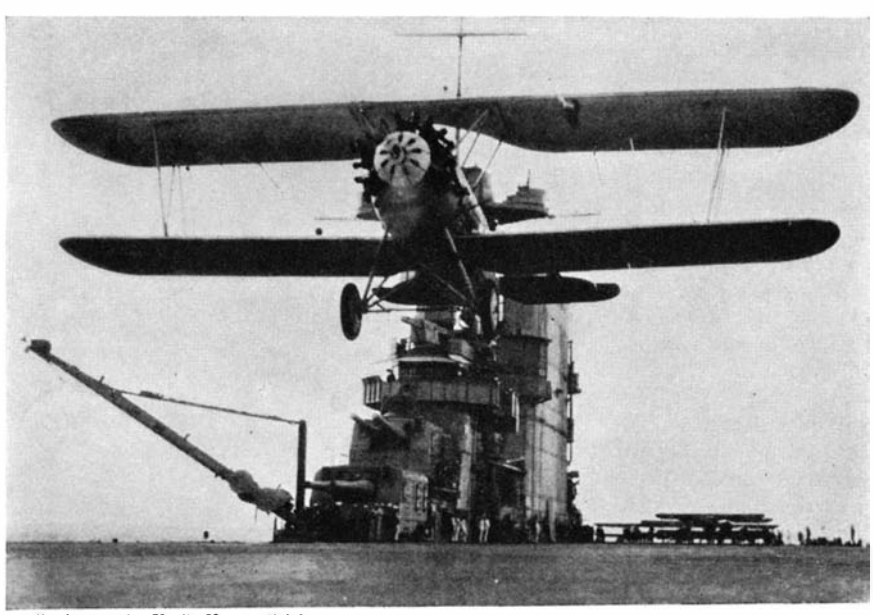
Naval aviation has taken tremendous strides since the inauguration of the five-year construction program. There is no question about it. The efficiency of the personnel and equipment, as well as methods of handling aircraft at sea, have been improved materially. This is illustrated by the safety record, which has shown a continued improvement, in spite of the fact that Navy planes are now operating with the fleet day and night and in as severe weather as the surface vessels can withstand.

Records of the Navy Department show that there were 168 planes assigned to the fleet aircraft squadrons in 1926. There are now 416. The number of hours flown annually has increased from 63,000 to 272,455; the number of hours per plane from 74 to 193; and the hours per fatality from 3100 to 10,090.95. No fatalities have resulted from catapult shots, and only one fatal accident on the carriers, due to landing operations, has occurred, although a total of approximately 30,000 landings have been made.

The maximum number of planes that can be handled efficiently aboard vessels comprising our present fleet, Navy officials testify, has just about been reached. Provision must be made for aircraft to equip our authorized ships concurrently with the construction of such vessels, and we must have more planes if our naval forces are to achieve the superiority of the air necessary for success at sea. It is obvious that ships to carry additional planes are needed, and that these should be ships designed for the purpose—aircraft carriers and flight deck cruisers—as recommended by David S. Ingalls, Assistant Secretary of the Navy for Aeronautics.

Under the arms limitation treaties, both the United States and Great Britain may build 135,000 tons of aircraft carriers. Great Britain now has six of these ships, totaling 115,350 tons. We have three with a total tonnage considerably less than that of Great Britain. The joker, it is explained, lies in the fact that the *Langley*, the old collier *Jupiter* which was converted into an experimental aircraft carrier in 1922, is the only one of our three carriers that can be replaced, while four of the British ships are classed as experimental. Great Britain actually has used but 45,000 of the 135,000 tons allotted to her. We have used 66,000 tons in the *Lexington* and *Saratoga*, and although these ships have greater striking power than any others afloat, they are far from being all that could be desired in the way of aircraft carriers.

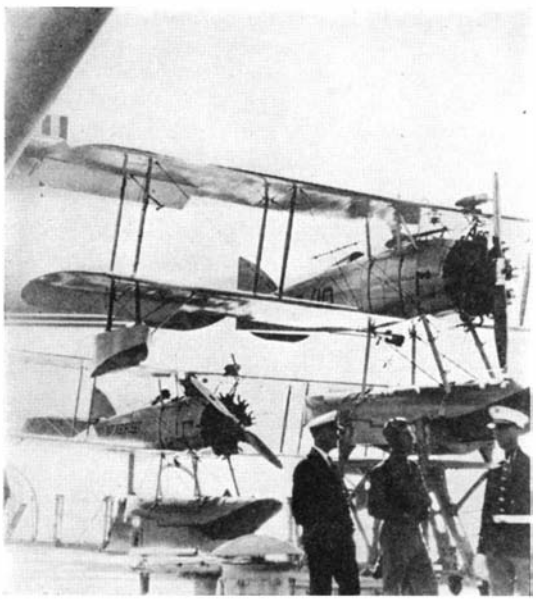
This fact was forcibly illustrated in



All photographs U. S. Navy, official

A Boeing fighter takes off from the *Lexington*. In the background are other planes being made ready to take off, and the bridge, gun turrets, and stack

the war games held off the Panama Canal last year. The problem was one of scouting. The *Lexington*, escorted by half a dozen cruisers, was ordered to determine the location of the *Saratoga*,



Seaplanes aboard a battleship. Here space is at a premium but the seaplanes earn their keep

which likewise had six cruisers for protection and had been ordered to seek the whereabouts of her sister ship. A cruiser of the *Saratoga* brood discovered one of the *Lexington* group. The commander-in-chief aboard the carrier was notified; 70 planes took off; and the *Lexington* theoretically was destroyed before she could launch a single airplane.

Each of these carriers is 888 feet long, has a beam of 105 feet, and is capable of steaming 33½ miles an hour. The large flight decks and the high speeds these vessels possess naturally are advantageous to the operation of aircraft, but it now appears that the ships are too large, too vulnerable to be employed on scouting missions, one of their most important jobs. Destruction of either the *Lexington* or *Saratoga*, designed to carry 80 planes each, would mean the reduction of our complement of torpedo, bombing, and fighting planes by exactly one half. As a consequence, the sole function of these ships in time of war probably will be to bring combat planes within striking distance of the enemy, launch them, and then retire a safe distance to the rear.

It is well known that it was only with great difficulty that the United States was able to prevent a reduction in carrier tonnage at the London Arms Limitation Conference. Certain powers sought to reduce it to 100,000 tons, arguing that the 135,000-ton limit was excessively high as evidenced by the fact that we had not built up to it. Having two ships with a total displacement of 66,000 tons, such a reduction would place us in a position of permanent inferiority. In this connection, it should be remembered that Great Britain has about 50 merchant ships which could be transformed into satisfactory aircraft carriers. This country has about 14 such vessels.

A study of the various disarmament conferences reveals the fact that the nations obtaining the concessions have been those with the greatest number of ships built or building. At the first conference, held in Washington in 1922, the United States obtained nearly everything that was asked, because the fleet then in course of construction would have been the most powerful in the world. In subsequent conferences, Uncle Sam has very nearly "lost his shirt." He has had no more ships to scrap, nothing with which to back up his arguments.

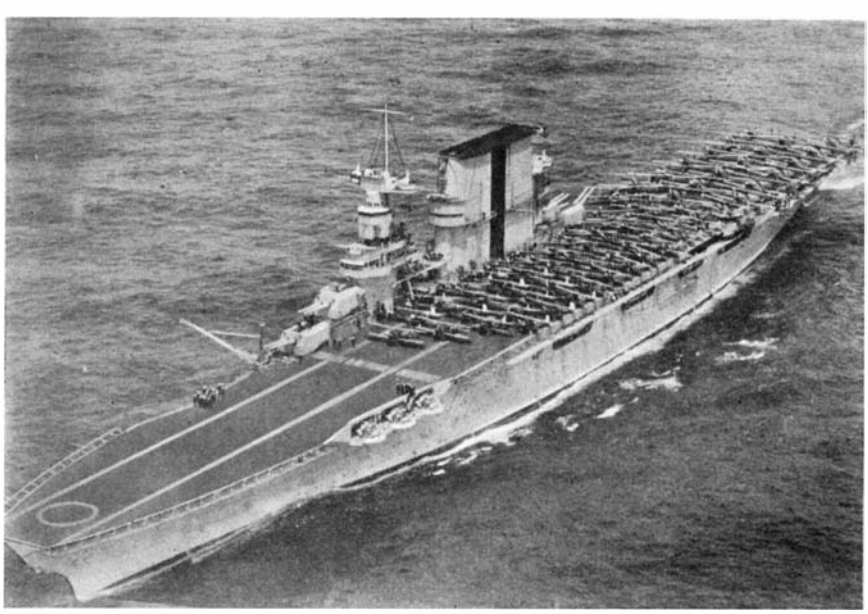
Naval students tell us that we must build up to the tonnage limit for aircraft carriers to forestall a reduction in this category when the next disarmament conference under the London Treaty meets in the spring of 1935, and this is undeniably true. The issue may even be forced at the conference called this year by the Preparatory Commission on Disarmament of the League of Nations. We may also expect a reduction in the percentage of cruisers that may be fitted with flight decks. All the weight this nation could bring to bear was necessary to force an agreement that 25 percent, 80,750 tons, of the total cruiser tonnage, might be of the flight deck type. I believe it is of vital importance to national defense that no further reductions be made in these categories.

As a result of its experience with the *Saratoga*, *Lexington*, and *Langley*, the Navy Department has reached a decision that the most efficient carrier is one of 13,800 tons. The *Ranger*, the first carrier of this size to be constructed by the United States, probably will be delivered in 1934. Navy officials have recommended the construction of four more vessels of the same displacement to fill the remaining 55,200 tons of carriers allotted to us under the treaties, thus providing the country with a total of seven useful carriers. We have been shown time and again that a paper navy means nothing. Construction work on these ships should be started without delay.

THE London treaty permits the United States to have 180,000 tons of eight-inch and 143,000 tons of six-inch gun cruisers. The smaller vessels, it is generally agreed, are not particularly suited to our requirements. That is, the ordinary six-inch gun cruiser is not. Both the cruising radius and gun power are said to be small. Equip these vessels with landing platforms and a number of planes, though, and the story is entirely different.

The small flight deck cruiser can accommodate from 20 to 30 aircraft, each of which can carry a 500-pound bomb. With this armament it should be possible for the light platform cruiser to defeat a number of cruisers of the same tonnage, or a group of destroyers, not equipped with aircraft. At the same time, the flight deck cruiser should run little risk of being destroyed, since it can remain out of range of the enemy guns, allowing its aircraft to conduct

(*Please turn to page* 251)



The *Lexington* underway during a review by the President. Dozens of planes are lined up and waiting to take the air one after the other in rapid succession

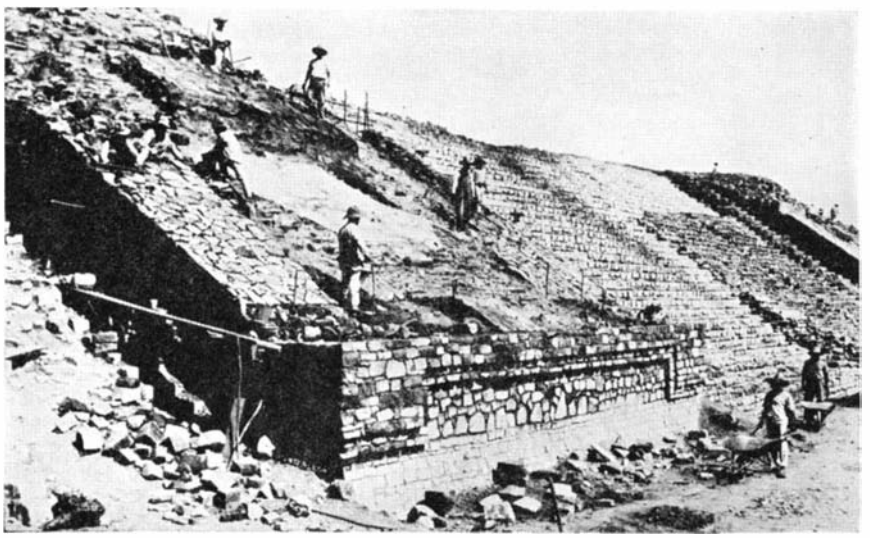
FROM THE ARCHEOLOGIST'S NOTE BOOK

A Mexican Treasure Trove

THE most extraordinary archeological treasure ever discovered in the American continent was unearthed in an ancient fortressed city on Monte Alban, high above Oaxaca, Mexico. The work of excavation has been carried on secretly by Alfonso X. Caso, the Mexican archeologist. Hunt for the treasure was financed in part by the late Dwight W. Morrow. So cleverly was the treasure concealed that it was overlooked by Cortes and his conquistadors 400 years ago.

Mask covered with turquoises; from the skull of a Mixtec warrior

Several tombs have been excavated. The most important tomb, Señor Caso said, contained two rooms; in one of the rooms were six dead warriors, jewel-covered and ornamented with gold, seated around the wall. The skeletons had virtually disintegrated. The precious articles were at once removed and sent under guard to the Bank of Mexico for safekeeping.

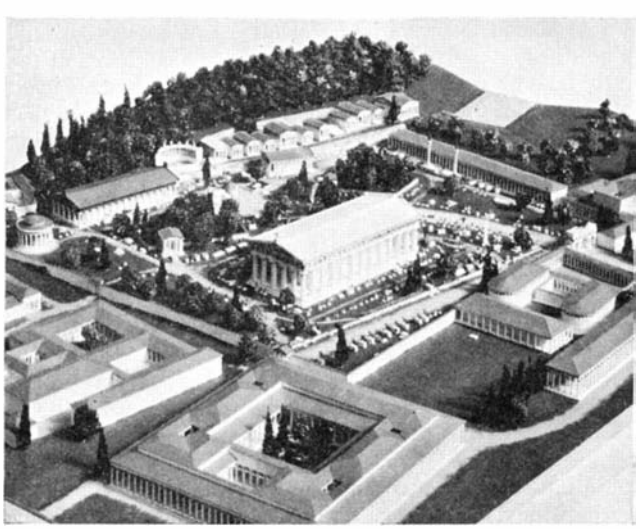


View of the great steps and platform on Monte Alban, overlooking Oaxaca

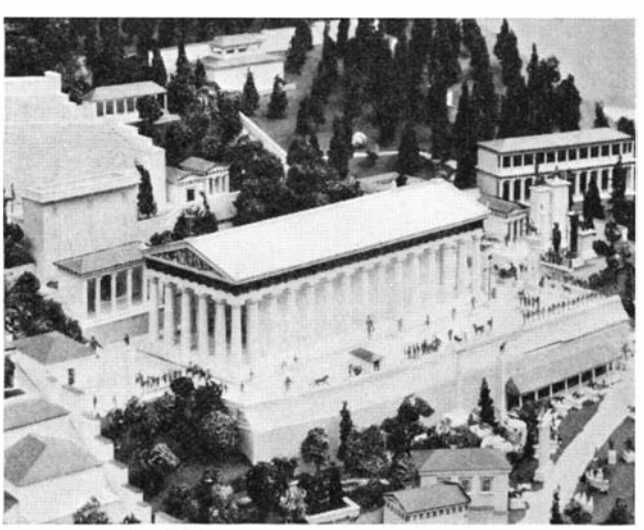
One of our illustrations shows a sacred mask of gold, turquoise studded. Excavations are being made around the principal site which includes a great acropolis platform and stairs. Dr. Clark Wissler thinks that the tomb is not of great antiquity because it gives evidence of such high development. Dr. Herbert J. Spinden says that while such discoveries are common in the old world, this is the first time that jewelry and works of art have been found in a burial chamber of early American origin. He says: "Study of these fine works of art will bring about a better appreciation of the artistic capabilities of Central American Indian tribes, and enable us to understand the emotional forces of their civilization before the coming of the white man." The work will be abandoned in the rainy season, but will be resumed early in October.

Classical Models

MODELS of the two great sanctuaries of ancient Greece have recently been added to the collections of The Metropolitan Museum of Art. The models were made in Berlin of wood and pasteboard and reproduce the topography and architecture of part of these great temples and surrounding buildings, not as ruins, but reconstructed as presumably they were seen by Pausanias, the early forerunner of Baedeker in the second century of our era. The casts from the original structures are in adjacent galleries.



Model of Olympia, one of the two sanctuaries of Greece



Model of Delphi, the second great Grecian sanctuary

HOW COLD IS SPACE?

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

MANY people are interested and not a few puzzled when thinking of "the cold of space." We all know that as one climbs a high mountain or ascends in an airplane the air gets cooler and cooler, until even in the tropics the temperature is permanently below freezing only three or four miles above the surface. Aviators making altitude records encounter air so cold that they must take special precautions to avoid injury. What would happen if in some wholly chimerical craft they could rise to a height of 80 miles instead of 8, and go on to 800, 8000, 80,000,000 miles, and so on indefinitely? Would they find it hot or cold there?

The question must be answered in traditional Yankee fashion by another: *What* would be hot or cold? Upon this hangs all the significance of the first question, for only a material body can have a temperature. Empty space can no more be hot than it can be soft or green. But a specified object at a definite position in space will tend to take up a certain temperature, depending on the influences of its surroundings and to some degree on its own nature as well.

IT is only in this sense that we can speak of the "temperature of space" —a very loose phrase which really means the temperature which some test object would gradually approach if it were left to itself at a given point, subject to all influences which normally act upon it there. This depends of course upon a balance between influx and outgo of heat. From the surface of every material object, so long as it has not sunk to the unapproachable absolute zero of temperature (— 273 degrees Centrigrade or — 460 degrees Fahrenheit) heat streams away continually by radiation into space, passing out beyond the planets, the stars, the nebulae, into unknown depths. If our test body had no internal sources of heat and received nothing worth considering from other bodies, as would happen if it were alone in the depths of space, it would steadily radiate its heat away and its temperature would fall and steadily approach the absolute zero, but with ever-increasing slowness, so that it would never quite reach this limit.

Even if the body had some internal source of heat, such as radioactivity, this could not be unlimited in amount and would ultimately tend to exhaustion. The fall of temperature toward the absolute zero would be delayed perhaps very greatly but could not ultimately be averted unless, indeed, as Professor Tolman has recently suggested, space itself which now shows evidence of "expanding," may ultimately come to contract again, bringing back the vanished energy out of its far recesses. Before this happens anyhow our test body, isolated in empty space, would have become almost though not quite as cold as anything could be.

But the part of space which we can observe is not empty but sown with stars which are sending out heat and light. Anywhere within the visible universe our test body will steadily receive heat from them, and it must be warm enough to get rid by its own radiation of as much heat as it takes in. Near the sun or any other star it will be very hot; in interstellar space very cold.

IF our test piece is a black body, or perfect absorber for all kinds of radiation, whether long or short waves, it will be equally efficient in emitting radiation on its own account, and its temperature at any given point in space will be quite definite. Just outside a star, for example, a small black body will have 84 percent of the star's own effective surface temperature. This figure results from the law that the radiation from a black body varies as the fourth power of its temperature. If it should be completely surrounded by an enclosure with walls at a given temperature it would evidently take up the same temperature. But, close outside the star's surface, half of the celestial sphere is covered by the star, and our test body gets just half as much heat as it would in the enclosure. Hence it gets rid of half as much, which lowers its temperature in the ratio of $\sqrt[4]{2}$:1, or to 84 percent.

The sun's surface has an effective temperature (measured by its radiating power) of 5740 degrees, so that a black body just outside its atmosphere would be heated to 4830 degrees. A million miles away from the sun's surface the temperature would fall to 2250 degrees. In the inner part of the solar corona all known substances must therefore be volatilized, but in the outer streamers there may be small drops of liquid or even solid particles.

At greater distances the heat received from the sun falls off inversely as the square of the distance from the sun's center, and the temperature of the test body inversely as the square root of the distance. At the earth's distance it comes out 277 degrees above absolute zero, or + 4 degrees Centigrade. At Jupiter's distance it is — 152 degrees C. and at Pluto's — 230 degrees C.— cold enough to liquefy all gases except hydrogen, helium, and neon. At one percent of the distance of the nearest star the sun's radiation would keep our black body at a temperature of 5.3 degrees above absolute zero, so that even hydrogen would be solid, though helium would still be liquid.

BY this time we would have to begin to take into account the heat received from the stars. The whole light of the starry sky equals that which would be received from the sun alone at about 11,000 times the earth's distance. Allowing for the red stars, which give more heat in proportion to their light, we may estimate the whole heat from the stars as equal to that of the sun at 8000 times its distance from us. This would maintain a black body at only 3.1 degrees above the absolute zero. This is probably a fair sample of the temperature at which our test body will settle down if exposed in interstellar space. Outside the Milky Way, in the vast emptiness between the nebulae, the intensity of radiation is much less. According to Hubble's measures of the numbers and brightness of nebulae, it is about one thousandth as great as that of our starry sky. The corresponding temperature of a black body is about six tenths of a degree above absolute zero, so that scattered masses of matter, if such exist in internebular space, are indeed cold.

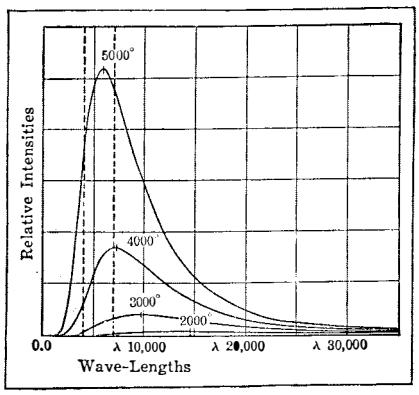
Very different results, however, would be obtained if we could use test bodies of different kinds. The inflowing supply of heat from the stars is carried by short waves like those of visible light. The outgoing radiation from the body at ordinary terrestrial temperatures is carried mainly by waves 20 times as long, while if the temperature is only a few degrees above the absolute zero

the feeble radiation consists of far longer waves—something like a millimeter in length. The absorbing and emitting powers of various substances differ greatly, and vary with the wavelength. For example, rocks stained red or yellow by oxide of iron absorb violet and ultra-violet strongly and red light much less. When photographed through a violet screen they look almost black, since little light remains for reflection; with a red screen most of the light is reflected and they appear as bright as snow. Suppose now that we take a test body of this sort and another black one and set them up side by side near a white star which gives out mainly violet and ultra-violet light. The two will be nearly equally good at absorbing it and (assuming for the moment that they are equally good at emitting long waves) they will reach almost the same equilibrium temperature. Now take them near a red star at such distance that the total amount of heat received per second is the same. The black body will reach the same temperature as before, but the other (which reflects most of the red light, leaving little to be absorbed) would have only this little to get rid of and will be considerably cooler.

SIMILAR differences may exist in the emitting power for long waves (which is always equal to the absorbing power for waves of the same sort). Two test bodies equally efficient in absorbing the short waves from the sun or the stars, but one good and one poor at emitting long waves, will have different temperatures. The poor emitter of course will have to be hotter to get rid of the same amount of heat per second. Suppose that it were possible to find or make a substance which refused to emit any long waves at all but was a good emitter and absorber of visible light. A test body of such a substance, even in interstellar space, would have to get rid of its heat by shining visibly, that is, it would have to be at least red hot. If it could emit violet light only, its temperature would be still higher. No such substance is known and it is probable that none exists. But it is worth while to imagine one (as the French physicist Fabry first did) in order to show to how great an extent the "temperature of space" depends on the thing, real or hypothetical, with which we might try to measure it.

Two planets, for example, at the same distance from the sun need not have the same temperature. This actually happens in the case of the earth and the moon. The earth rotates rapidly, so that the night side does not cool off very much before the sun rises again. Hence it radiates heat out to space from its whole surface. But on the slowly rotating moon the night side cools to such an extent that it radiates almost nothing, and almost all the heat received from the sun is dissipated by the daylight hemisphere and especially by the part of it which directly faces the sun. In this region the temperature rises above the boiling point of water. This difference is exaggerated by the fact that the moon's surface has extremely little capacity for storing heat, while the earth's atmosphere and oceans give it a very great capacity.

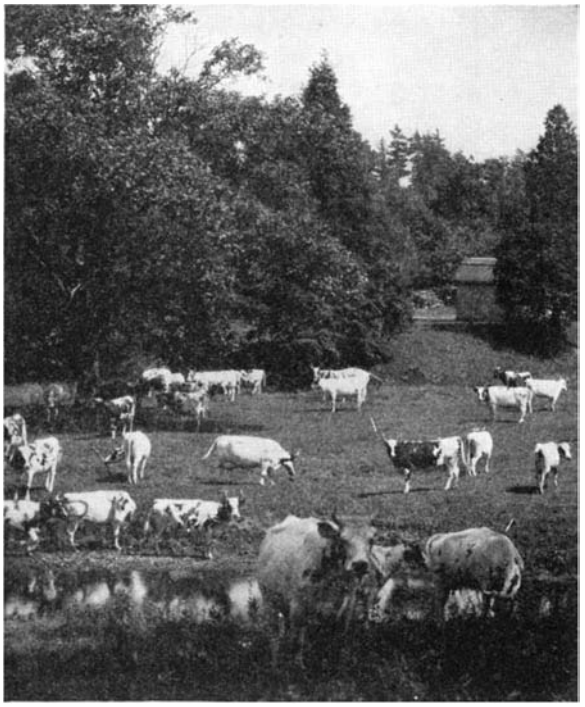
The atmosphere affects the earth's temperature in many other ways. It is fairly transparent to the incoming short-wave rays of the sun, and lets most of the heat through to the surface (when it is not cloudy). But it is seriously opaque to the outgoing long-wave radiation which is relayed from the surface to the upper atmosphere, absorbed there, and again radiated from this out to space. To keep this process going the earth's surface must be hotter than otherwise it would be. This effect is of the utmost importance for our planet's inhabitants; without it we would have at best a temperate climate at the equator, while the temperate zones would be as cold as the arctic regions are now. The rapid fall of temperature in the first few miles above the earth's surface originates mainly in the vertical circulation of the atmosphere, rising masses of air being cooled by expansion and descending currents warmed by compression. Above the level of the highest clouds, in the stratosphere, the vertical circulation ceases and the temperature is nearly constant and low. Still higher up where the ozone of the upper layers absorbs the extreme ultra-violet light which the sun emits, but which we on the surface never receive, the atmosphere, though extremely rarefied, is much warmer. There is a good deal of evidence that the temperature may reach 100 degrees Centigrade, or even more. These upper layers, which have a very strong absorbing power for ultra-violet light and by no means as good an emitting power for long waves, come near to realizing one of the "freak" test bodies of which we spoke above.



From Russell, Dugan & Stewart's "Astronomy," courtesy Ginn & Co.

Energy curves of a black body. These throw incidental light on Professor Russell's statement that the inflowing supply of heat from the stars is carried by short waves, but that when this heat is *reradiated* from any object it has a very much longer wavelength. Wavelengths (λ) are shown on the horizontal scale in ten millionths of a millimeter (Angstrom units). Those between the vertical dotted lines are for visible light—violet at the left, red at the right of this band; while everything shown to the right of this visible band is in the infrared (longer waves). The hotter a body is, the larger the proportion of its radiation falls in the shorter wavelengths. This is what the four curves show. Note how their peaks shift to the left with increasing temperatures. The upper curve might represent sunlight, which is only a little hotter than the 5000 degrees indicated. The bottom curve is more like that of heat radiated from a body at earth temperatures—the re-radiated heat of Professor Russell's article. Note that the peak of the curve (bulk of the rays) is now in the longer wavelength range. It is true, these curves ignore certain selective absorption effects of the earth's atmosphere. They are for sunlight (or starlight) outside the atmosphere. They also ignore the variable "absorbing and emitting powers of various substances" mentioned in the text. However, the influence of these factors generally affects the results only relatively

EVEN in interstellar space there are scattered molecules and atoms of gas. We told a few months ago how these absorb fine, sharp calcium and sodium lines in the spectra of the hotter and more distant stars. This interstellar gas is not cold but hot. The temperature of a gas must be measured by the average energy of motion of its molecules or atoms. Eddington's calculations show that these motions should be so rapid as to correspond to a temperature of something like 10,000 degrees. Nevertheless, a standard black test body immersed in this gas would remain cold. The atoms, though flying fast, are very far apart. Few will strike the body in a given second, and the total amount of energy they bring in will be small. On Eddington's assumption that there is one atom per cubic centimeter, the whole inflow of heat from the gas is not enough to supply the radiation from a surface at one degree above absolute zero. We therefore have the remarkable paradox that a body at absolute zero, immersed in a gas at a temperature of 10,000 degrees. will be warmed less than one degree, so long as the gas is sufficiently rarefied. —*Princeton University Observatory, February 5, 1932.*



IS RAW MILK

IN a recent editorial entitled "Raw Milk versus Pasteurized Milk" the *Journal of the American Medical Association*, official organ of the association which includes the majority of the physicians in the United States and Canada, makes the following statement:

"The beneficial influence on the public health which has accrued from the widespread practice of pasteurization of milk and dairy products has left little doubt in the minds of most public health workers as to the necessity for the more or less universal adoption of this simple preventive measure. Furthermore, the enormous increase in the production and consumption of milk and milk products has introduced new problems relating to its safety and wholesomeness. The responsibility of public health officials, milk distributors, and dairymen in securing a clean and safe milk supply is indicated by the constantly recurring milk-borne epidemics in this country. During the six-year period from 1924 to 1929, 258 milk-borne epidemics were officially reported by state health officers. These epidemics involved 10,906 persons and resulted in the death of 371.

"To the embarrassment of those public health officers who have succeeded, often after a bitter struggle, in securing the passage of laws requiring the pasteurization of milk and dairy products, reports of alleged superiority of raw milk over pasteurized milk appear from time to time. A recent example is an article by Scott and Erf of Ohio State University, who conclude that milk subjected to heat loses its hematogenic and growth-promoting properties; that rats fed on commercial pasteurized milk fortified by cod-liver oil and tomato juice failed to equal in growth and development rats fed on the milk of cows given a diet high in mineral vitamins; that the pasteurized milk from cows fed on a special

By BRUCE M. PIERCE

IN the month of May, 1927, 202 cases of scarlet fever occurred in Washington, New Jersey, within six days.

The same year in the city of Montreal, Canada, there were over 5000 cases of typhoid fever, with upwards of 500 deaths.

Recently in Lee, Massachusetts, a total of 950 cases of septic sore throat were recorded, with 48 deaths.

It is not altogether true to say that these epidemics can be laid at the door of that gentle animal, the cow, but it is true that investigation traced their origin to infected milk. Further, a recent report by the United States Public Health Service revealed that upwards of 500 epidemics of typhoid fever, scarlet fever and diphtheria in America had their source in diseased milk supplies.

These are merely outward evidences of a war that has been waged intensively and extensively throughout the United States and Canada for the past quarter of a century, particularly in the last ten years. Opposing forces in this fray have been public health officials and medical men on the one side, and the general public on the other. The former offer these numerous epidemics as incontrovertible evidence of the dangers of raw milk, and the latter demand a vast amount of education and persuasion before gradually succumbing to the arguments of their — one could not say opponents, because the physicians and scientists simply have the public weal at heart in their campaign.

The crux of this long-drawn-out battle over the product of the cow is whether or not incorporated municipalities in the United States and Canada are ready to submit to compulsory pasteurization of all their milk supplies.

Nearly every man, woman, and child in America drinks milk. Until the early years of the present century milk was drunk only in its natural, raw condition. Our forefathers consumed it as it came from the udder and seemed to suffer no ill effects from it; rather they flourished and grew into brawny, muscular manhood. Occasional epidemics of diphtheria, scarlet fever, and other ills may have occurred, but milk was never blamed. Our own fathers and many of our own time drank largely of raw milk.

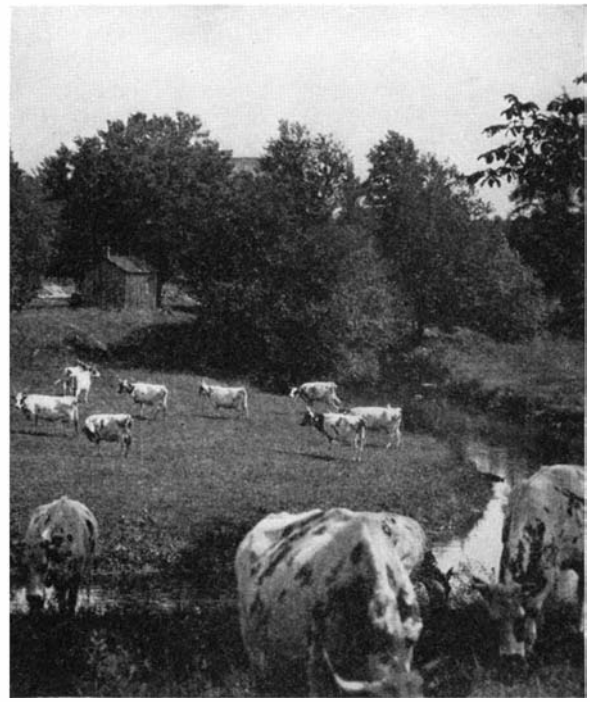
BE that as it may, health authorities today are convinced that raw milk is no longer a safe food, and they say so resoundingly throughout the length and breadth of America. In written and spoken word their message comes like a clarion call to 20th Century America. Henceforth he who consumes unpasteurized milk is courting sickness, possibly death. Dairymen may take every possible precaution in the way of cleanliness of cows, stables, equipment, and employees, but this is not enough. To insure absolute safety, so our health men declare with remarkable unanimity, milk must undergo pasteurization before entering the human body.

Many a householder, heeding this advice and learning that 10 percent of all deaths caused by tuberculosis in children under five years is due to bovine infection, has hurriedly changed his or her standing order at the local dairy, principally for the sake of Young America.

On the other hand, any thought of drinking pasteurized milk is spurned by thousands of people, especially the older classes who were raised on raw milk. They have never suffered any ill effects from it and they distrust pasteurization, regarding it as a mode of destroying the health-giving, body-building elements in the milk. Most authorities assure them that this belief is an absolute fallacy, but vast numbers remain unconvinced and they find support in the discoveries of some scientific workers who profess to have proved the superiority of raw milk from a nutritional standpoint.

The fact remains that pasteurization has made enormous strides in America in the last 25 years. Looking back, it seems a strange thing that, although Louis Pasteur, the genius who discovered the process, revealed it to the world as early as 1864, nearly a half

A 'RAW DEAL'?



diet rich in minerals does not produce the anemia usually reported as occurring in the albino rat following an exclusive milk diet."

The Scott-Erf report mentioned by the Journal is the same one referred to by the author of the present article in the SCIENTIFIC AMERICAN, under the name Erf, and its fallacies are pointed out in the editorial by the *Journal of the American Medical Association,* which adds:

"There is no convincing evidence at hand to indicate that the feeding of raw milk, pasteurized milk, or raw or pasteurized milk which has been boiled, has any appreciable influence on the blood picture of infants, children or adults on a milk diet. Many writers on infant nutrition recommend boiling cow's milk in order to destroy disease-producing organisms and for its favorable influence on the curd.

"There is evidence that the antiscorbutic vitamin is largely destroyed by pasteurization or boiling. When one realizes that the amount of vitamin C in raw milk is insufficient to protect against scurvy and must be supplied by vitamin-containing adjuvants, this factor assumes little importance."

Finally, the medical journal quotes the recent report of the Committee on Milk of the Conference of State and Provincial Health Authorities of North America, which reached the following conclusion:

"It would, therefore, be unscientific to draw any conclusions from these experiments with reference to the effect of pasteurization on the nutritive value of milk."

Thus the leading medical journal in this country, representing the bulk of the medical profession, definitely throws in its weight against unpasteurized milk and against a widely quoted report which apparently favors its retention.—*The Editor.*

century passed before it came into general use in America.

New York City may be cited as typical. As late as 1903 only 5 percent of the milk supply of New York City was pasteurized. About ten years prior to that time pasteurized milk had been introduced into New York by Nathan Straus, the well-known philanthropist, who established his infant milk depots there. He did so on the advice of Professor Jacobi and Professor Roland G. Freeman and the result was a tremendous diminution of the infant death rate among the poorer classes to whom the milk was fed. It is acknowledged that this action on the part of Mr. Straus constituted the real beginning of the use of pasteurized milk in America.

By 1912 about 40 percent of New York's milk supply was being pasteurized. In 1914 the proportion had risen to 88 percent, and in 1921 approximately 98 percent of the milk sold in that city was pasteurized, the remainder coming from certified herds.

Once established as an effective instrument for disease prevention, the practice of pasteurization spread rapidly. A glance at the formidable list of disease germs capable of propagation by milk has caused many a consumer to swing away from the raw product, and has given many a municipality such concern that it hastened to inaugurate compulsory pasteurization of all milk supplies sold within its limits.

Of the maladies transmitted by milk, bovine tuberculosis has caused deepest concern. In part this has been overcome by the inauguration of the tubercular test and the accredited herd system under which enormous strides toward the goal of tuberculosis-free cattle have been made in recent years. But thousands of herds remain outside the scope of these plans and the municipalities, though they have full control of their respective milk supplies, in many cases continue to permit uninspected herds to furnish milk within their borders. Bovine tuberculosis thus remains a very real danger, especially where children are concerned. Pasteurization is regarded as the only absolute safeguard against this pernicious disease.

THE second ailment of bovine origin which has taken a vast toll in America is septic sore throat, resulting from the consumption of milk manufactured by cows with diseased udders.

The third danger, known as Bang's disease or undulant fever, has played a prominent part in the new popularity of pasteurized milk. In recent years contagious abortion, the source of this affection, has seemingly become more prevalent in dairy herds. Regardless of the care exercised by dairymen, the undulant fever germ is likely to creep into milk, even into that from accredited herds. One well-known dairyman has expressed the view that this disease may have been prevalent for years, but that only recently have medical authorities definitely diagnosed it.

The list of disease-producing germs of human origin which can be passed along in cow's milk includes typhoid fever, dysentery, diarrhœa, septic sore throat, human tuberculosis, diphtheria, scarlet fever and others of less importance. Typhoid fever is the most common of the milk-borne diseases. As in the case of infected water supplies, it has caused many serious outbreaks in different towns and cities of America. It is noteworthy that in the case of nearly every afflicted municipality, the epidemic has resulted in a compulsory pasteurization measure, even though this may have been a case of "locking the stable door."

Even those who object to the pasteurization of milk on the ground that it destroys beneficial properties in it, cannot refute the concrete testimony offered by the ravages of diseased milk. The death record speaks volumes, sufficient to move health officials to come out flatly for universal pasteurization of milk, a process that definitely kills harmful bacteria and removes 95 percent of the possibility of transmission of disease germs. In the case of modern dairies using machinery that performs every step of the bottling process automatically, the percentage of safety is virtually one hundred.

S. Henry Ayres, formerly of the Department of Agriculture at Washington, D. C. and recently bacteriologist for the Bureau of Dairy Industry, a

man who has given years of his life to the painstaking study of this question and who has contributed a most valuable treatise on the subject written from a scientific as well as practical standpoint, summarizes his views in this fashion: "From a sanitary viewpoint, the value of pasteurization is of greatest importance when market milk is under consideration. When properly performed, it affords protection from disease-producing bacteria. The fallacy of the objections to pasteurization have been shown through scientific research in the last few years and as a result the value of the process is firmly established."

DR. CHARLES H. MAYO, head of the famous Mayo Clinic, expressed the view of a majority of medical men when he said: "After having studied for many years the problem of safe milk, I am of the opinion that pasteurization is the only known treatment which adequately serves the purpose of destroying the germ cells without materially reducing food properties. I do not contend that it will make unclean milk clean, but I do contend and can prove by the records that pasteurization will and does make unsafe milk safe."

Faced with a staggering mortality record and with such decided opinions prevailing among medical and health authorities, why have we not made pasteurization universal in America?

One great obstacle has been the prejudice created in many minds because of the improper pasteurization of milk. For many years dairymen used the "flash" process, consisting of heating the milk to 160 degrees Fahrenheit or higher. This caused the destruction of vitamins and gave the milk a cooked flavor. Inferior equipment and defective pasteurization not only failed to attain the objective of producing safe milk, but consumers rightly took issue with pasteurization on the ground that it destroyed its nutritional value—and it most certainly did. Today, however, most towns and cities in America have up-to-date pasteurizing plants and the program of extension proceeds apace, chiefly because consumers are demanding a high quality of pasteurized milk.

Milk as received from the dairyman is too warm to ship to the city; germs would multiply in it. Hence it is cooled in coils beforehand

The accepted method of pasteurization—accepted by health authorities—is now known to dairymen, even in the smallest towns. The milk is heated to 145 degrees, Fahrenheit, is held at that temperature for 30 minutes and then is rapidly cooled to below 50 degrees. At 145 degrees a complete destruction of the disease-producing bacteria is assured and at the same time a maximum percentage of the essential lactic-acid bacteria required to offset the action of putrefactive organisms remains. The cream line is but slightly affected and the only injurious effect upon the vitamins is the impairment of vitamin C, a deficiency easily made up by feeding orange and tomato juice to infants, a very common practice today.

YET, even now, the objection is very frequently raised against this process that the nutritional properties of milk are affected by it. Although most health authorities flatly reject this contention, a few men who have given it scientific study are not so sure. Indeed, some have upheld it.

The most recent pronouncement on this point was made by Prof. Oscar Erf, Chief of the Dairy Department of Ohio State University, who fed various kinds of milk to a group of 150 white rats over a period of three years. His findings were summarized as follows:

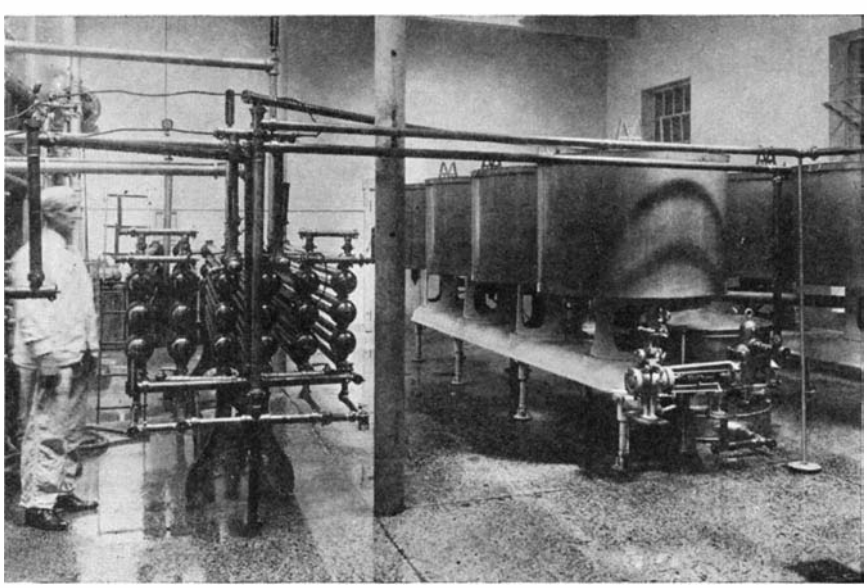
Certified milk is without doubt a health-sustaining and health-building food, showing the best gains and most nearly approaching the results obtained with the rats' natural diet.

Natural milk from especially fed cows is both health-building and health-sustaining, and only a shade less valuable than certified milk. This same milk when pasteurized loses a great deal of its value and is not growth-promoting.

The commercial pasteurized milk used was neither health-building nor health-sustaining. The food value was gone.

Dr. J. M. Brennan, noted American food authority, in an address last year at the Dairy Manufacturers Conference at the University of Illinois, discussed these points at some length. "The most recent experiments," he said, "show a nutritional deficiency in the heated milks. This deficiency in most cases has been attributed to a loss of the calcium and phosphorus." He qualified this statement by referring to earlier experiments which showed that "while there may be some change in the calcium and phosphorus of the pasteurized milk, its effect on the food value of milk is nil." Therefore he concluded: "It is evident that there is no unanimity of opinion as to the effect of heat on the food value of milk."

A second objection advanced by raw milk advocates is that pasteurization



When the milk in cans reaches the city it is pasteurized on a large scale. Milk is a good culture medium for germs—so good that they thrive in it all too well

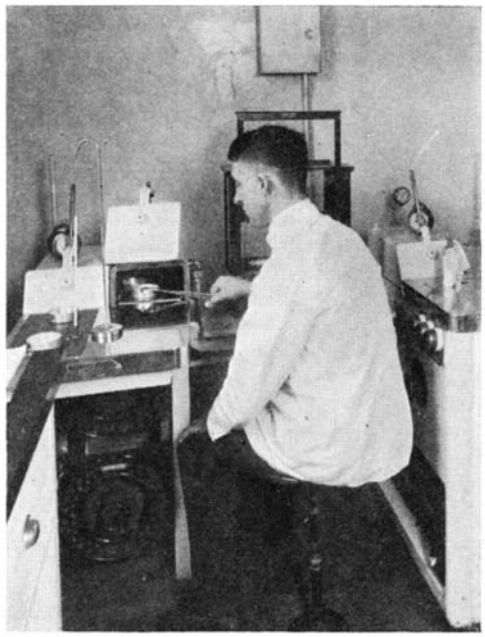
injures the digestibility of milk. However, S. Henry Ayres avers that the results of feeding experiments with babies show that low-temperature pasteurization does not have this effect—rather the digestion of milk is enhanced by heating. The raw milk advocates further protest that the flavor of their favorite food is altered by pasteurization. This may be correct in the case of milk having a high butterfat content, but not with the ordinary run of milk. Recently the leading dairyman in a small town sought to prove his point that the flavor was not changed. One morning he delivered pasteurized milk to a large number of consumers who had been using raw milk of the same brand. He received not one complaint or comment from his customers. They had not detected the difference.

A WELL-KNOWN Canadian health official recently propounded a somewhat startling theory for this change in the flavor of milk, real or imaginary though it may be. He declared: "The complaint usually is that none of the milk tastes the same as it used to. This complaint is for the most part well-founded, but the change is due to the absence of dissolved cow manure which for generations, until recent years, has been an almost constant ingredient of market milk."

Opponents of pasteurization argue, too, that the introduction of a compulsory measure would result in a relaxation of sanitary measures on the part of herd-owners and dairymen who, knowing the milk was to be pasteurized, would be careless in its production.

Medical officers of health go so far as to agree that pasteurization will not make dirty milk clean nor render it safe for human consumption. They urge that every municipality subject its milk to the "dirt test" and pass only that which conforms to a certain standard of cleanliness. And they declare that a rigid inspection of the methods of producing and handling milk is just as indispensable in the case of pasteurized as of raw milk.

At present, many a town in America lacks an adequate system of inspection of herds, stables, equipment, dairies and employees. Many even have no ordinance requiring milk producers and handlers to maintain certain standards of cleanliness and efficiency. The owner of a non-inspected, non-accredited herd, peddling raw milk in the municipality, enjoys the same privileges as the owner whose herd is accredited and whose milk is pasteurized. Often the town officials will argue that the widely-scattered nature of the herds furnishing the local milk supply makes it unduly expensive to inaugurate a system of inspection. In more than one municipality, investigation has shown that the medical officer of health never visited the herds or stables.



In the bacteriological laboratory the milk is tested, and counts of its germ content are made daily, in order to avoid risk

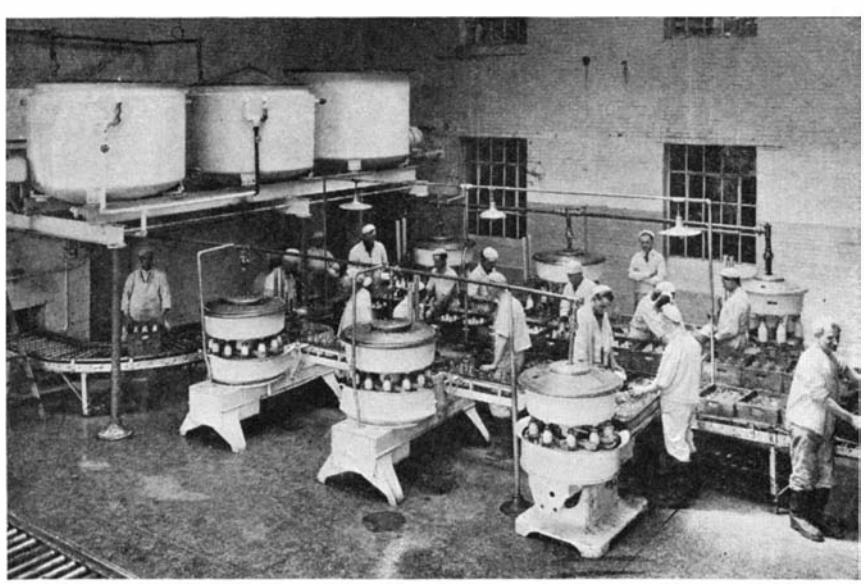
If it rested with governments, compulsory pasteurization would probably be universal in America today. But the full responsibility for its milk supply is shouldered upon the municipality, with the respective departments of agriculture and health standing ready to aid in inspection of herds and dairies and to give advice directed toward improving the milk supply.

The drawback remains, however, that as a rule no modern pasteurization equipment is available in the smaller communities. These communities could contract for supplies from nearby towns and cities, but that would put their own dairies out of business. They do not relish the idea of a monopoly, nor do the incorporated villages and towns relish it.

Meanwhile, in the larger towns and cities of the United States, pasteurization has made gigantic strides in the last decade. A compilation by S. Henry Ayers a few years ago showed that every city in the United States of more than 25,000 population had at least 66 percent pasteurized milk, cities of over 100,000 had 81 percent, and those over 500,000 had 98 percent. But the cities of less than 25,000 population had only 42 percent of their milk supplies pasteurized, and in communities under 10,000 population the percentage fell to 33 percent.

This tabulation reveals a distinct backwardness on the part of the smaller communities. In the matter of pasteurization they have not kept pace with larger ones, possibly because most of them have never come face to face with an acute situation. Nevertheless, since these figures were compiled in 1924, a rapid improvement undoubtedly has been recorded. The smaller municipalities in many instances are waking up and demanding more rigid control of their milk supplies, with regular inspection by qualified men and the enactment and enforcement of local by-laws.

IN other places, men and women, for the sake of their children's safety, have reached the point of accepting the opinion of one eminent authority on the subject, who says: "There can be little question that the dangers which are known to be avoided by pasteurization should receive more consideration than the rather questionable points of superiority of raw milk."



Automatic bottling and capping machinery for good milk. Extreme caution must be exercised in order to avoid contamination of the milk by careless handling

FORTY TONS OF CORAL

Torn from the Ocean Floor to Form a Huge Museum Exhibit*

By ROY WALDO MINER

Curator of Living Invertebrates, American Museum of Natural History

THE ideal museum group is not merely a work of art. It is a record of living beings in their natural state and environment, depicted in their proper relations to their surroundings, and emphasizing the truth that the real unit in nature is the association rather than the individual.

To make these groups accurate portrayals of reality, the modern museum finds it necessary to send out well equipped expeditions to all parts of the world to gather the facts of nature at first hand. Consequently, if it is desired to build a group which will faithfully depict the life of the sea bottom, one must descend to the bottom of the sea to obtain the material and the observations which make this possible.

The preparation of the group in the museum, while not so romantic as the field work, nevertheless is full of interest and is beset with fascinating problems. Often these present special difficulties involving original and unprecedented methods, which, however, give greater zest to the work. This has been especially true of the Coral Reef Group.

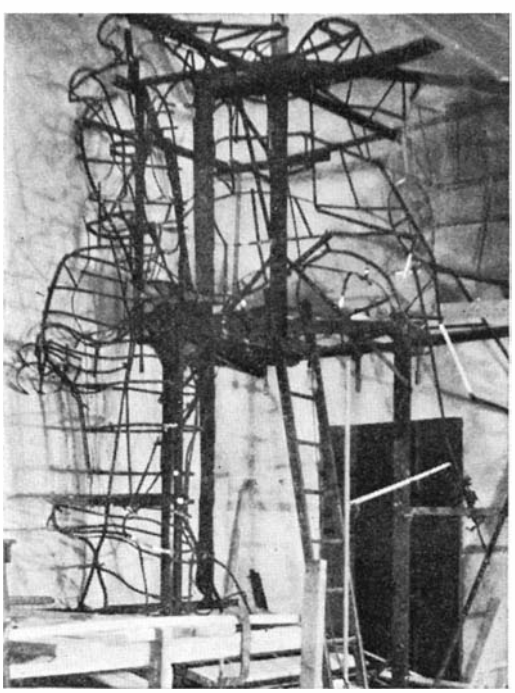
In order better to understand our aims let us first try to visualize the exhibit as it will appear when finished. We pass through the archway leading to the Hall of Ocean Life and find ourselves standing on the gallery surrounding an enormous hall 160 feet long and 130 feet wide. What first strikes the attention and holds the eye as we enter the hall is the enormous, brilliantly lighted group immediately facing us at the farther end.

The exhibit is framed in a great arch rising from the floor of the hall 16 feet below the gallery and, passing through the latter, sweeping in an enormous half-circle 35 feet above the main floor. Apparently one looks through the portion of the arch above the gallery into a tropical lagoon overarched by a brilliant sapphire sky with towering trade-wind clouds drifting by. In the foreground is a cay overgrown with shrubbery and plumed with wind-blown coconuts. In the distance is the long, low-lying shore. Glancing downward we are looking into the heart of a coral reef.

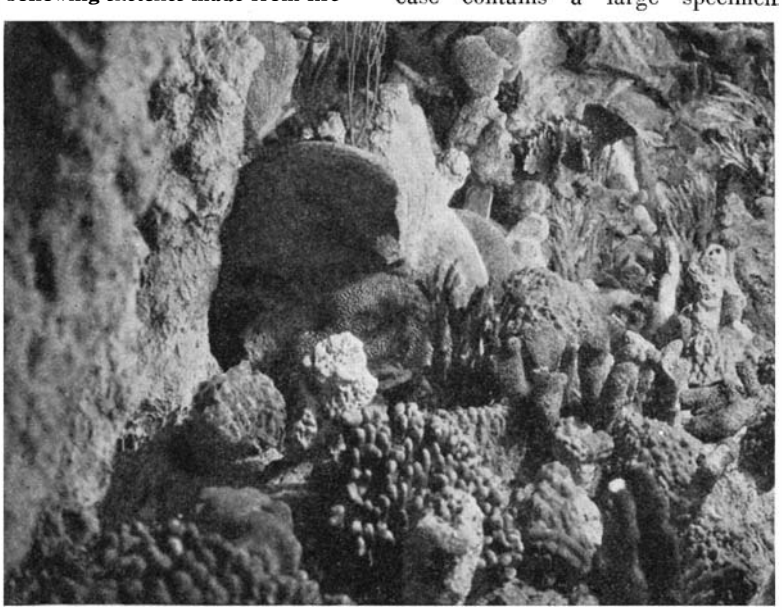
LET us imagine we have just returned from the expedition of 1924. Our 40 tons of coral have arrived. In the courtyard outside the Hall of Ocean Life are 31 huge cases of hard pine. Our men carefully remove the planks from the tops of the cases and disclose the soft masses of closely packed sponge clippings in which our corals are imbedded. Each case contains a large specimen

*An article on this subject by Dr. Miner was published in the August 1926 issue of the *Scientific American*. Since this time there have been two more expeditions. The present article, slightly abridged from *Natural History*, details the work of preparation of this exhibit on the floor of the Hall of Ocean Life of the American Museum of Natural History, forming one of the most costly exhibits ever attempted.

The coral surface is first coated with melted beeswax, then appropriately colored with oil colors following sketches made from life



Making a "coral cave" with the aid of special iron framework which supports a great weight



Fantastic growths of coral in weird formations crowd the sea bottom. The corals have been placed in a museum group and made imperishable

blocked and braced in its center, while around it the lighter and more fragile specimens are closely packed, separated from one another by the elastic cushion of the sponges. As the specimens are laid out in long rows in the courtyard, we are delighted to find that but very few of them are broken after their long voyage of a thousand miles over a rough sea.

After all are unpacked, the next step is to clean the specimens thoroughly. There are so many of them, and they are frequently so complicated in their branching structure, that it takes six months of industrious work to accomplish this process properly.

Next, each specimen is coated with a thin layer of beeswax to simulate the animal layer, which in life invests the coral. This also serves to fill and seal the minute crevices with which coral is permeated, thus keeping the crumbling limestone dust within and furnishing a proper surface substance for coloring.

NOW each specimen is colored with oil colors, following sketches made from life. Each species has its appropriate color combinations and it is necessary that they should be faithfully represented to give a lifelike appearance. Some of the brain corals are peculiarly difficult, for three main colors are involved, one of which, a green hue, must be applied in the bottom of the sinuous winding valleys with which the huge heads are covered in a most complicated pattern.

Some of the delicate fan corals were quite broken, and these had to be mended. All the broken tips had to be saved and carefully matched to their proper stumps, drilled and pegged with wire pegs, cemented with litharge, and the joints colored so that they could not be detected when finished.

Meanwhile the modeler busied himself in constructing miniature models of each essential coral mass on the scale of three fourths of an inch to a foot, and these were built up into a miniature composition according to the design which I had projected. This gave us a working model. Fixed points were designated upon this model and corresponding points were plotted in the space 30 by 16 by 16 feet which the group was destined to occupy.

A skilled iron-worker was assigned to our work, and began erecting a sloping steel framework in the form of a grid, to hold our heavy but fragile corals. The largest coral masses were suspended by powerful chain-hoists in their proper places above this, using the sketch-model strictly as a guide. Each was carefully adjusted in a lifelike position, with due regard to the growth of each branch as determined by the prevailing oceanic currents and then the steel structure was built up to support it properly, each piece, whether I-beam, channel iron, or T-iron, being carefully cut to fit. It was always a case of try and cut and try again, bending and fitting according to need.

A carefully worked out system of light boxes with special daylight lamps will illuminate the exhibit.

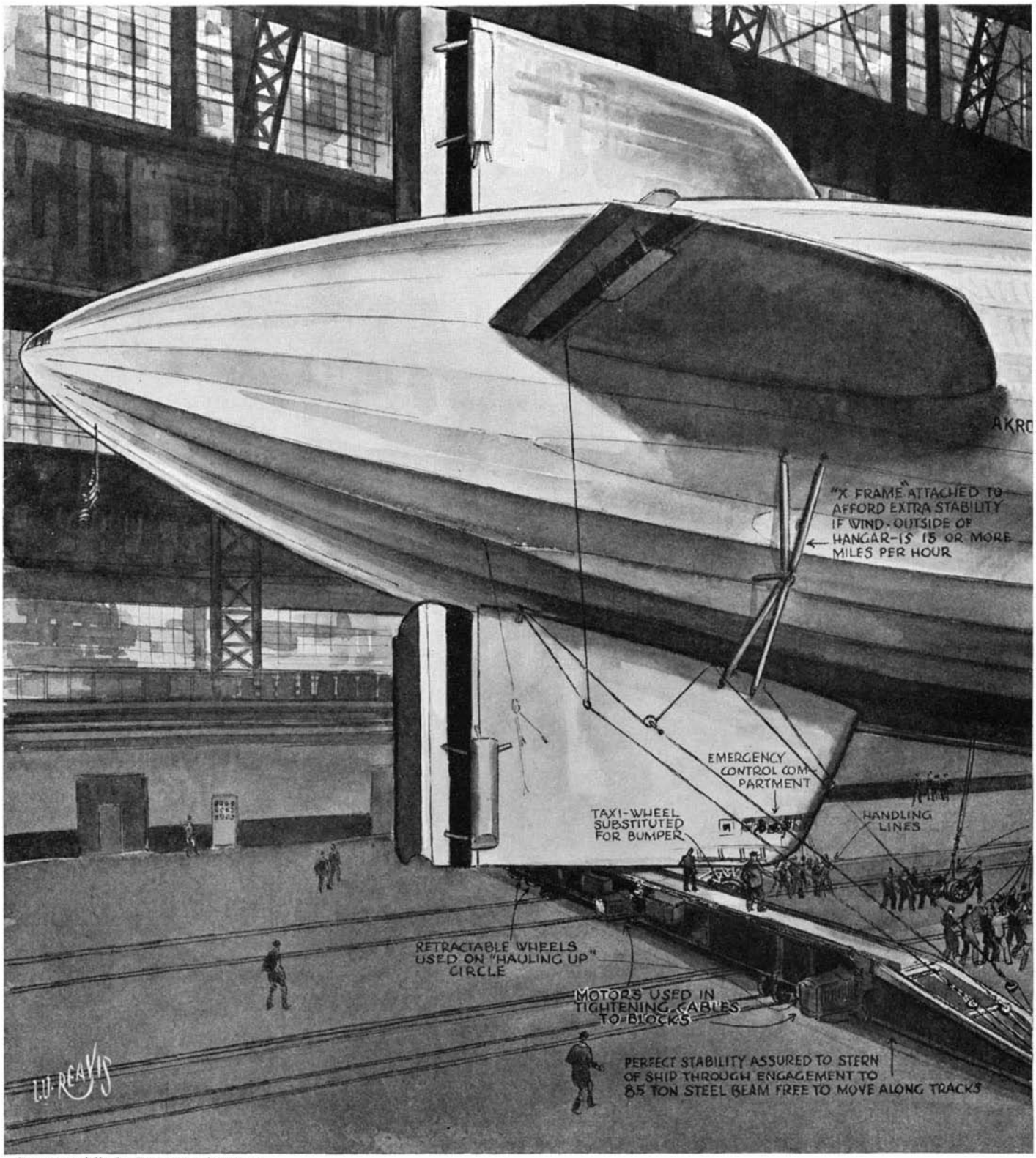
The artists are mending and touching up; the iron worker is drilling the supports

The cleaned specimens of coral have received a thin coating of wax and have been colored to simulate the living animal tissue covering the corals in life

Dr. Miner directing the modeling of the coral specimens in miniature. The massive corals are assembled into corresponding positions in the real group

Within the coral forest beneath the crystal water-surface, hundreds of reef fishes of all the typical species will be seen disporting themselves between the branches or darting in and out of the coral arches and caverns. These will be cast in wax from the plaster molds made from actual fishes in the field, and colored to the verisimilitude of life.

Finally, it is hoped that the group, when finished, will create in the visitor the illusion that he has actually descended beneath the tropic seas—that, without leaving the metropolis, he has been able to witness a world of life that would otherwise require long voyages, special equipment, and the willingness to don diving helmet and leaden weights in order to lower himself into Davy Jones's Locker!

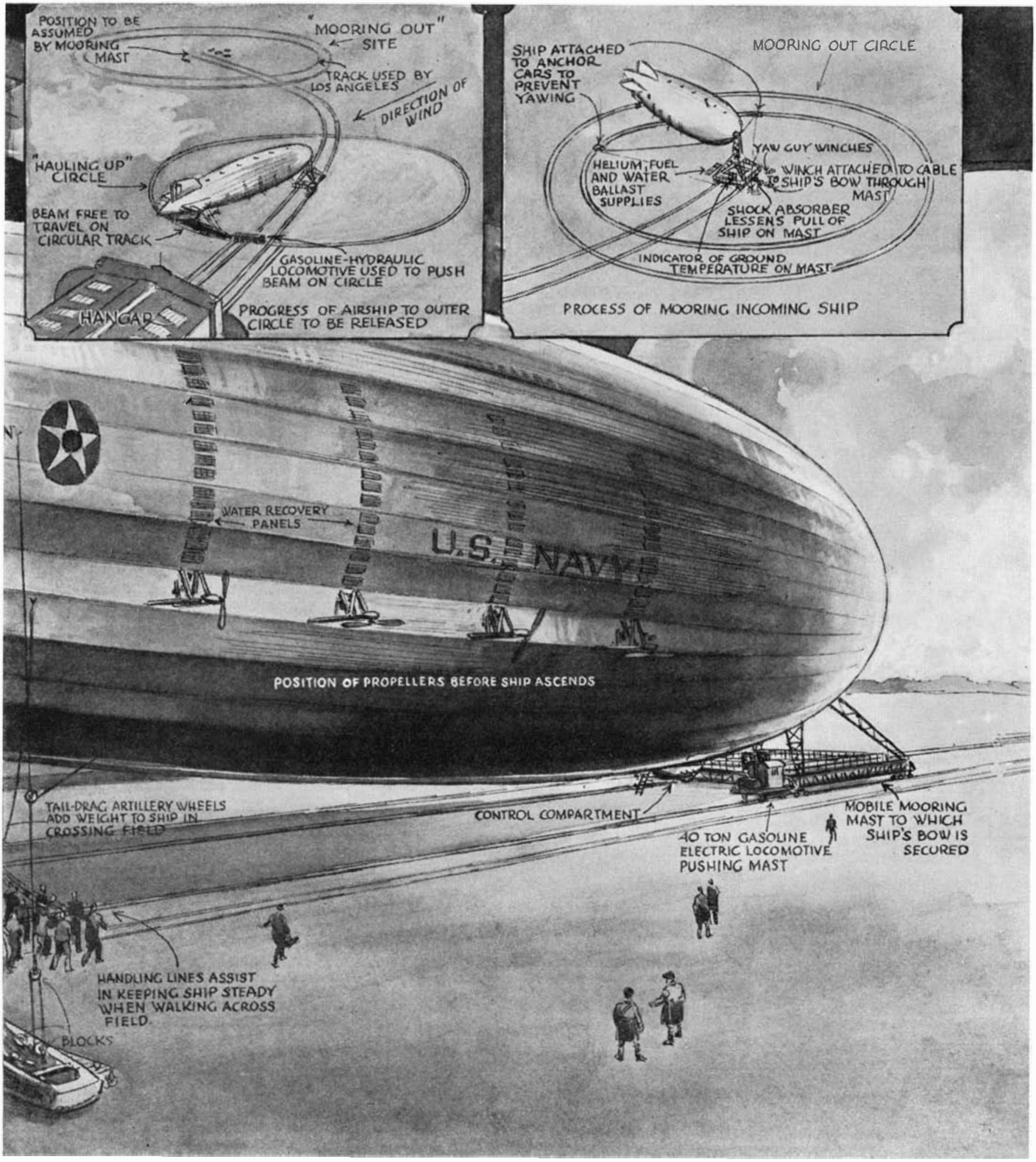


Drawn especially for SCIENTIFIC AMERICAN

IMPROVED TECHNIQUE OF HANDLING AIRSHIPS ON GROUND

DEVELOPMENT, at Lakehurst, New Jersey, of a new technique for docking and undocking airships, eliminating a large percentage of the small army of men formerly necessary and providing protection against the capricious gusts of wind always encountered at the door of a hangar, gives America supremacy in this phase of airship handling.

Two hours before her exit from the hangar, an airship's various weight components—water, fuel, and so on—and any increase or decrease of lift due to difference between temperatures within and without the hangar are figured, and compensation made in ballast. When all is ready, the ship's bow is secured to a mooring mast on tracks, pushed by a gasoline-electric locomotive. Beneath the lower stern fin is attached, by an ingenious bridle arrangement, an 85-ton steel transverse beam also on tracks, invented by Lieutenant C. M. Bolster. This beam, traveling broadside, and artillery wheels which are dragged, anchor the stern. A stern taxi-wheel takes the place of the usual bumper.



With the signal to go, the mast is pushed by its locomotive; the Bolster beam, non-automotive, is pushed by 20 men; and squads of men grasp "spiders"—short lines from the sides—to insure steady control. When the mast reaches the center of the "hauling up" circle, another set of wheels on the beam, being retractable, are lowered to the track of the circle so that the "broadside wheels" are lifted. A gasoline-hydraulic locomotive pushes the beam around the circle until the ship faces into the wind. The beam is then removed, the ship's stern is supported by the taxi-wheel, and the ship is pulled (by the mast) to the "mooring out" circle, the mast, tail-drag wheels, and "spiders" maintaining control. A final check of weights and the taxi-wheel, drag wheels, and "spiders" are released; the propellers start turning; the cone inserted in the mooring mast is tripped; and the ship rises slowly.

When an airship is to be moored, a flag is laid to show the path she should follow to approach the mast. She settles, and drops a landing line which is picked up and attached to a line from the cup of the mast. A Very pistol signals completion of this operation and again signals contact of the bow cone with the mast cup as the winch hauls in. Meanwhile trail ropes and others for attaching anchor cars and taxi-wheels have been grasped by the ground crew. The "mooring out" circle has a track for each of our two airships.

ART RESTORATIONS AND FRAUDS

Detected by the Use of Ultra-violet Radiation

By ALBERT A. HOPKINS

THE late Director of the Metropolitan Museum of Art, Dr. Edward Robinson, once said to the writer, "Museums repair but do not restore." As a matter of fact, a certain amount of restoration is sometimes necessary as in the case of a suit of armor, where missing pieces have to be fabricated in the armor shop. It is very necessary for museums to guard against fraud in the purchase of artistic material, for the visitor assumes that with the expert knowledge of directors and curators all articles exhibited are authentic. The museum curator therefore welcomes with open arms any

The parts of a statue under ultra-violet showed different materials

method of fraud detection which science has to offer. It must be remembered, however, that any such help in identifying frauds and repairs is only supplementary to the discerning eye of the expert. The X ray has been particularly valuable in the examination of paintings and several of our great museums are now equipped to handle work of this nature.

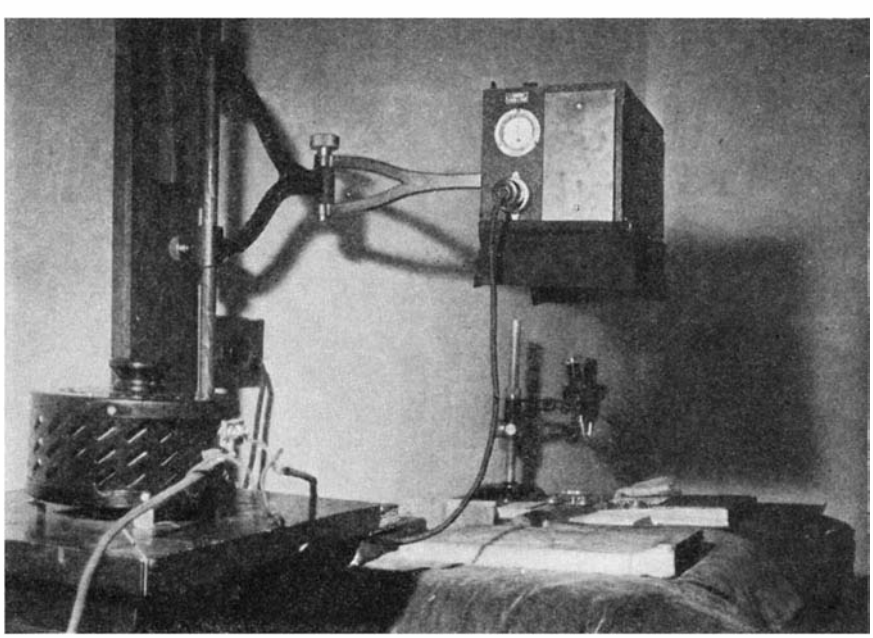
A more recent development is the use of ultra-violet rays for examining works of art. In these studies the Metropolitan Museum of Art has taken a leading part through the efforts of Mr. James J. Rorimer, Associate Curator in the Department of Decorative Arts, and the Museum has just published his monograph entitled "Ultra-violet Rays and Their Use in the Examination of Works of Art." This book gives the results of his experiments over three years. The first investigations were made on marble sculpture but the method has now been applied to other materials employed by the artist. The monograph is an excellent introduction to the use of these rays in examining works of art. The presentation of plates in color, showing how the objects really look under ultra-violet light, is most helpful to the student.

In general it may be stated that all works of art have a different appearance under ultra-violet light than they do under visible light, and it is this fact that renders this method of examination valuable. In chemical and physio-chemical investigations it is necessary to remove particles of the substance for examination, but not so with ultra-violet examinations. It is most useful and valuable to study more than minute particles. With such physical processes as those involving the use of ultra-violet rays, it is possible to study not only small sections directly or photographically with a microscope, but also large surfaces and generally the entire object.

Mr. Rorimer says: "The use of ultra-violet rays does not supersede other methods of scientific analysis. While often the use of the ultra-violet rays is sufficient for forming conclusive decisions, it is also conceivable that the examination of a single object might involve the use of photomicrography, spectrophotometry, microchemistry, roentgenology, chemical analysis, and other processes."

In the book mentioned, the author deals with the theoretical aspect of the physical constituency of light and then goes on to describe his equipment. He prefers the mercury-vapor arc as a source of ultra-violet light. The lamp used is of a standard type with the arc enclosed in a quartz tube. The apparatus on its bracket is shown in one of our illustrations. The lamp can swing in all directions and can be raised and lowered so that it may be used for studying and photographing works of art of various kinds and sizes. Small objects can be placed on a table fitted with casters; larger objects can be left on trucks or placed directly on the floor. The object is perferably placed only a few inches from the source of the ultra-violet rays so as to give the best effects in the visual examination of fluorescences. The machine can be adjusted so that the light comes from either the bottom or the front of the metal box enclosing the mercury-vapor arc. The front light is used only when a large field like a painting is to be observed. The observations are carried on in a darkened or, preferably, totally dark room. One must use isolated waves of light to obtain fluorescence and other ultra-violet reactions. To segregate these waves, glass filters containing a fused oxide of nickel are used.

OBJECTS of art may be examined visually under the ultra-violet rays, or they may be photographed. Certain



The ultra-violet apparatus used at the Metropolitan Museum of Art by Mr. James J. Rorimer to examine stone, ivory, and bone objects, ceramics, glass, enamels, textiles, metals, woodwork, prints, drawings, books, paintings, and so on

reactions are often recorded on the sensitive photographic plate more definitely than by the retina of the eye. In fact, some phenomena can not be seen by the eye and therefore can only be studied in photographs. Mr. Rorimer finds panchromatic plates used in a view camera to be best for this work, and he uses filters of various types.

There is little or no danger of damage to the object under examination, particularly where filters are used. It is the consensus of experts that the use of filtered ultra-violet rays for the examination of works of art is in no way harmful to them.

THE book describes the various materials which have been examined, beginning with marble. The results obtained are entirely satisfactory and the examinations have given important results. Alabaster and limestone also give good reactions. Variations in texture are accentuated under the ultra-violet rays sufficiently to indicate restorations.

Ivory and bone can be well studied by this plan. The use of ultra-violet rays affords a method of determining both visually and photographically the relative degree of aging so it is possible to distinguish recently carved ivory from that of great antiquity. Ivory which has been artificially patinated by tobacco juice or otherwise treated, can readily be distinguished, under ultra-violet rays, from natural aged ivory.

The restorer of fragile ceramics is unequaled in cleverness. Skilful restorations of many kinds of ceramics may deceive even the best connoisseurs. In the detection of such restorations ultra-violet rays are of great value and often are indispensable.

Reproductions, imitations, forgeries, and restorations set up difficult problems for the textile expert. Mr. Rorimer says: "The fact that works of art in probably no other material are so subject to destruction largely accounts for the comparative rarity and poor state of repair of old textile fabrics and the consequent temptation to falsify them. The field is complicated from the point of view of technique; that is, fabric weaves or patterns, dyestuffs, and so on."

Left: **Oil painting seen under visible light.** *Above:* **Same painting seen in ultra-violet light. The light spots indicate the restorations**

Below: **Renaissance marble relief as seen in visible light.** ***Right:*** **Relief examined under ultra-violet shows by black lines where repaired**

In estimating the value of a print or drawing, condition is a prime requisite. The restorer has his paper patches and paste, acids and alkalies, and a magnificent technique. Ultra-violet rays will frequently enable the skilled examiner to determine the extent of such repairs and restorations, since the materials employed, as a rule, are chemically not the same as used in the original. This is a portion of the subject which is particularly interesting.

ONLY rarely have ultra-violet rays been found to be useful in the examination of works of art in metal. With glass, however, as with ceramics, the results were found very satisfactory. With wood it is possible to distinguish between artificial and natural aging.

The usefulness of ultra-violet examination of paintings is conceded. Restorations not to be distinguished in ordinary light, are readily apparent under ultra-violet light, owing to the difference in fluorescence between the old and new paints.

There are 81 illustrations in the book and the technique is described in sufficient detail to help the beginner in this work. Mr. Rorimer justly says: "These rays cannot of course be used as sort of magic to answer all kinds of questions, but they bring into view definite factors which are not to be observed in any other way and which, properly interpreted, can be used as evidence in arriving at conclusions. With practice and experience the experimenter perceives important phenomena which to the uninitiated may seem meaningless."

HIGHWAYS AND RAILROADS

By THOMAS H. MacDONALD
Chief of the United States Bureau of Public Roads

Highways Are the Railroads' Feeder Lines. Both Go Forward. We Must Use Them Both

A HUNDRED years ago, we are told, there was a memorable race between a horse of iron and a horse of flesh and blood. Very unexpectedly the representative of the old order won the dash from the Relay House on the Patapsco River to Baltimore, 12 miles away.

It was, we can imagine, a glorious day for the stage-coach men whose bottom dollars were laid on old Dobbin to beat the tea-kettle-like contrivance that Peter Cooper had set upon rails to bedevil them. But it was their last celebration; for everything but a broken belt was pulling for Mr. Cooper and his miniature locomotive, *Tom Thumb;* and it was these newcomers in the transportation derby that took every race thenceforth.

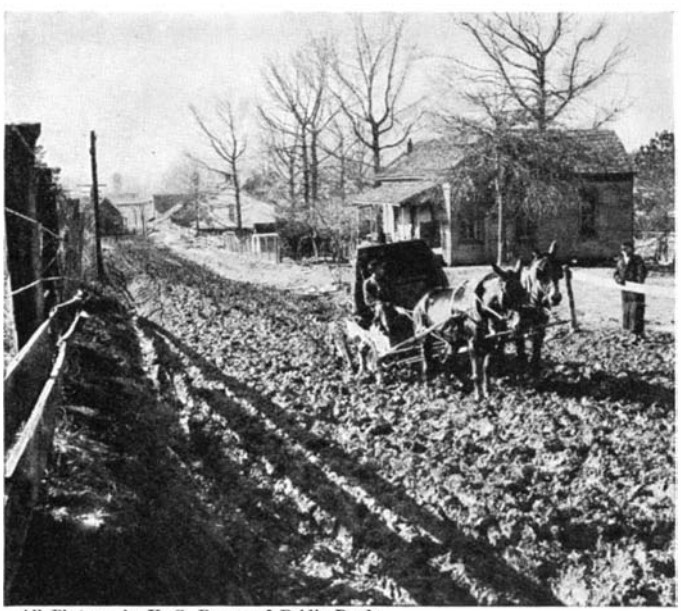
AS we look back upon it now we see that race as a great turning point in American transportation history; it is not too much to say in American history. The greatest need of the country at that moment was its need of means of transportation that would enable people to travel and move goods over long distances quickly and cheaply. That is what the railroad gave it; and the railroad made this country. There is no doubt about that.

By no other means could so vast an expanse of virgin territory have been so quickly settled. Certainly, by no other means would that settlement and the ensuing economic development have taken precisely the same course.

When the first rails were laid, the first regularly established roads were 200 years old in Virginia, and up and down the Atlantic seaboard there were roads almost as old in the other 12 original states.

It was not entirely the fault of the roads that in the first century and a half after Jamestown there was no settlement west of that narrow fringe of the continent between the Appalachians and the Atlantic. The fact that the Colonies looked backward upon the Mother Country rather than forward to the wild land to their west was perhaps the largest contributing factor to this result. The people, grouped in small hamlets or scattered thinly over the narrow settled area had, for the most part, the simplest of wants, and were almost completely self-sustaining. Their trade was with England rather than with the other Colonies. So there was very little reason for them to travel far from the home hearth, and they did travel very little.

It is easy to see how these conditions would be changed by the Revolution and the causes leading to it. The common quarrel with England arose over taxes imposed upon articles of trade. The accustomed trade communications with that country were broken; and more and more the Colonies were thrown into commercial relations with each other. After the war there was another and stronger reason which demanded for the first time an improvement of the main routes of travel from colony to colony. That was the need of preserving and fostering the rather feeble Union that threatened for a time to fly apart.



All Photographs U. S. Bureau of Public Roads

Only a few years ago, America had roads like those in the days of the Colonies—all bad! In recent years, however, we have laid thousands of miles of highways like that below

So, in a land in which all roads had been alike, all bad and all local, there was developed a new kind of road, improved as to surface with rock or gravel, and traveled by flying stage coaches and freight wagons whose runs were between the larger cities and the states themselves.

These were the turnpikes. So rapidly did they grow after the Revolution that when Albert Gallatin, Secretary of the Treasury under Jefferson, made his report to Congress on the state of internal improvements in 1808 he was able to say that there were more than 3000 miles built or building in New York

alone, 770 miles completed in Connecticut, and hundreds of miles in other states.

We went ahead building turnpikes until well along to the middle of the century; but after that race between *Tom Thumb* and the coach horse, there was no real question about what was to happen. To the man in the street, of 1830, and to many that sat behind important desks in counting houses, and others who might be expected to study and know the situation, the railroad meant simply a new kind of road and the steam locomotive simply a substitute for Dobbin.

THERE was violent opposition, of course. The stage-coach men set up a terrific clamor. They would be ruined and the country would be ruined with them, if this thing were allowed to happen. There was a rather vocal group of citizens, excessively proud of their newly donned democracy, who objected to the new roads on the ground that they were undemocratic, who protested that common roads were good enough for common people. Let the rich ride on railroads if they would! Then there were those who knew that the excessive speed of the trains—actually 15 miles an hour—would soon cause all right-thinking people to give up the insane notion.

As for the friends and promoters of the new roads, they were busy building track and planning and purchasing new equipment. Body styles in coaches occupied a good bit of attention; and new and better locomotives were produced annually.

In 10 years' time nearly 3000 miles of railroad were built. Miles upon miles of it were conceived to render the kind of service which no railroad has ever yet been able to render satisfactorily.

Here were people in need of a radically new sort of transportation agency, if any people ever were. Here was precisely the kind of transportation agency they needed. And there were many so blind that they could only see in it an affront to their backwoods democracy, and among the more alert, few who could think of any use to put it to other than that for which the common roads were quite adequate.

The usual plan involved the construction of a short line serving a city, to be operated for a distinctly local purpose. Connection even between important cities within a state came only when lines projected from one center entered territory tributary to another, and even then there was often a deliberate effort to defeat what we now know to be the principal mission of the new agency, by laying the tracks on different gages so as to prevent transfer from one to another.

But there were some men who saw the real meaning of the railroads; some like Benjamin H. Latrobe, one of the greatest of the early railroad engineers, who had seen clearly for many years the difference between the service for which railroads were fitted and that for which the common roads would suffice. It was such men as these, and the great builders who came after them, who made the railroads into the great continent-wide transportation system they became in the space of 60 years.

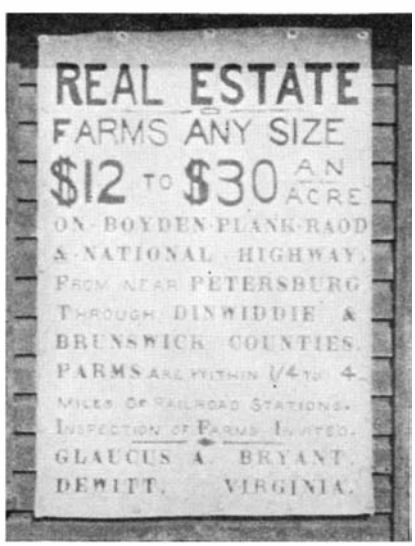
To repeat, it was the railroads that made the country. It was they that so quickly spread a population over a continent. It was they that built cities where log huts had stood short decades before. It was they that, by spreading our people thinly over a vast, virgin, and fabulously fertile area, enabled us quickly to garner marvelous riches.

CERTAINLY, the common roads had nothing to do with these major trends. The turnpikes, deprived of their traffic by superior rails, lost completely their character as main arteries, and becoming once more, in point of usage, purely local lanes, reverted from private corporate ownership to public control at the hands of inefficient local authorities. Again, as in the days of the Colonies, America had but one kind of common road—a bad road.

It was known that the cost of transporting a bushel of wheat nine miles to the railroad in a Middle West state was as great as the cost of shipping it thence by rail and water to Liverpool. But who wanted a farm nine miles from the railroad anyway? Nobody; and nobody had to take one because there was plenty of good land much nearer.

For it must be said that this the railroad did also! It developed a great territory, but it did it extensively. It brought New York close to San Francisco; but it left land within 50 miles of each in virtual isolation. Picture the rail system as a great network covering the whole area of the United States, with cities at the intersections and

A survivor from the day of the turnpikes. Now and then, in out-of-the-way places, one may find one of these old toll gates but as a general rule our highways are open to all



Proximity to the railroad was for years of primary importance in land valuation as this old poster shows

In the early days of road improvement, the railroads sent out many "good roads" trains

narrow bands of cultivated land bordering each strand, their width limited by the difficulty of reaching the railroad over all but impassable roads, and you have an idea of what the railroad did. In the center of each mesh there was idle, unproductive, isolated land. But the cities, standing at the intersections, grew fat upon what the railroad brought them, and more than fat—congested. Without aid the railroad could do much; but the more it did to develop the country the nearer it drew the day when it could do no more.

At the turn of the century, the railroad was nearing its height. The country likewise was approaching the peak of its rail-induced prosperity. But, no one can say we are not a favored people! Providentially, it seems, there was already at hand the new agency that was needed to carry us further. We were approaching another transportation turning point. Whereas in 1830 it was new facilities for distant movement that we needed, what we needed in 1900 and would soon need badly was better facilities for local movement. Well, there was the gasoline engine and the motor vehicle, and the urge for better roads.

WHAT followed is such recent history that we can pass over it very quickly. There was the same misunderstanding of the character and mission of the new vehicle and its roads as there had been in 1830 of the character and mission of the railroad. A passing fad! Toy of the idle rich! Ship by truck! Ship anything, anywhere! Transcontinental highways! No; farm-to-market!

The War; rails clogged; thousands upon thousands of motor trucks thrown into the breach. They save the day; but the unready roads are ruined! Damn the trucks! No, rebuild the roads and rebuild them right. Finally, out of all the clamor, the emergence of clear principles of highway transportation, and the building of systems of state and federal-aid highways with a speed and efficiency that surprises the world. A whole people owning motor vehicles.

Far-seeing railroad executives were among the first to see the need for better roads. They were quick to place at the disposal of the Office of Public Roads the "good roads trains" that first carried the message of improved highways into many a community. Far-seeing railroad executives today know that the railroads do not now and never have performed a complete transportation service. They know that their freight must come to them over highways and that the only way by which the area tributary to their lines can be increased is by improvement of the highways that feed them. They know, too, that the highway and the motor truck and the motor bus afford them the means of solving many of the problems of congestion, of short-haul, of branch lines, that are insoluble without them. These far-seeing railroad executives look upon their companies as transportation agencies—not as rail carriers bound fast to their rails. They expect to use the highway and the motor vehicle to supplement their rail service.

But not all who speak for the railroads are far-seeing executives. There are those who, seeing the conditions of their business change, can think of nothing better to do than decry the change. The truck is robbing us of our business, they say. (It carries about 2 percent of the total ton-mileage of freight, of which the railroads carry 77 percent.) The motor vehicle is subsidized. It pays nothing for its roads and competes unfairly with us who must build our own tracks. (The motor vehicle pays 82 percent of the cost of the main roads over which it competes to any degree with the railroads; and 23 percent of the cost of the local roads which are the necessary feeders of the railroads.) We are unduly restricted by public regulation. Restrict the motor vehicle similarly. (See "Our Railroads Must Be Saved," SCIENTIFIC AMERICAN, February, 1932—*Editor*.)

As a sample of the kind of regulation of the motor vehicle proposed in the interest of the railroads, refer to the recent act of the Texas legislature which limits the load that may be carried upon a commercial motor vehicle to 7000 pounds unless it is carried to a railroad station, in which case 14,000 pounds is permitted.

Two views of the same road, before and after. *Above:* The National Pike in Ohio in 1915 before improvement. *Below:* The same section of highway in 1928

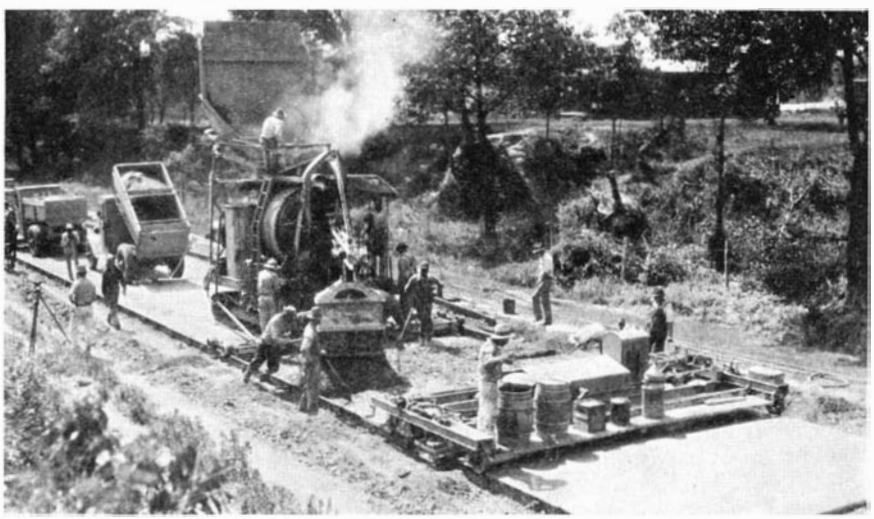
All of this has a most familiar ring. It is distinctly reminiscent of the cries of the stage-coach men in 1830. But there is far less reason for crying. For all of us will join with the railroad defenders in the answer to the query: "How could the country get along without the railroads?" The answer is "It couldn't." But some of us may be inclined to add: "And just you try to get along without the highways and the motor vehicles and see what happens."

There is no disposition to minimize the seriousness of the problems involved in the necessary readjustment of the railroads to the new conditions. They have lost much to the private automobile that can never be reclaimed. They will lose more to the truck and

the bus. Loss is unavoidable in the adjustments that must take place; but there is gain to be had by the railroads also if they are wisely managed.

But, alone, they can not serve the future of this country. Their unaided task is done. The quick, extensive exploitation of the land is over. Henceforth we must follow the path of older nations toward the intensive development of the deeper lying wealth. We have ploughed the center of our field. Now we must begin the job of ploughing around the borders; and that is another kind of job, calling for a rig that will permit the furrow to be turned close to the fence.

The road and the motor vehicles are the new transportation facilities which, joined with the different service of the railroads, will make possible the intensive development that lies ahead.



Above: **In some sections the road mender still used his primitive tools until the dawn of the 20th Century.** *Below:* **Modern concrete road-building operations**

We have just begun to build roads. Fifteen years ago there were still a number of states that could not be crossed by highway in comfort. Since then we have made much progress with the main roads. Of these—the state and federal-aid roads—there were 325,000 miles in 1930 and 226,000 miles were surfaced. But of the 2,680,000 miles of local roads only 467,000 had been surfaced. And of the surfaced mileage—state and local—a very large part was still of pioneer type, for in the improvement of our road system we are following exactly the methods of the railroad builder. The first job has been to get the traffic through. To do that we have built by stages. At first we build a grade and a light surface, perhaps a narrow one. Admittedly inadequate, they serve until something better can be added. Just so, the railroad builders laid their first tracks directly upon the soil and left the ballast to be added later. Just so, they built at first a single track and let the second wait until the traffic increased sufficiently to warrant it.

The road builder's test of the character of the road to be built is: Will the traffic pay for it? By that he means will the accumulated savings in operating expense accruing to the number of vehicles that will use the road as a result of its improved surface and grades—will that accumulated saving pay and more than pay for the improvement? The roads we are building meet that test.

But we stand now about where the railroads stood in 1880. The main lines are cut through and traffic is moving. There is a big job of new construction ahead on thousands of miles yet unimproved; there is as big a job of gradual upbuilding of the roads already improved to some degree as the growing traffic requires it. We are not even in sight of the end of original construction; and of course maintenance, and reconstruction—the operating functions—must go on as long as the roads are used.

We are not investing the large sums we are pouring into this newest of the great works of internal improvement simply to provide pleasure roads for motorists. The purpose is much more serious than that, as I have tried to indicate. It is commerce as well as personal travel that we are providing for—a kind of commerce, an intensity of commerce that will not be possible unless we have these roads. It is absolutely necessary that we build for trucks as well as for automobiles; and the roads we are *now* building are not destroyed by trucks. The story of such destruction no longer has the merit of truth, but it has been given considerable vitality by much assiduous propagation; we find that it has even won acceptance by the federal courts.

We have come to our present state of national and economic development by two roads. For 200 years of our early existence we had only the common road—a mere trail in the seemingly limitless wilderness of a raw country. Then there opened before us a better road—the railroad—by which we have traveled in a hundred years to the limits of that vast territory, spreading over it as we went an extensive culture. Now we have reached the point where we must intensify our development. We no longer look beyond the horizon for our fortune, but in the next field. Long distance and large bulk will continue to be the specialties of the railroads in increasing measure; but with them we now have a great multiplication of short distances and small volumes, and for this the common road comes back and on it a new vehicle built to our exact need.

HENCEFORTH there are two roads—the railroad and the highway. Both go forward. We must use them both.

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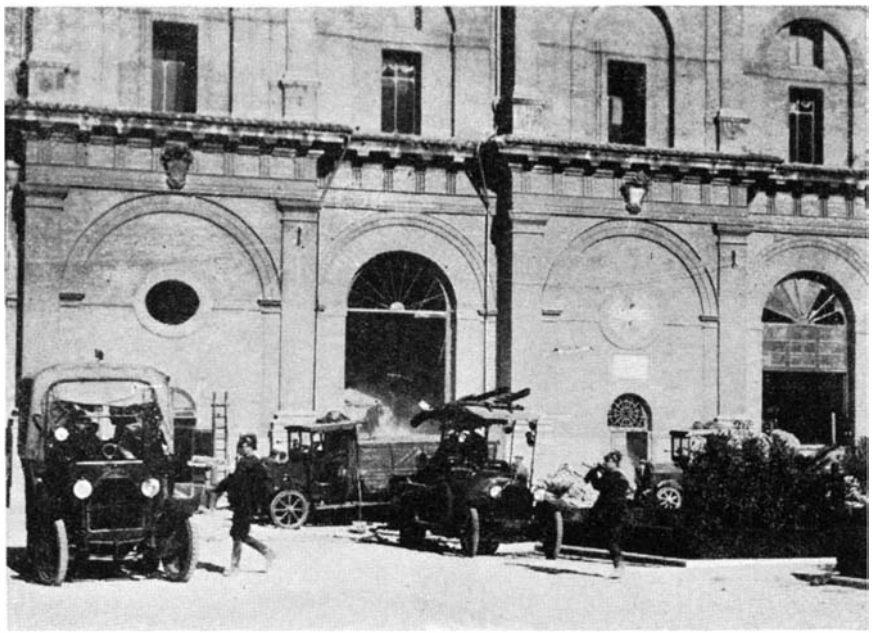
A United States Army general becomes a captain of industry, controlling a world-wide communications system. Why was such a man selected? An article soon to be published tells the whole story.

THE DISASTER IN



Firemen of Rome reached the Vatican after the collapse of the roof of the Sala Sistina and searched for the dead. Five bodies were found under 700 tons of debris that covered them

The Collapse of the Roof Is Laid to an Infinitely Slow Earthslide Unforeseen by the Original Builders . . . . . .

THE Vatican is one of the great cultural heritages of the ages. With its gardens it occupies a considerable part of the 109 acres of land which comprise Vatican City. It is not of great antiquity, dating only from the 15th Century, as the Popes formerly lived at the Lateran Palace on the opposite side of Rome. The Vatican owes its priceless collections of sculpture, paintings, antiquities, books and manuscripts principally to the art loving Popes of the Renaissance who assembled the greatest collections in the world.

When the news of the falling of a portion of the roof of the Sala Sistina was brought to me in the early afternoon of December 23rd, I felt a personal sorrow which is very easy to explain. I had made three visits to Rome in connection with the installation of modern stacking in the Vatican library. The irony of fate was that if the accident had been deferred for only a few weeks, the books would have been housed in the new American-built stacks which had just been completed in the gallery of the old mosaic factory.

Before considering the disaster let me explain how the modernization of the wings adjacent to the Sala Sistina came about. In 1928 the Carnegie Endowment for International Peace provided funds for indexing and cataloguing a section of the library. An American mission of librarians under the leadership of Dr. W. W. Fisher of the University of Michigan visited Rome and worked with the Vatican library staff to perfect both the technical and physical arrangements for the new library. Extensive new bookstacks were a prerequisite, and for the initial unit estimates were secured from British, French, Italian, and American firms. In the end, preference was given by the Pope to an American concern, and stacking from a Jersey City plant 4000 miles away now cares for some of the greatest literary treasures in the world.

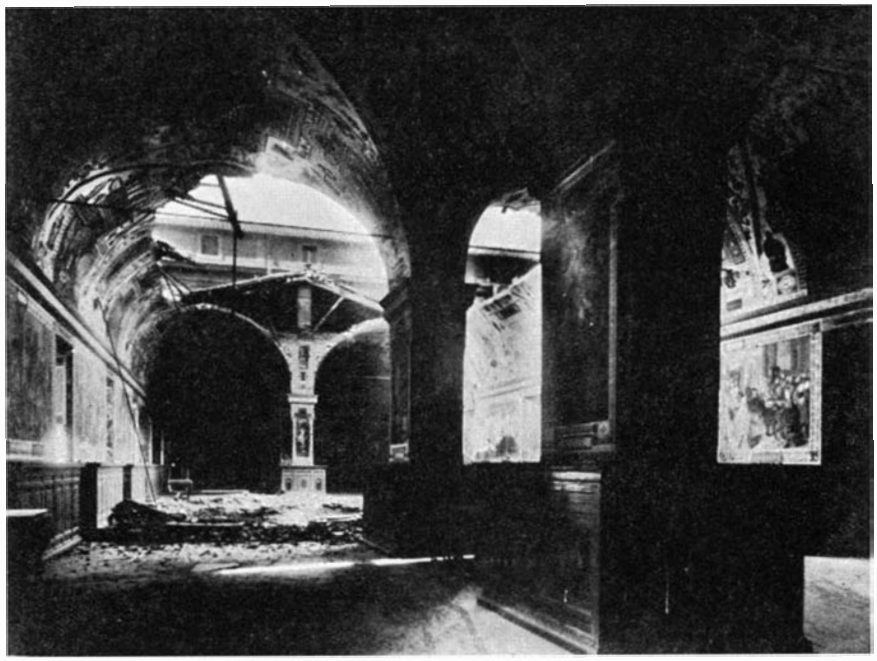
The present Pope is a librarian of distinction and was at one time Prefect of the Vatican library. While holding a deep appreciation of art and antiquities, he is at the same time eager to take advantage of modern opportunities. He therefore readily ordered the conversion of the old Vatican stables into an up-to-date library stack room and the erection of a new building to house the Vatican mosaic factory in order to make room for a still larger stack extension. The new stacks are of a type well known to the American librarian but never before seen in Europe. They have a combined capacity of 770,000 volumes which will allow for increased collections for a long time to come. The new stacks are in two long galleries, each having three tiers with deck floors of white Carrara marble to reflect light. Electric lights that switch themselves off after three minutes, and a system of cleaned and tempered air are novelties for the stately old Vatican.

AT a very early period the Popes began to collect and preserve documents, thus gradually forming the archives which are mentioned as early as the 4th Century of our era. The library, which can now be regarded as one of the leading public reference libraries of the world, was established in 1450. In 1588 Sixtus V erected a new library wing across the Belvedere court where there was a change in grade

The superb Sala Sistina, a section of which was destroyed by the collapse of the roof, destroying 1000 rare books, damaging many more, and killing five persons

THE VATICAN LIBRARY

By
ANGUS S. MACDONALD
President of Snead and Company



View of the library taken after the accident, showing the faulty construction of the roof; two of the great pillars fell. The frescoes portrayed the birth of alphabets and also great libraries

of about 15 feet and it was in this structure that the collapse occurred, carrying destruction through three stories.

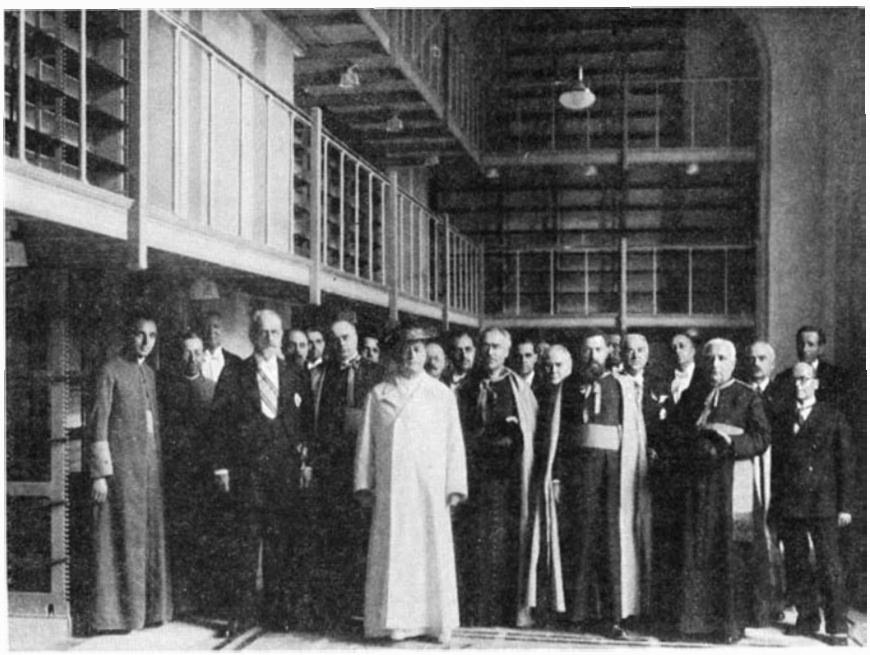
There has been much speculation as to the cause of the disaster. It has been attributed to worms destroying the roof trusses, vibration from the Vatican City power house nearby, concrete construction without the reinforcement familiar to builders of today, and faulty foundations. Characteristic of the construction of the old building was the lack of technical information concerning foundations. Massive masonry construction was erected without complete understanding of subsoil formations which frequently settled or shifted. The numerous cracks which have appeared from time to time in the Vatican buildings are doubtless the result of such settling. In the original stack-construction work of 1928 this factor was taken into consideration and substantial foundations were assured.

The latest report from Rome, however, blames the cause of the accident to an earthslide. Signor Mannucci, for many years chief architect of the Vatican, is satisfied that the earth under this part of the Vatican, due to the change of grade, is slipping with infinite slowness and carrying the structure with it. Repeated cracks have appeared in different parts of the structure as is borne out in a letter to me by Monsignor Eugène Tisserant, Sub-Prefect of the library, which is of special value as being the testimony of an expert. He says:

"Ten minutes before the collapse I was in the reference room examining a crack in the pavement. We have seen so many cracks in our old buildings that it is not usually a matter for serious thought. Fifteen of them perhaps had been repaired in September in the same pavement, and none of them was serious. The roof was made in a very curious manner, with only rafters and struts, the principal rafters being heavy beams connected only by two inverted V's of iron on each side fixed to each rafter by three or four big nails.

"ALL the central part of the building, two pillars, the intermediary arch, and half of the adjacent ones fell from the roof to the ground in a very short time, some say two or three minutes; it seemed to me less. As soon as the collapse occurred, the firemen of Rome arrived. Sixty of them were at work and in a few minutes 40 more were helping uncover the bodies of the five men buried in the collapse. This work was carried on with feverish haste until the last body was recovered. Seven hundred tons of debris were removed. Meantime we were removing the books to the new stacks in the old mosaic factory. Carpenters erected scaffolding sufficient to support the rest of the pavement and arches. Rain began on the 27th just ten minutes after all the books were protected. From 800 to 1000 of the books are so damaged that it will be impossible to repair them. Perhaps 10,000 need to be cleaned, repaired, or rebound."

In spite of the shadow cast by this disaster the program of technical and physical development to make the treasures of the library available to scholars of the world is being carried forward with all possible facility.



Pope Pius XI opening the stack wing of the Vatican library in November, 1931. In a few weeks the books which were destroyed would have been housed here

TOTEM POLES—

Their Significance and Modern Origin

By MARIUS BARBEAU

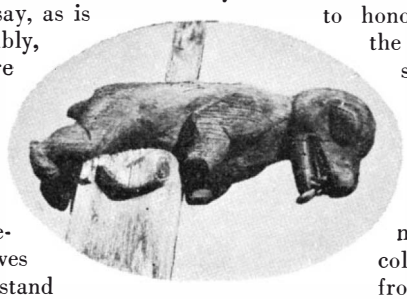
Photos by the author

The finest totem poles in existence, near the Nass River. Several of them will soon topple over from old age

TOTEM poles were once a characteristic form of plastic art among the tribes of British Columbia and southern Alaska. The natives took great pride in them and exerted every effort to make them worthy symbols of their own social standing and achievements; they were discriminating judges of the quality of a carver's work.

The art of the totem-pole carver now belongs to the past. Ancient customs and racial stamina are on the wane everywhere, even in their former strongholds. Totem poles are no longer made. Many of them have fallen from old age; they have decayed and disappeared. Some have been sold, cut down, and removed to museums or public parks. Others have been destroyed by the owners themselves in the course of hysterical revivals held under the banner of Christianity.

The poles as a rule face the water front. They stand apart from each other, usually in front of the owner's lodge, and they dot the whole length of the village, in an irregular row. Their height ranges from 10 to 60 feet. They were carved from large cedar trees carefully selected and sometimes hauled from a long distance, and erected in commemoration of the dead, in the course of elaborate ceremonials. Now that the villagers have moved to new quarters, to keep up with the times, the poles seem forsaken in the old deserted abodes of the past, among cabins where some of the natives casually smoke salmon in the summer. Some of them have already fallen and decayed, while others lean precariously or totter in the wind, soon to come down with a resounding crash.



It is a mistake to say, as is often done irresponsibly, that totem poles are hundreds of years old. They could not be, from the nature of materials and climatic conditions. A green cedar cut and reset without preservatives in the ground, cannot stand upright far beyond 50 or 60 years on the upper Skeena, where precipitation is moderate and the soil usually consists of gravel and sand. Along the coast, it seldom can endure for much more than 40 years in the dampness that prevails most of the time, and in the muskeg foundation in which it is set.

A POLE was left to stand as many years as nature, unopposed, would permit. Sometimes two or three poles belong to the same family and commemorate the same name as borne in as many succeeding generations. They stand side by side in front of the owner's house. It is not the custom to mend or transplant a pole, however precarious its condition. Once fallen, the pole is pushed aside, if it is in the way, and decays gradually or is cut up and burned as firewood.

The art of carving poles is not really as ancient as is generally believed. The growth of this art to its present proportions was confined to the 19th Century; that is, after the traders had introduced European tools—the steel axe, the adze, and the curved knife—in large numbers among the natives. The lack of suitable tools, wealth, and leisure in earlier times precluded the existence of elaborate structures. The benefits that accrued from the fur trade, besides, stimulated ambitions and rivalries between the leading families. Their only desire was to outdo the others in wealth and display. The totem pole became, after 1830, the fashionable way of showing one's power and crests, while commemorating the dead or decorating the houses. The size of the pole and the beauty of its imagery published abroad the fame of those it represented.

The native accounts of the earliest carved poles lead to the conclusion that carved house-front poles and house-corner posts were introduced first, many years before detached memorial columns to honor the dead became the fashion. However, this style of house decoration was superseded as soon as the natives gave up building large communal lodges of the purely native type; memorial columns standing away from the houses became

Row of totem poles at Kitwanga, on the Skeena River; since restored. *Above:* Carved grizzly bear atop pole, executed by Haesem-hliyawn

the new fashion. It is fairly safe to say that none of these monuments existed on the coast before 1820 or on the upper Skeena before 1840.

The remarkable west-coast custom of carving and erecting house poles and tall mortuary columns or of painting coats-of-arms on house-fronts is sufficiently uniform in type to suggest that it originated in a single center and then spread in various directions.

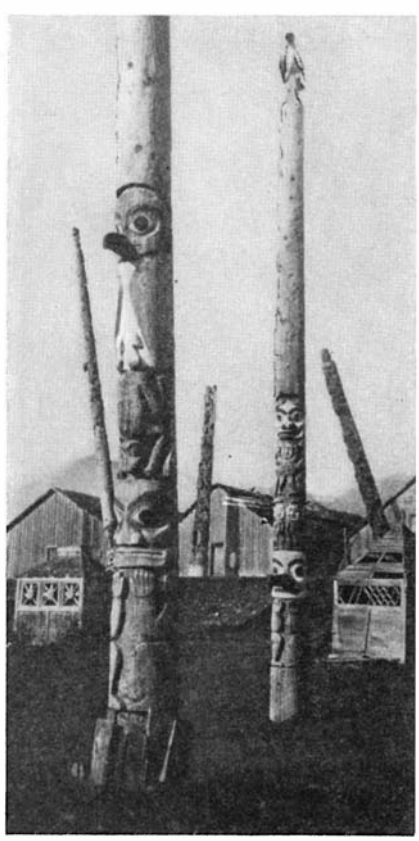
THERE is a striking lack of evidence in the memoirs of the early navigators—Cook, Dixon, Meares, Vancouver, and so on—as to the existence of totem poles proper; that is, of detached funeral memorials, either south or north. Yet several villages of the Tlingit, the Haidas or the Tsimsyan, the Kwakiutl, and the Nootkas were often visited by mariners in the early days. The casual descriptions or sketches that appear in some of their records of exploration fail to give us any hint of their presence, still less of their actual appearance. For example, Dixon examined several of the Haida villages on the Queen Charlotte Islands; yet there is no mention of totem poles in his records. He, however, described small carved objects, trays and spoons, and left some illustrations.

But there were already—from 1780 to 1800—some carved house poles in existence. The custom of carving and erecting memorial columns to the dead is therefore modern; it may exceed slightly the span of the last century.

PRECISELY where did the totem poles or mortuary columns first appear and at exactly what moment? The presumptions boil down to two. These heraldic monuments first became the fashion either on the Nass River or among the Haidas of the Queen Charlotte Islands. At first sight it seems more likely that the Tlingit, of the southern Alaskan frontier, might have initiated the custom of erecting memorials to the dead. They were closer to the Russian headquarters, and must have been among the first to obtain iron tools. There is no doubt, also, that they were most skilful carvers and weavers, through the whole local evolution of these crafts. Yet there are good reasons why the credit for originating totem poles should not fall to their lot. We know that the early circumnavigators that called at some of their villages made no mention of large carvings, not even of such house or grave posts as they observed among the Haidas to the south. The custom of planting poles is not widespread among the Tlingit. Most if not all the Haida and the Nisrae tribes, on the other hand, were totem pole carvers and owned many poles in each village. The concept is more typically theirs than it is Tlingit.

The Haida poles, as we know them, are partly house poles and partly totem poles proper; the house poles are far more numerous in proportion among them than among the Tsimsyan. Indeed, none of the present Nisrae carvings were house poles. The two large posts observed among the Haidas by Bartlett and Marchand, in 1788-1792, were house portals. Though the Haida villages were often visited at the end of the 18th Century and in the first part of the 19th, we find no other reference to large poles; not even to the famous rows of poles at Massett and Skidegate which were photographed about 1880. They were presumably from 10 to 30 years old when the Haidas became converts to Christianity and in consequence gave up their customs, cut down their poles and sold them to white people about the year 1890 or afterwards. There is no evidence of mortuary poles among the Haidas antedating 1840 or 1850, though a few earlier and transitional ones may have served to introduce the fashion.

The probabilities are that totem poles proper originated among the Nisrae or northern Tsimsyan, of the Nass River. It seems that a few mortuary columns were erected on the lower Nass at a fairly early date, that is, a few generations ago. It is otherwise evident, from traditional recollections, that the custom of thus commemorating the dead is not very ancient among them, and it is far more likely that the Haidas and the Tlingit imitated them than the reverse.



Totem poles and Indian houses at Gitwinlkul, in British Columbia

Base of an old totem pole lost in the bush at Angyada, on the Nass

The estuary of the Nass was the most important thoroughfare of Indian life in all the northern parts. This is in British Columbia south of the long southern leg of Alaska. *Ulaken* fishing in the neighbourhood of what is now called Fishery Bay, near Gitrhatin—the largest Nisrae center—was a dominant feature in native life. The grease from the *ulaken* or candle-fish was a fairly universal and indispensable staple along the coast. For the purpose of securing their supply of it, the Haidas, the Tlingit, the Tsimsyan, and the Gitksan traveled over the sea or the inland trails every spring and camped in several temporary villages of their own, from Red-Bluffs eastwards on the lower Nass, side by side, for weeks at a time. During these yearly seasons, exchanges of all kinds, barter, social amenities, or feuds were quite normal. As a result, cultural features of the local hosts—whether they were willing hosts or not is an open question—were constantly under the observation of the strangers and were often a cause of envy or aggression.

IT is accepted among specialists that the Nass River carvers were on the whole the best in the entire country. Their art reached the highest point of development ever attained on the northwest coast, and their totem poles—more than 20 of which can still be observed in their original locations—are the best and tallest seen anywhere.

'SEEDS' OF MASS PRODUCTION

By JAMES G. DONLEY

INFINITE variety in the things she produces is perhaps the goal of Nature, as it is undoubtedly her greatest charm. Exact duplication, on the contrary, is of necessity the goal of man's production efforts, and his near approach to perfection in making two things identically alike is perhaps his highest mechanical achievement.

Each individual product of Nature's workshop reaches its final form through a process of growth during which its parts exist in active relationship to one another. The branch fits the tree trunk, the leaf fits the twig, the flower and fruit the stem, because they grew there —at least, that is the obvious reason.

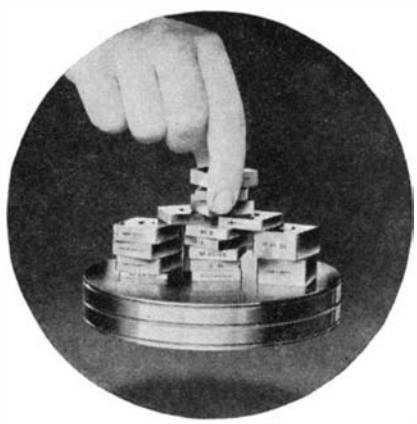
In his efforts to produce adjoining parts of a machine, which will fit together as smoothly and accurately as the knee-joint of an animal, for example, man labors with infinite patience to microscopic measurements. Machines, like living things, have been improved through an evolution-like process down the years, but the only analogy with Nature's method of growth lies in the process of putting the various parts together—assembly.

We hear it said "as like as two peas in a pod," but no two peas in any pod even approach man's accuracy in making machine parts identical. Man has developed remarkable ingenuity for making things more and more accurately alike. In fact, man's entire progress in mechanical production, especially in building machines, has pivoted upon his closer and closer approach to an ideal of accuracy.

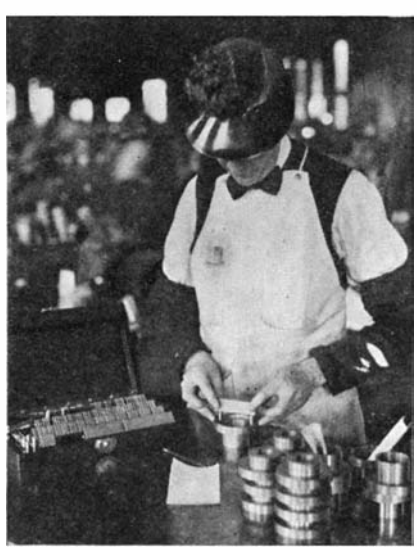
IN many living things, to seek another analogy with the methods of the Master Manufacturer, tiny seeds carry within themselves that which marvelously patterns the growth after the likeness of its kind. The "seeds" through which man reproduces thousands of machines in duplication of the parent model are small blocks of steel—precision gages—which epitomize his highest achievements in accuracy. These gage blocks are the most accurately manufactured articles in the world, representing precision in the order of millionths of an inch.

Just as the oak tree has its beginning in the acorn, the finished automobile has its beginning in gage blocks. Without gage blocks the automobile could not have become ubiquitous.

The reason for this is that interchangeability of parts is the first principle of mass production. True interchangeability of parts means that the parts necessary for the complete product may be selected at random from thousands of others, just as they come from the production machines, and may be assembled readily into the finished product. Because of wear on machines and tools there must be constant checking of the tools, the working gages and



Gage blocks "wrung" together in stacks and supporting a heavy toolmakers' flat. This test proves that the gage blocks are self-checking



Toolmakers use gage blocks as a quick and accurate means of checking up all kinds of work. Note case of various sized blocks at left

the machines, as well as the finished parts themselves. This checking always works back to—or up from—the precision gage blocks.

I have used the automobile merely as an example of a machine which man has fashioned in immense quantities. In all truth it would be difficult to mention any convenience, any labor-saving machine entering into our everyday lives which does not owe its existence —in quantity sufficient to supply our needs and at a price within the reach of the average man—to progress in accuracy. Without our industrial structure of mass production, built upon accuracy, the cost of these products would be so high that their use would be limited to the wealthy. Progress in accuracy is not only working toward finer and better products, but it tends to bring these more satisfactory products within reach of the masses.

The story of the beginnings of accuracy is interesting. It was during the Civil War that American metal craftsmen first visioned the ideal of precision, for a very practical purpose. Muskets were urgently needed in large quantities. With the parts roughly machined, as was then the practice, it was necessary to finish and fit them together by hand. Under the spur of urgent need for firearms by the tens of thousands, the methods which have made our modern mass production possible were first thought out and put into practice.

From that day engineers have been constantly striving to devise ways and means to measure finer and still finer dimensions.

TO embody accuracy in gage blocks it was necessary first to produce metal having an inherent quality of maintaining accuracy. Everybody knows that wood swells and warps, but steel is commonly regarded as an inert, stable mass. On the contrary, steel which has been subjected to heat or stress is prone to later internal readjustments; it warps or "grows." Production of an inherently accurate steel for gage blocks has involved the expenditure of thousands of dollars in research and has demanded a long continued study of steel and methods of heat-treating and artificial and natural seasoning.

But accuracy is, of course, useless without a basic standard of measurement. Believe it or not, there was no commercial standard inch in America before the Civil War. The length of a commercial yard varied with the number of yard-sticks. The establishment of a standard inch, accurate to millionths of an inch, required years of

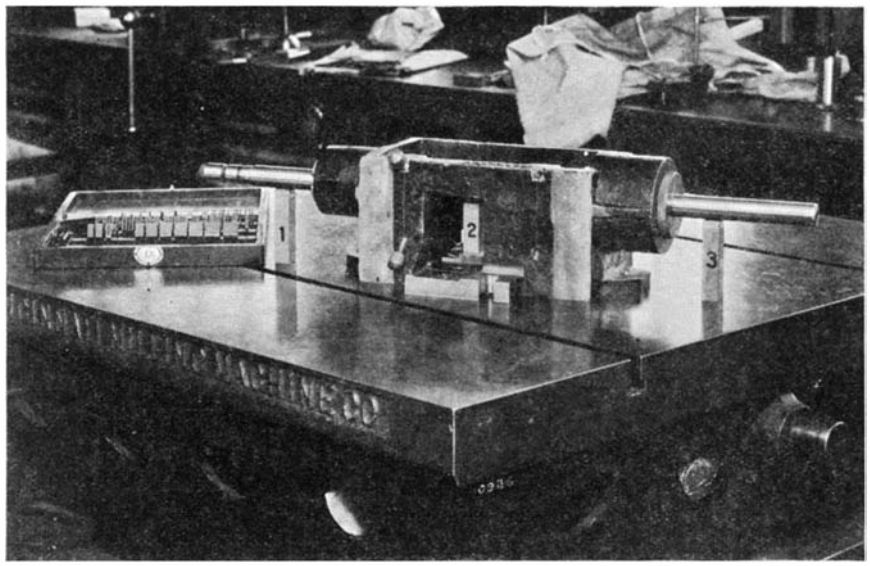
work, involving the conception and development of the now historically famous Rogers-Bond Comparator, reliable transfers of both the British Imperial Yard and the French Meter d'Archives, and exhaustive comparisons of the standard bars so prepared with the United States Standard Yard, designated as Bronze No. 11. This work, begun in 1879, was practically completed in 1885.

AGAIN spurred onward by war needs, accuracy made rapid strides during and immediately after the World War. During the war our manufacturers were handicapped by a pronounced shortage of accurate gage blocks, which up to that time had been imported from Sweden in very small quantities at high prices. Making millions of accurate parts in shops hundreds of miles apart and having these parts fit perfectly when assembled was not easy. Any one shop could produce the various parts fitted together, but there was no accurate commercial standard of measurement available at reasonable cost which each shop, large or small, could use as its basic standard to check and govern parts made to fine limits.

It was then that Major W. E. Hoke, of the Army Ordnance Department, working with the United States Bureau of Standards, developed the blocks which bear his name. Precision lapping —a finishing operation for parallel surfaces, more like polishing than grinding—produced blocks of far greater accuracy than previously had been possible. After the war the Bureau of Standards assigned the right to make these blocks, and the idea, originally a laboratory process, was developed into a practical manufacturing system. Gage blocks are now produced which can be guaranteed permanently accurate to within five millionths of an inch.

SUCH precision is well-nigh inconceivable. But you will be able to get some conception of it when you consider that five millionths of an inch in relation to a full inch is comparable to the thickness of a new dime in relation to the height of the Woolworth Building.

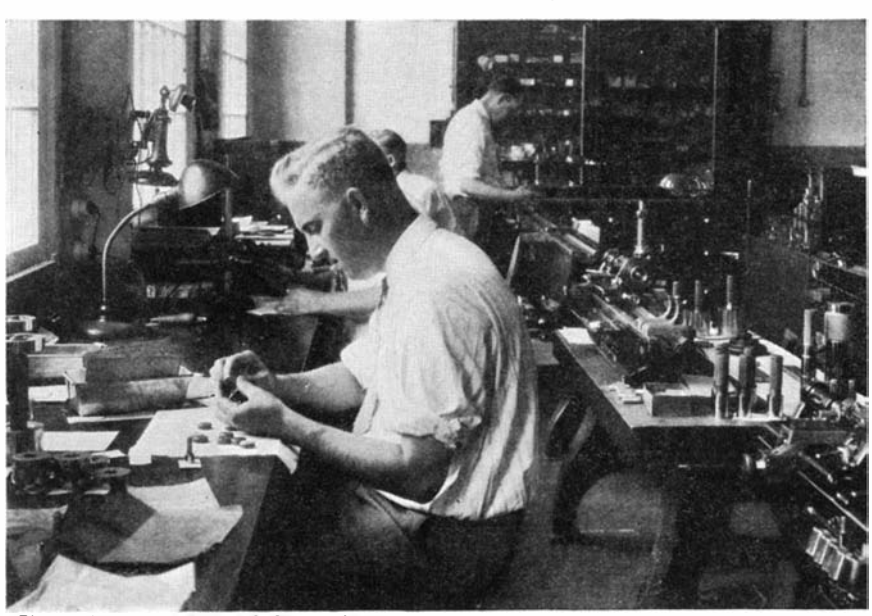
These gage blocks are solid square blocks of specially hardened, high carbon, chrome alloy steel. Each block has two gaging surfaces which are true, flat planes, parallel to each other, and the distance between the gaging surfaces must be accurate within a few millionths of an inch. The almost perfect accuracy and parallelism of the gaging surfaces of each individual block permit the combination of several blocks the total cumulative error of which cannot be determined except with extremely accurate measuring instruments. They are made in sizes varying from fractions to decimals, full inches, and multiples. With sets of blocks "wrung" together, any dimension can be obtained within a range from 0.1 inch to 10 inches, in increments of thousandths or ten-thousandths.



Gage blocks, usually of steel with two faces plane, parallel, and a specified distance apart, are used in the shop as reference standards for checking micrometers and other measuring instruments, and also as distance pieces or size blocks for precise mechanical work. Here three separate stacks (numbered 1, 2, and 3) were set up to check to very fine limits the spindle of an internal grinding machine

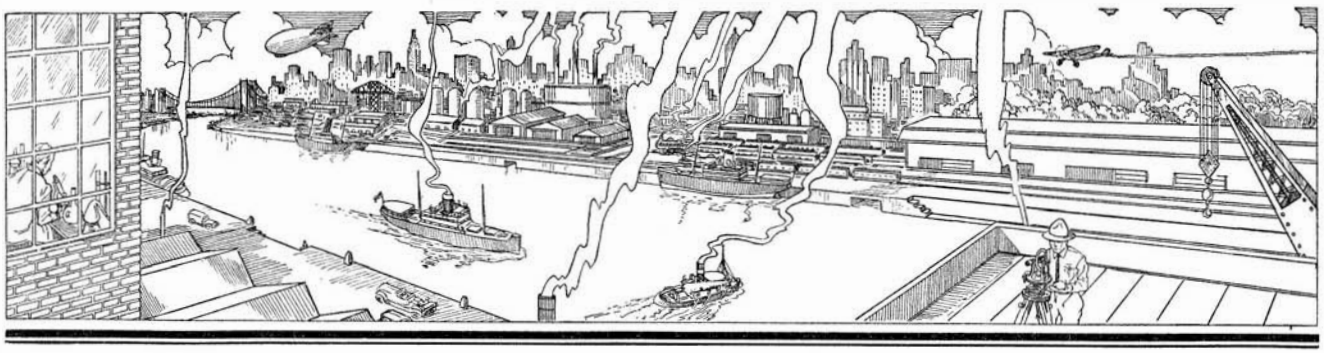
One of the most interesting things about these blocks is the fact that they can be "wrung" together and are regularly so handled in use. After being carefully cleaned, the gaging surfaces are placed together with a circular motion, using a slight pressure. A stack of 10 or a dozen blocks may be "wrung" together so that it may be held in a horizontal position by grasping only the end block, and such a stack will support more than its own weight. Tests have shown that when thoroughly "wrung" together, two of these blocks —and they are only one inch square on the gaging surfaces—will support a weight of 200 pounds before being pulled apart. Since the blocks are carefully demagnetized, the source of this force, many times that of atmospheric pressure, is a mystery which has so far defied solution.

It seems likely that accuracy finer than our present achievement of millionths never will be needed. Yet every day brings new applications of accuracy which improve or speed up or even make unnecessary past inventions. And perhaps the achievements of the next century in the science of gaging will make our present ideas look like schoolboy experiments—for engineers never have rested on their laurels. But accuracy, in whatever form, will always be the "seed" from which multiple production springs.



Photographs courtesy Pratt and Whitney Company

Checking gages to infinitesimal limits in a room maintained at constant, standard temperature. The two machines at right measure directly to .00001 of an inch



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

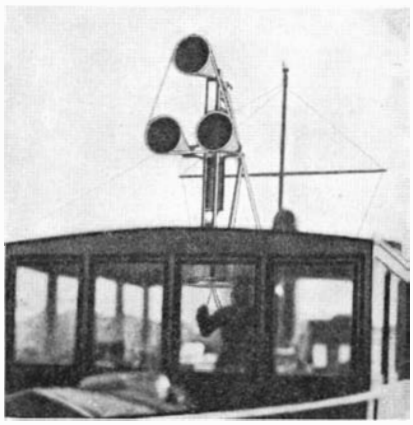
In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.

Lehigh University

Sound "Bullets" for Fog Navigation

"BULLETS of sound," which bound back to the boat from which they are sent and warn the pilot of fog-screened obstacles in his path, have been employed in an acoustic navigating device announced by Chester W. Rice, an engineer of the General Electric Company, and successfully operated off New London, Connecticut. The new device is termed a sonic locator, and is a direct outgrowth of the sonic altimeter recently developed by Mr. Rice as an aid to fog-flying.



The sonic locator was mounted on the pilot house of the motorboat *Wanango* for tests at New London

As the sonic altimeter tells the airplane pilot his distance from the ground and indicates the presence of projecting hills or buildings, so does the sonic locator, by using the sound-echo principle, warn the navigator of boats, buoys, or shoreline which may be totally obscured by fog.

A sending megaphone mounted on the boat projects short blasts of a high-frequency air whistle. These blasts strike objects ahead and rebound as echoes. The number of seconds elapsing during this interval determines the distance of the objects from the boat, in plenty of time for the pilot to avoid hitting them.

The new device consists of the sending megaphone and a pair of binaural receiving megaphones mounted in a framework which may be turned with a handwheel inside the cabin or listening post. The top megaphone contains a 3000-cycle air-whistle mounted at the effective acoustic focus of the horn. The receiving megaphones are connected by reducing cones to high-pass shielded acoustic filters, thence through a shaft to binaural ear-pieces worn by the listener.

Acid Mouth More Common in Calm Persons

ACID saliva, popularly known as "acid mouth," which attacks the enamel of the teeth, also has a relation to the personality of the individual. The more excitable person tends to have a less acid saliva than does the calm and apathetic person, it has been found by Dr. Gilbert J. Rich, of the Institute for Juvenile Research, in Chicago.

Dr. Rich suggests, on the basis of his and previous studies, that abnormal acidity or alkalinity may affect not only the temperament of the normal person, but also the more serious personality disturbances of mental disease. "So far the data all point in the same direction," he said. "The evidence may be summed up as showing that, in the gross personality deviations of mental disease, there is some disturbance of the acid-base balance; and that, by and large, lowered acidity tends to be associated with the more active states and heightened acidity with the more apathetic conditions."

A similar relationship was found by Dr. Rich between the excitability of the person and the amount of the chemical creatinine found in the blood. The most emotionally excitable persons have the greatest amount of this substance which is a product of muscular metabolism found in greater or less amounts in the blood of all normal persons.—*Science Service.*

World Record Non-Stop Run

"GO!" The starting flag in the hand of Charles Merz, official representative of the American Automobile Association, swept downward. Across the starting line on the huge brick oval of the Indianapolis speedway sped a heavily-loaded truck—almost 12 tons weight altogether.

Then, hour after hour, day after day, and night after night, the big truck circled the Speedway without stopping until two weeks had elapsed—and it had established a new world record.

It had traveled farther than any other vehicle of any kind had ever traveled before, without stopping and without refueling. At the end of the run, A.A.A. officials found that the speedometer registered 14,600 miles. The truck had run more than 10,000 miles on its original cargo of fuel and it had been re-fueled without stopping.

Down from the driver's seat stiffly climbed Dave Evans, veteran A.A.A. race driver in Memorial Day classics, and C. L. Cummins, relief driver, their faces covered with two weeks' growth of beards. To-

Before the start: The group that put on the test of the Diesel-engined truck

After the 14-day run on the Indianapolis Speedway, the tires of the truck which made the non-stop vehicle record showed little wear

gether, they had driven the truck to its new world record, alternately driving and sleeping in a bunk improvised in the truck. Mr. Cummins is head of the Cummins Engine Company, of Columbus, Ohio, and the designer of the Diesel engine which drove the truck to its new record.

Besides being a satisfactory, as well as spectacular, demonstration of the stamina of the Diesel engine applied to automotive use, the run showed up to remarkable advantage the General tires with which the truck was equipped. They showed almost no signs of wear even though, when the run started, the tremendous load of fuel oil carried had overloaded the truck balloon tires far beyond their normal capacity; and also in spite of the fact that the steeply banked speedway with its well-worn brick surface, repaired every few feet with rough patches of concrete, has cut many a good tire to shreds in a short time.

The maximum tread wear was three thirty-seconds of an inch on the center of the tread of the rear tires after being driven, without stopping, at an average speed of 43 miles an hour, a distance more than half way around the world. Four of the stock tires showed the same air pressure at the end of the run as that with which they had started. One had lost four pounds and the sixth tire had lost two pounds in the two weeks of the run.

Softened Water Not Injurious

SEVERAL employees in a certain office building were sent to the hospital with kidney trouble, and a rumor arose, "It's the salt used to soften our drinking water —they use 30 tons every year!" says *Chemistry and You.*

Chemical analysis of the water showed it pure and harmless and facts about the softening process dispelled anxiety.

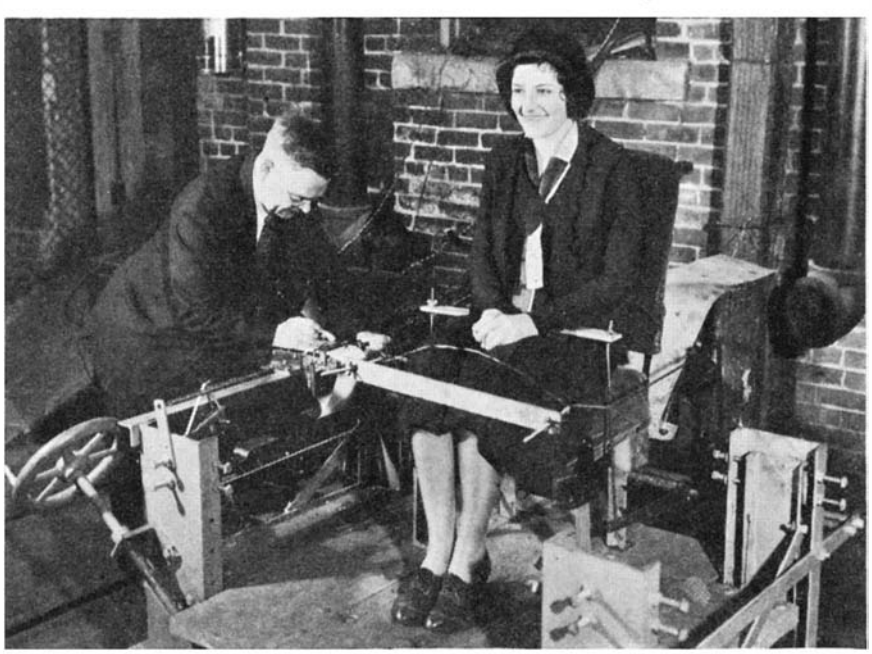
Salt is used, not to soften water, but in connection with a clay-like material, "zeolite," which is the softening agent in some apparatus sold for this purpose. When hard water is passed through the "zeolite," it becomes soft, but the "zeolite" must then be rejuvenated. This is done with salt, and the material is ready for use again. Salt does not enter into the softening process.—*A. E. B.*

"Shake Table" Aid to Motor Safety

"NON-SKID" automobile upholsteries materially aid comfortable and safe riding and driving positions in moving cars, a series of interesting "shake table" tests just completed at Purdue University disclose.

Thirty university students were taken by H. M. Jacklin, professor of automotive engineering, for a rough and jolty ride on the vibrating table which duplicated, in a few minutes, the effects of a long automobile ride. The subjects sat on four different kinds of upholstery fabrics while a recording tape measured their slipping and sliding on each sample tested. Ninety readings were made for each material and the averages computed by comparing all the curves recorded. The results showed that long pile mohair velvet and velmo were more than 50 percent more effective in maintaining correct posture than were the smooth-surfaced fabrics tested.

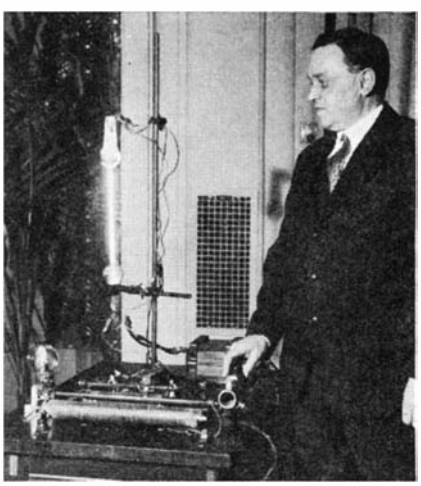
Riding conditions were duplicated almost exactly so that the experiments, according to the engineers conducting them, represented a true condition of actual rides. Rubber blocks were mounted under the rear of the seat to give the "pitching" effect experienced in passing over "washboard" roads.



The manner in which students of Purdue were strapped in the "shake table"

New Sodium Lamp is 70 Percent Efficient

ONE of the "Scientific Conquests of 1931" demonstrated by Dr. Harvey C. Rentschler, Director of Research of the Westinghouse Lamp Company, at a recent meeting of the New York Electrical Society was a sodium vapor lamp which is 70 percent efficient. This lamp, invented in Germany by Dr. M. Pirani, who is Director of Research of the Osram Company of Berlin, may prove to be an important link in man's search for an efficient light. Dr. Rentschler explained, however, that its practical applications, if any, have not yet been determined.



Dr. Rentschler, of Westinghouse Lamp Company, and the new lamp

The new sodium vapor lamp is three or four times more efficient than the neon lamp, and gives six times more light for the same current than does the 40-watt tungsten filament lamp. This increased efficiency is due to the fact that practically all the radiation from the element sodium, one of the two components of common table salt, falls very near that part of the spectrum to which the eye is most sensitive. This fact has long been known but its application to the manufacture of a lamp had not been found practical because vaporized sodium turns ordinary glass brown or black. The new lamp was made possible through the development by Dr. Pirani of a new glass which does not change color under the action of the sodium vapor.

Iodine from Seaweed

FEW people realize that seaweed is a valuable source for iodine and potash. Professor Thomas Dillon of University College, Galway, England, recently outlined a new method for obtaining the iodine and potash without using the usual process of burning the seaweed. Professor Dillon

places the seaweed in tanks where it is allowed to rot. The liquid formed contains both iodine and potash as soluble salts; and on evaporating and clarifying the deposit, the iodine and potash are easily separated. The residue left in the tank is principally cellulose, which may be used in the manufacture of paper or rayon. —*A. E. B.*

Detects Freshness of Butter

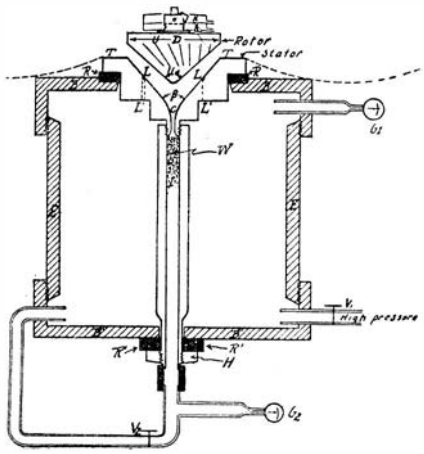
A DELICATE test has been developed by two Italian scientists for determining the freshness of butter. As reported by G. Testoni and W. Ciusa in an Italian scientific publication, the determination depends upon the presence of a compound called biacetyl. Melted and pasteurized butter as well as margarines do not contain any biacetyl, whereas fresh butter contains about .0005 percent. Nickel sulfate is used in making the test.

Giving One Disease to Cure Another

SIGNAL success in treating paresis, a hitherto fatal disease of the brain, has been achieved at St. Elizabeth's Hospital, government institution in Washington for the treatment of nervous and mental diseases, Dr. William A. White, superintendent of the hospital for 28 years, stated in a report recently made public.

The earliest patients treated by the new method have remained alive for over five years now, a sufficient time so that physicians feel certain of the success of the treatment. The disease, general paresis, is being arrested or cured in nine out of ten cases brought to the hospital, whereas a few years ago no one recovered from it and more than half the patients brought to the hospital died within a year.

The change is due to the discovery by a Viennese physician, Wagner von Jauregg, that paresis patients recovered from their brain disease after they had suffered an attack of malaria. Dr. White was first to use this treatment of paresis in America. That was in 1922. Success of the treatment depends on the fact that the microscopic organisms called spirochetes which cause paresis cannot live at a temperature over 104 degrees Fahrenheit. Malaria produces such a fever in the body of the patient, and when he has recovered from the malaria, the spirochetes in his body have generally died and his brain disease is arrested or cured. If the germs have seriously damaged the brain the patient will not recover his former mental competence, of course.—*Science Service.*



The ultra-centrifuge, a little "top" which rides on a steady blast of air

The Ultra-centrifuge

SO far as is known, all previous attempts to obtain extremely high velocities of rotation in any kind of apparatus have been surpassed by Dr. J. W. Beams and A. J. Weed of the Rouss Physical Laboratory at the University of Virginia at Charlottesville, who have driven a rotating cone of steel at as high as 500,000 revolutions per minute. While the Beams-Weed apparatus was devised for use as a centrifuge for separating liquids, as in a cream separator, its other possible applications in science and industry are likely to prove numerous.

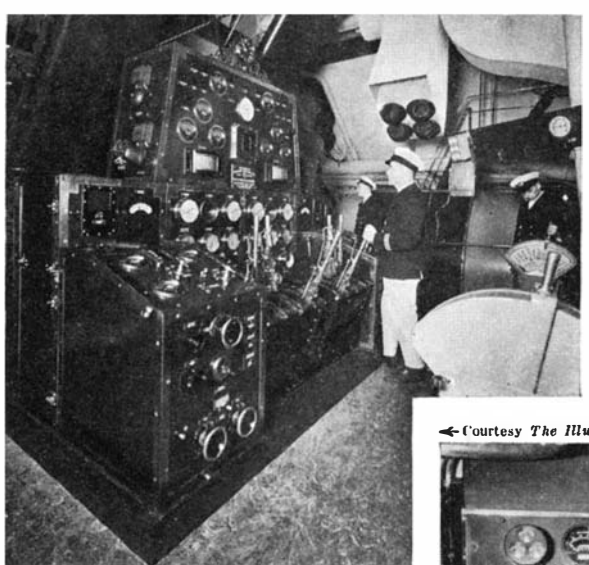
In the illustration, which is reproduced by courtesy of *Science*, the rotating part or rotor is shown at the top—indeed, it resembles a top. Its diameter is about an inch. The remainder of the apparatus is the stator. Air from a compressor is admitted to the chamber through the valve shown at the lower right hand corner, and the rotor, which is entirely detached from the stator, is then placed in position. Tiny air jets at L and L′ and from C at the center impinge on the rotor and slightly raise it. As its under surface bears diagonal flutings the rotor is given a rotatory motion. It finds a position of stable equilibrium very near the stator and continues to rotate at high velocity entirely on "bearings" of air. With a steel rotor one inch in diameter and air at 100 pounds pressure per square inch, a velocity of 3500 revolutions per *second* were easily obtained. The velocity remains remarkably constant as long as the air pressure remains constant.

The scientist-inventors have perfected a way to introduce liquids and remove them without stopping the centrifuge, the rotor being hollow and having small communicating openings near the top center.

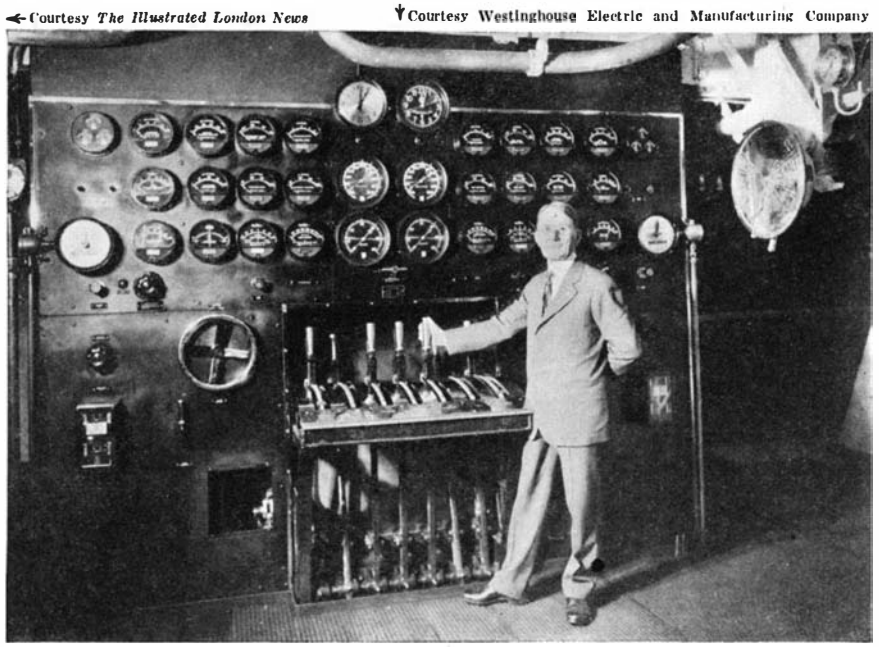
In the illustration the angle of the cone of the rotor is 103 degrees, that of the depression in the stator 91.5 degrees.

Air Offsets Heat Damage to Tires

THE tremendous heat generated in automobile tires due to the flexing of the rubber has long constituted one of the most serious problems of the industry, as heat is an enemy of rubber. Until recently this problem has remained virtually unsolved. Within the past six months, however, an ingenious method of manufacture



←Courtesy *The Illustrated London News*



↑Courtesy Westinghouse Electric and Manufacturing Company

An interesting study in contrasts of the switchboard and controls on British and American electrically propelled ships. *At left:* The controls of the Peninsular and Oriental Navigation Company's *Strathnavar*, of 22,547 gross tons, recently completed in England. *Below:* The control room of the new Dollar liner *President Coolidge*, of 33,800 tons, recently built in America and the largest ship of its kind in the world. Their speeds are 22 and 21 knots, respectively

has provided a simple and easy method for the dissipation of large amounts of this heat. In a newly developed tire hundreds of transverse holes have been placed in the tire tread. Each time the tire is cushioned against the road hot air is expelled from the holes. As the holes expand they draw in fresh air, thus keeping the tread rubber cool.

On tests already conducted, air-cooled tires were found to run as much as 36 degrees cooler than conventional tires. Thermocouple readings on some tires revealed temperatures as high as 200 degrees, just 12 degrees below boiling. Certain truck tires are known to get as hot as 230 degrees. By cooling the tread it is not only possible to increase the wearing qualities of the rubber but it also permits the manufacturer to use a greater quantity of tread rubber. Heretofore this was impossible as large masses of tread rubber induced high temperatures and caused what is known as "tread separation."

Isolation of Pure Vitamin A

AFTER six years of research work, Dr. I. M. Heilbron, professor of organic chemistry at Liverpool University, in collaboration with Dr. R. A. Morton, of Liverpool University and Professor J. C. Drummond, of University College, London, has obtained the first extract or distillation of pure vitamin A, although Professor Karrer, of Zurich University, working by a different method, has also been similarly successful. He hopes that it will eventually be possible to synthesize vitamin A, and thus make it available in larger quantities for the use of the medical profession. —*A. E. B.*

Isolation of Vitamin B Followed New Line of Research

THE isolation in pure form of the anti-neuritic vitamin B is the result of a new line of research developed by Professor Adolf Windaus of the University of Göttingen, Germany.

Vitamin B is now thought to be a complex substance made up of several vitamins. The one investigated by Professor Windaus, called B_1 by some investigators, is the one which protects pigeons and other non-human animals against the disease known as polyneuritis, and man against beri-beri.

Lieutenant Williams ready to go aloft and follow instructions radioed to him from the ground

Some authorities believe that rheumatism may be due to insufficiency of this vitamin in the diet. It is found in many foods, among them milk, egg-yolk, fruits and nuts, but is particularly prevalent in yeast and the germs of cereals. Another part of the vitamin B complex is the factor thought to protect man against the disease pellagra, and called vitamin G by American scientists. The formula Professor Windaus found for the vitamin is $C_{12}H_{17}N_3OS$.—*Science Service.*

Disaster Would Strike Earth if Air Gases Changed

DISASTER in many forms would come to the earth if the odds and ends of the atmosphere were tampered with in some way, according to data assembled by Dr. W. J. Humphreys of the United States Weather Bureau.

Without water vapor, which even in the wetter parts of the earth constitutes only 1 percent of the atmosphere, no plant and no animal life would be possible and the whole earth would be as dead and barren as the moon. There would be winds, Dr. Humphreys says, but never a shower. Clouds would be everywhere though only of fine pulverized rock such as now fills, some believe, the atmosphere of the planet Venus.

The small amount of carbon dioxide in the air, Dr. Humphreys explains, is absolutely essential to plant life, and, since all animal life is dependent, directly or indirectly, upon plants, the removal of carbon dioxide would result in the extinction of life on earth.

High above the earth some 25 to 30 miles there is an amount of ozone so small that if brought together at average outdoor temperature and pressure it would make a sheet only about a tenth of an inch thick. If this gas were removed, Dr. Humphreys explains, our eyes would soon go blind from the action upon them of that portion of the ultra-violet solar radiation which at present it shuts out completely. If, on the other hand, the quantity of ozone were increased several fold, the ultra-violet light now reaching earth would be excluded, no vitamin D would be formed by it, and there would be a rapid extinction of most if not all animal life, including man.—*Science Service.*

'Phoning Instructions to the Flyer

THE Western Electric Company has perfected a radio transmitter and a receiver of compact dimensions and comparatively small power which can be used to give instructions to the pilot at an airport.

Alford J. Williams, of racing fame, has provided much excitement to visitors by following such wireless instructions, heard simultaneously by spectators via a loud speaker, and by the pilot through a radio receiver.—*A. K.*

Good Prospects for Large Flying Boats

THE *DO-X*, at the time of writing, is being refitted at the North Beach airport, Long Island, and will soon be ready for flying again. This ship has been criticized for the length of time it took in getting to the United States, and for the many mishaps it encountered. It did, however, demonstrate conclusively that very large, seaworthy flying boats were entirely practical, and set the fashion for the construction of other large flying boats. Thus the Koolhaven Aircraft Company, of Holland, is actually designing a flying boat of 328 feet wing spread—more than twice the span of the *DO-X*.

The design characteristics of the Kool-

A new restaurant table which eliminates tipping, since there are no waiters, and also eliminates tray carrying. The patron writes his own check which he drops into a

chute in the table. In a short time, the tray in the center of the table is lifted, flowers, condiments, and all, by an elevator, and the patron finds his order arrayed on shelves

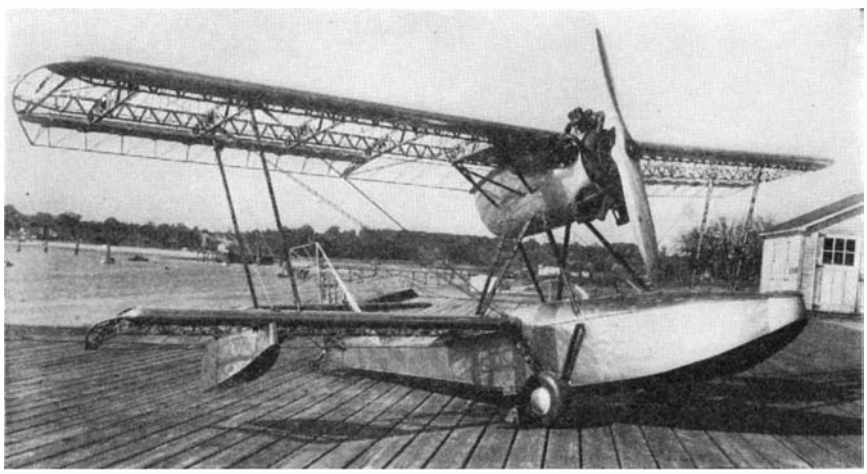
haven flying boat are as follows: Wing spread, 328 feet; wing area, 10,764 square feet; total flying weight, 100 tons; useful load, 42 tons; 10 motors of 1000 horsepower each, with a fuel consumption of only 0.4 pounds per horsepower hour (this figure is so low that we are led to believe some form of Diesel or semi-Diesel is in contemplation); cruising speed, 140 miles per hour, at which only 68 percent of the full power will be needed, so that the engines will not suffer unduly from wear, and the large amount of reserve power will facilitate take-offs and flight even with a number of engines not functioning.

With 200 passengers on board, the radius of action will be 2200 miles. The new machine is intended for service to the Dutch East Indies, and will make several trips in the time a steamer requires to make one. Hence it will actually carry more first-class passengers in a given time than will a large ocean liner.

The huge flying boat will be built on a regular shipway and will cost about 1,200,000 dollars. The builders state that the new machine will fly at low altitudes, but it is difficult to see what will be the advantages of flying low near the water. It is true that when an airplane is flying near land or sea, there is an aerodynamic "reflection" phenomenon which somewhat increases the efficiency but on the other hand there is more chance of bumpy air even when flying over sea; and, in general, it is both safer and more pleasant to fly at a reasonable altitude. No doubt later information will disclose the reasons for this plan.

We have often predicted in these columns that the large aircraft of the future will be a flying wing, and we read that the Koolhaven flying boat will have no fuselage, properly speaking. The passengers will be distributed along the span of the wing, and the wing covering will be, in part, of Triplex glass. The reason for this distribution of load is that the wing weight can be kept down to a reasonable figure when the loads are distributed instead of being concentrated. Also, when loads are distributed along the span, and not spread out along the longitudinal axis of the machine, it is possible to maneuver the machine with an elevator placed much nearer to the center of gravity. That is the reason why the fuselage can be dispensed with, and important savings thus made in weight and head resistance.

Finances may delay actual construction, but it is to be hoped that in a year or two the project will nevertheless be realized. —*A. K.*



The *BB-1*, the first amphibion built entirely of welded stainless steel

Flying Boats of Stainless Steel

WITHIN the last few years steel alloys of chromium have come into increasingly wide use. Some alloys of this type are known as stainless and are claimed to be almost entirely non-corrosive. We are accustomed to seeing ships, bridges, and steel structures in general being repainted at frequent intervals to protect them from the ravages of weather and the effects of rust. Now there comes the era of these new steels which may stand indefinitely in the open without requiring an ounce of paint.

Those steel alloys which resist oxidation are of obvious use to the aircraft builder, particularly the seaplane builder. Wooden flying-boat hulls do not rust but rapidly become water-logged. Hulls of duralumin require careful protection with special paints or the use of "alclad" in which the dural has a thin layer of pure aluminum on each side. Stainless steel, needing no special protection, has obvious attractions for hull construction. Moreover, the stainless steel is so strong that it has less bulk for the same strength than either duralumin or wood.

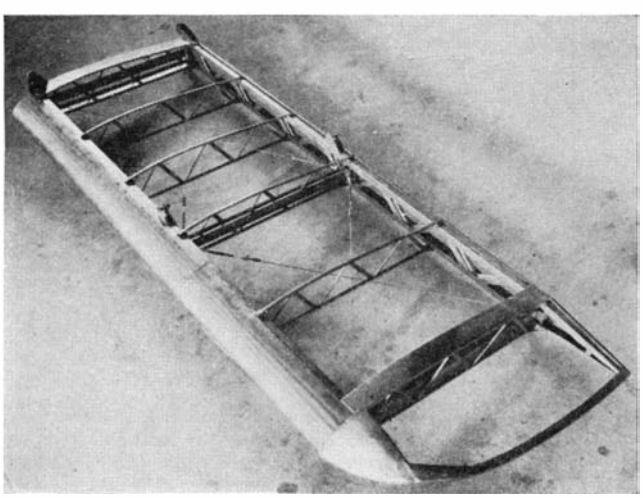
Another advantage of the stainless steel is that it can be electrically spot-welded, although such spot-welding has only been rendered possible by long and extensive experimentation, by the Budd Manufacturing Company, among others. Spot-welding avoids the difficulty and expense of riveting. A pair of simple pliers carrying the electrodes are applied to the spot where the weld is to be made, the current is turned on by a switch and the weld is made in a fraction of a second. The pliers are so constructed that no matter how their handles are gripped the electrodes will apply just enough but not too much pressure to the two sheets of metal to be welded. The strength and duration of the current are automatically determined. The current passing through the weld is very high but the voltage is so low that the pliers are uninsulated and can be handled without any precaution whatsoever.

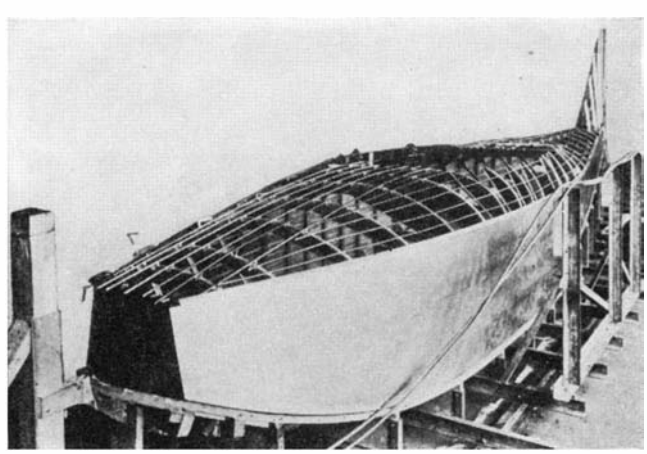
The first flying boat to be built completely of spot-welded stainless steel is the metal *BB-1*, an open cockpit four-seater, constructed by the American Aeronautical Corporation. One of our photographs shows this neat looking amphibion, equipped with a 210 horsepower Kinner engine. The wing is uncovered and the spars and ribs, though immensely strong, appear to be of lace-like delicacy. Even the hull has its sides and bottom of very thin sheet steel running from eight thousandths to twenty thousandths of an inch thick.

It is too early yet to say that the use of this new material will revolutionize aircraft construction, but it is certainly bound to be extremely useful.—*A. K.*

Scientists Learn Effect Of Cleaning on Metals

THE effect of disinfectants and cleaning materials on metals, which is coming to be important to the housewife as well as





***Left:* Welded stainless steel wing frame. *Above:* The lines of the stainless steel hull are laid out with extreme care**

to the engineer because of the growing popularity of metals for the home, has been carefully studied by German scientists and reported in the publication *Metallwirtschaft.*

Sheet samples of 40 different metals were immersed for 24 to 48 hours at certain temperatures in 24 disinfectants and cleaning solutions. The samples were carefully cleaned, loss in weight was determined, and they were examined microscopically.

According to the magazine's report, iron and steel were attacked by most of the solutions, and copper was not much better. Zinc was found to resist their action poorly, while aluminum and aluminum alloys were attacked by all acid and alkaline solutions. Tinned steel and tinned copper were fairly satisfactory. Nickel, nickel alloys, stainless steel, and chromium-plated steel were best.

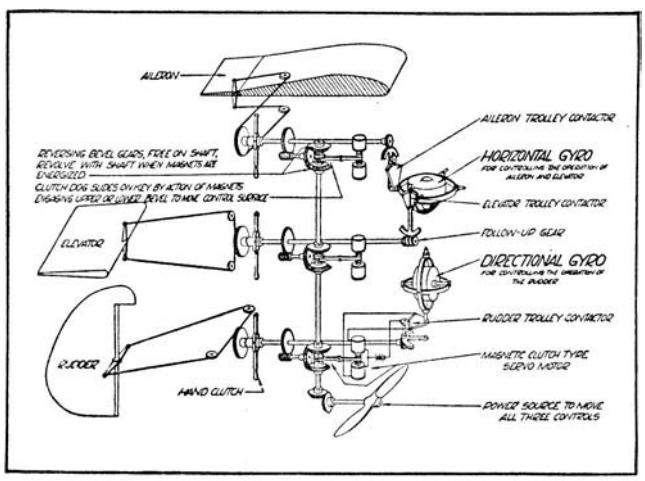
British Civil Aviation

THE British Air Ministry issues each year an annual report on the progress of civil aviation which is of real interest and which American aviation people study very carefully. It is interesting to read, in these days when the question of co-ordination of various forms of transportation is so much to the fore, of a combined rail, air, and ocean service. Urgent freight handed in at any railway station in England will, when it gets to London, be collected by motor trucks of Imperial Airways, taken to the London Airport at Croydon, and then flown by air all the way to India on British services via Ostend, Cologne, Nuremberg, Vienna, Budapest, Belgrade, Salonika, Athens, Alexandria, Gaza, across the desert to Bagdad, then to Basra, Bushire, and finally to Karachi in India. The territory of the Arabian Nights can now be traversed without the aid of the "Magic Carpet." From Manchester to Karachi by train and cargo boat would be approximately 45 days as compared with only seven and one half days by air-rail-truck service. The report states that an urgent parcel could reach India from New York in 14 days.

The appended map showing the existing European Air Services is certainly very encouraging as showing rapid development.

Another part of the report states that the Air Ministry has issued a specification for small passenger- or mail-carrying aircraft, to be employed in connection with the operation of feeder services from confined spaces. The specification calls for ability to land on and take off from a space not more than 200 yards in all directions and surrounded by obstacles 100 feet high. Several designs have already been submitted and have come near meeting the requirements. The designs already received include machines on the Gyroplane and Heliocogyro principles. Airplanes of more normal types have also been submitted.

In these airplane designs, the weight per horsepower is kept down to a minimum; the loading per square foot of wing area is also very low; and to increase the gliding angle on landing, various devices are introduced for increasing drag. We wish that designers in this country were engaged in similar designs.—*A. K.*



The automatic pilot described in the accompanying columns. Here are shown diagrammatically the various gears, clutches, et cetera, through which the two gyroscopes control the rudder, elevator, and ailerons of an airplane in flight

An Automatic Pilot

THE Sperry automatic pilot, based on the use of the gyroscope, has been placed, after long development work, in actual commercial service on the Condor biplanes of the Eastern Air Transport lines.

The automatic pilot maintains the plane on a level keel and on a straight course without intervention by the pilot. Not only does it relieve the pilot on long flights, but it assures level flying in foggy weather, and gives the passengers infinitely more safety and comfort. Even when turning, it is possible to avoid the banking of the airplane, always a source of slight misgiving to the public.

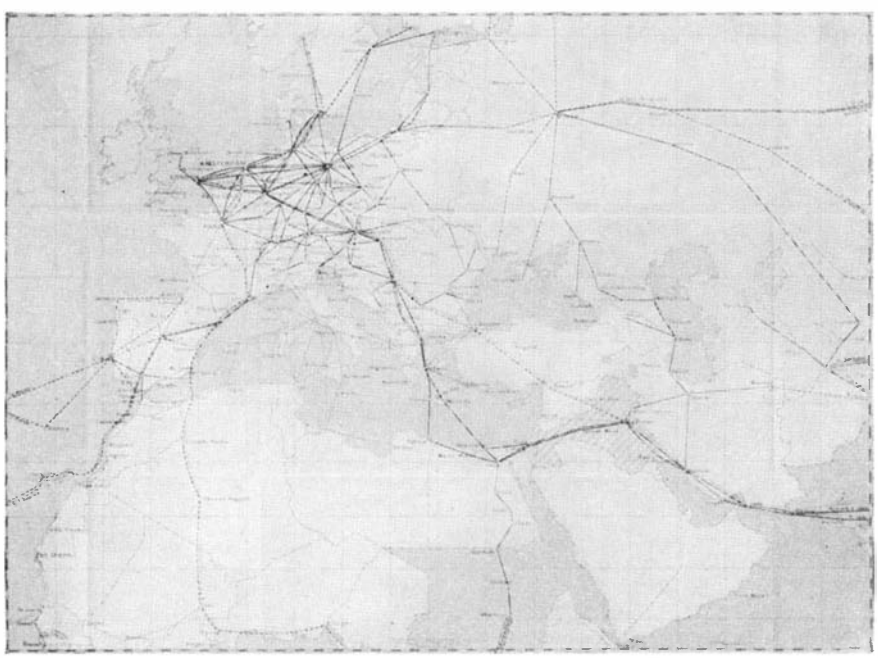
In spite of its apparent complexity, we believe that the Sperry automatic pilot will prove an immense step forward in air transport. The diagrammatic sketch which we reproduce herewith is from an original sketch by Elmer A. Sperry, Jr. and constitutes in itself the simplest explanation of the device yet available.

Two gyroscopes are employed, driven by a propeller in the air stream. Another similar source supplies power to the controlling mechanism, in which the shafting and gearing are in constant motion.

One of the two gyros spins about a horizontal axis; the other is for lateral and longitudinal control, and it spins about a vertical axis. Both gyros, mounted on gimbals, are free to swing about three axes in space.

The awe-inspiring property of the gyro is that it will try to keep its axis steady in space. Therefore when the airplane departs from a straight course, rolls or pitches, the gyros in the automatic pilot are displaced relative to the airplane. By this change in relative positions, electrical contacts are established which bring clutches into operation. The clutches engage parts of the control mechanism with the constantly running power shafting; the control mechanism operates the rudder, elevator, or ailerons as the case may be. A follow-up system then comes into play by means of which the electrical contacts are withdrawn, preventing over-control. With proper adjustment of the follow-up system, the gyros keep the machine level and on a straight course but never over-control or "hunt."

To fly in a cockpit where the automatic pilot is installed is almost uncanny. The controls operate as if by an invisible hand. The gyros seem to think!—*A. K.*



A general idea of the European airways and extensions, 1930-1931

Steam Turbines for the Airplane

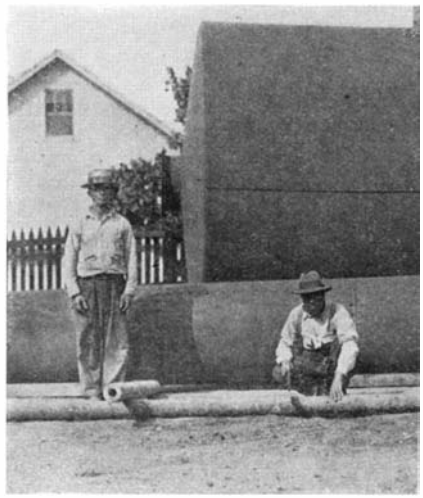
ABOUT 1840 Henson built a model of an airplane equipped with a small steam plant. In 1890 Professor Langley flew a number of experimental models likewise equipped with steam. At irregular inter-

vals ever since Langley, engineers and inventors have given serious consideration to steam for aircraft propulsion, and for very good reasons.

First of all, the intermittent action of the internal combustion engine is eliminated. The steam engine has earned a well deserved reputation for reliable and continuous operation at sea; and the elimination of ignition systems, carbureters, and other delicate devices is an attractive possibility. Again, a steam turbine will not lose power in the rarefied atmosphere of high altitudes. On the contrary it will gain power because the steam will exhaust at a lower pressure, and thus do more work on the expansion stroke.

Many authorities, however, have pronounced the use of steam for aircraft to be an impossibility. Their arguments have been that the steam engine is too heavy, that the boiler is likely to be too heavy, that no water is available for condensation so that air radiators of enormous area have to be employed, resulting in high head resistance, and that the efficiency of steam is less than that of the internal combustion engine.

The authorities who have thus fought the use of steam have not reckoned, however, with the modern improvements in steam turbine technique. Steam boilers, fired by cheap, heavy fuel oil, have now come into use on locomotives, and are surprisingly light and compact. Steam turbines can now work at enormous temperatures and pressures of over 1000 pounds per square inch, because advances in metallurgy have given us materials that will stand up under such conditions of temperature and pressure. With these very high pressures, the efficiency of the turbine begins to approach that of the gas engine. Again, turbines running under these high pressure conditions and at 10,000 revolutions per minute can be made surprisingly light and compact. At the same time, gear reduction methods have been so improved that the enormous speed of the turbine can be reduced to the few hundred revolutions per minute of a propeller with no more than a 5 or 10 percent loss in efficiency. The problem of radiators for condensation has been partially met by the modern method of using the metal covering of wings and other parts of the airplane as the radiating surface; with a "skin" radiator no head resistance is added.



Chemists wonder if they haven't something to learn from this old gas pipe laid in 1877 and found to be in excellent condition when dug up recently in Lockport, New York. Several hundred feet of this main were installed at that time and have been in service ever since. It consists of eight-foot lengths of white pine with a bore of 1½ inches and an external diameter of four inches. The only jointing material was red lead, and the main was covered with hard pitch. When dug up, the wood had the appearance of being newly laid, retaining the color of freshly cut white pine when sawed

With all these changes and improvements, the problem of steam begins to assume quite a promising aspect. At any rate, we hear that the Great Lakes Aircraft Corporation, in co-operation with the Ljungstrom Turbine Company and under the supervision of the United States Navy, is seriously experimenting with steam. Small scale working units have been designed with about one fourth of the power that is to be used ultimately, and experimental flights are soon to be undertaken.

It is not in small units, however, that much is to be hoped for. It is in the design of very large flying boats that lie the most attractive possibilities. If we think of the *DO-X* with its 10 motors out in the air stream increasing the head resistance enormously, and then think of what could be done with two compact turbines of say 2500 horsepower each, tucked away inside the wings, we shall be convinced that there are vast possibilities in the experiment.—*A. K.*

Versatile Hotel Radio

THE ceremonies opening the world-famed Waldorf-Astoria Hotel in its new home in New York City recently were heard in all the hotel's public rooms by means of its elaborate network of loud-speaking equipment. The hotel's system for electrical distribution of entertainment designed by the Bell Telephone Laboratories and installed by the Western Electric Company is the most complete ever brought together under one roof.

Six different programs can be made available over the entire system, both to the 1940 private rooms and to the many public rooms. These may be all or partly radio broadcasts picked up by the hotel's major antenna. Events going on in the hotel's public rooms, or the music of its orchestras, can be connected to any of the channels. In addition, the hotel can supply recorded entertainment for its guests by means of two music reproducers.

Each of the two towers is furnished with a separate antenna. By means of these and selective devices, occupants of the tower suites may have radios of their own choice installed and receive any programs that are on the air. All the antennas are specially shielded from interferences that commonly arise in the mid-town area.

Twenty-two racks of amplifying and control equipment are located in the radio room on the sixth floor which is the nerve center for the entire network of distribution. Here all programs are under constant supervision to secure the best rendition over the system.

A variety of horns, varying from several taller than a man to many smaller ones, are concealed behind the walls and ceilings of the public rooms. There is a permanent sound picture system of the theatrical type for the grand ball room and one portable set which can bring talking picture entertainment or lectures to the smaller public rooms.

Under full use, the system can take the voice of a speaker in one room and amplify it there, amplify it in every other public

A guest at the new Waldorf-Astoria selects one of the six programs available through a special loudspeaker

The control room of the Western Electric radio program distribution system installed for guests at the new hotel

Men and Women of America:

RECONSTRUCTION

Is in YOUR HANDS!

★

You have studied "depression" charts. You have heard "depression" speeches. You have read "depression" articles. You have dreamed "depression" nightmares.

If you are ready now to forget "depression" and give a thought to faith, common sense and reconstruction, come with us through this page.

☆ First, some figures—

By the end of 1930, the national wealth of America had reached the astounding sum of one hundred and ninety *billions*—one hundred and thirty-four billions more than in 1914, an increase of 71%.

In our savings banks and trust companies, we have stored up more than twenty-nine billions.

In safe-deposit boxes, in private hiding-places of all kinds, we have a billion or two more.

We have, ready for use, more than nine and a quarter million bales of cotton, valued at about three hundred millions; and four hundred and twenty-nine million bushels of wheat valued at more than two hundred and fifty-seven millions.

We possess uncounted millions of feet of unused lumber, tons of unused coal and wool and steel.

What do these stupendous figures mean?

That America has more resources than the next six nations—and can stand on its own economic feet.

That, if these resources are put to work, instead of being allowed to lie idle, America will rapidly approach a normal condition and benefit all the other nations of the world by showing a way out.

The Re-Employment Drive Is On, Too!

In nearly 11,000 cities and towns, local civic bodies, the labor organizations, employers in industry and commerce, and the American Legion, have joined together to put men and women back to work immediately. They are succeeding—by adding work, by making work, by spreading work. Already, community after community has reported employment increases. Each new employee means a new purchaser for more products of more workers. That's the c i r c l e which leads to prosperity. Go to your local organized headquarters and ask what *you* can do to help.

Let's put this wealth to work—NOW!

We're going to put this wealth to work—we're going to do the sort of thing we did in 1921. Back there, three years after the war, when the country was in the depths of economic despair, the War Finance Corporation helped lead us into the light of an unprecedented period of prosperity.

"We steadied the situation," said Eugene Meyer in the reconstruction year of 1922, "by taking over the slower loans that were good, removing the necessity for forced liquidation and putting the banks in position to carry their customers for a longer period and to make new loans where adequate security could be obtained. *But our loans have done more than this—they have provided that element which is so necessary in all businesses—the element of confidence.*"

The Reconstruction Finance Corporation, of which Mr. Meyer is Chairman and General Charles G. Dawes is President, has been empowered to use a vast fund of two billions of dollars to relieve credit stringency, to strengthen the sinews of business and to restore faith.

Let's get behind it and push!

THE NATIONAL PUBLISHERS' ASSOCIATION

"As the most nearly self-contained nation, we have within our own boundaries the elemental factors for recovery."

(From the Recommendation of the Committee on Unemployment Plans and Suggestions of the President's Organization on Unemployment Relief)

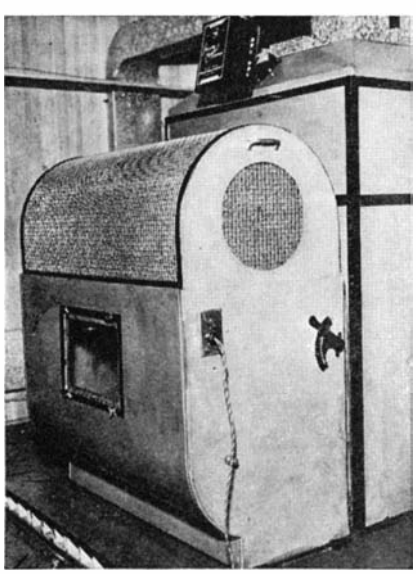
room, in the 1940 guest rooms, and carry it by wire to three broadcasting stations. Simultaneously, five other programs are available.

"Weather Factory" For Homes

AIR conditioning with its attendant benefits of health and comfort is now available to the average family in a home "weather factory" which heats the air in winter, cools it in summer, washes and circulates it at all times and which is adaptable to warm air, hot water, steam or vapor-air systems.

This interesting development is the result of research on the part of engineers of the Holland Furnace Company who sought for the home the advantages enjoyed in the large and relatively highly expensive commercial installations constructed for hotels, theaters, and other interiors. Year 'round comfort and health, with marked savings in fuel and the economies effected by dust elimination from the air, are now within the reach of the home-dweller regardless of the type of heating system he now may have.

The outfit is simple, inexpensive to operate and so sturdily constructed that there is little chance for anything to go wrong. The apparatus is contained in a metal cabinet occupying less than 10 square feet of



Above: **The home "weather factory" in use.** *Right:* **A diagrammatic view of the unit, cut away to show location of its various parts**

floor space. It is designed to be attached to the rear of a warm air furnace or may be used as an independent auxiliary with other kinds of heating plants.

Air drawn in from the basement first passes through a semi-cylindrical filter of standard construction where much of the dust and dirt are removed and then, forced by two fans operated by quarter-horsepower motors, it rushes through swirling sprays of water from the house mains. This combined filtering and washing, hundreds of tests have proved, removes more than 98 percent of the dust and dirt that the air may contain. Thus "laundered," the air goes into the furnace casing where it is warmed, in winter, in the usual manner and is distributed through the house.

The sprays not only thoroughly cleanse the air but they add one of the most vital factors of all, proper humidification or moistening. The amount of humidity is easily controlled by adjustment of the spray nozzles. Physicians, heating and ventilating engineers, and other authorities are unanimous in their verdict that the air in the vast majority of American homes in winter is far too dry. In thousands of houses, it is drier than the air in the desert regions. This lack of moisture seriously affects the throat and nasal passages, it damages furniture, and exposes the home dweller to various diseases by drying the tissues that line the breathing canals.

In summer, the air is cleaned and cooled by the spray washing. In some instances, effective cooling may require additional spray units and in extreme cases, a refrigerating unit may be added to reduce the temperature of the water and thus help cool the house.

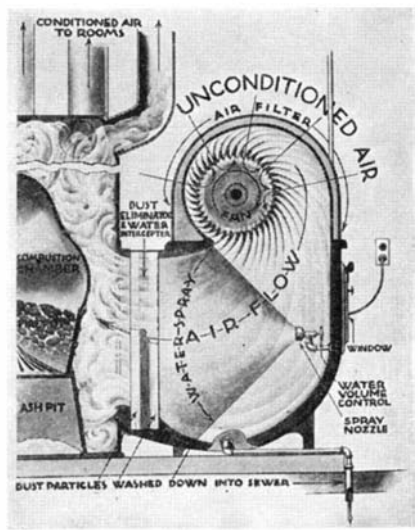
Hair Drying with Natural Gas

A NEW use for natural gas has been introduced into some of the leading beauty shops in Oklahoma. A hair drying machine, which utilizes natural gas, has been perfected. At a recent convention of beauty operators, it was found that gas used as a dryer does not injure the hair or scalp. The machine will dry 10 heads of hair at one time. A warm, light air, just moist enough to prove beneficial, circulates from bell-shaped domes that fit over the head.—*A. E. B.*

The Prevention of Simple Goiter

THE ease and simplicity with which goiter prevention is accomplished has nearly been the undoing of this very valuable procedure, according to a recent statement by the United States Public Health Service. Many persons with goiter, attracted by the apparent ease with which the malady may be prevented, have concluded that what is useful for prevention of the simple form is likewise efficient as a means of treating all types of the disease. Much harm has been done by this erroneous assumption. It is necessary, therefore, to caution people that there are certain goiters which are made worse by taking iodine. Moreover, the measures that may be effective in preventing simple goiter are in no wise useful in forestalling other and more severe forms of the disease.

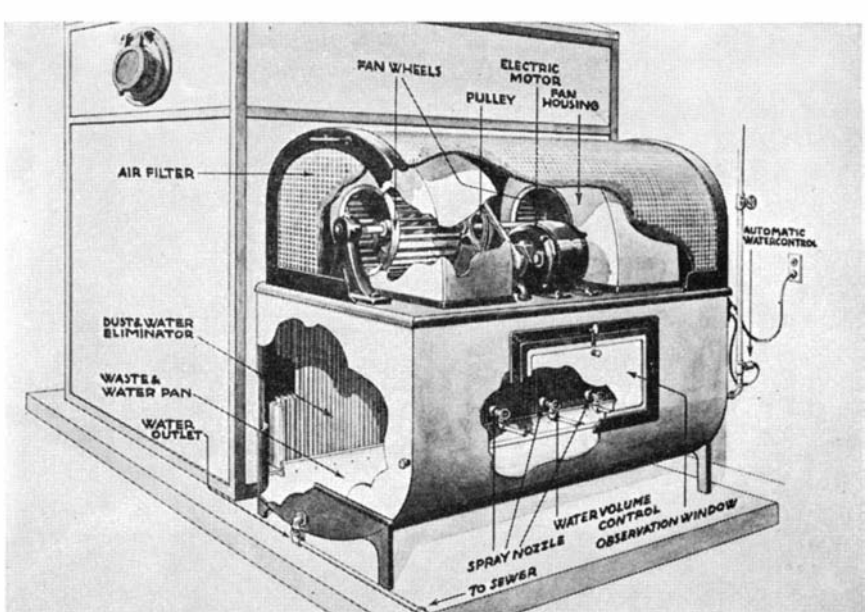
The following questions quite naturally arise regarding simple goiter: First, why should simple goiter be prevented? Second, is the condition more than a deformity of the neck? These reasonable questions may be answered by citing the experiences of certain foreign countries in which the disease prevails unduly. When unchecked,



The flow of air through the home "weather factory," showing the air washed by a spray of water

simple goiter is often associated with mental and physical degenerations, especially deaf mutism, feeblemindedness, and the idiocy of cretinism. The ill effects of uncontrolled goiter are particularly severe in subsequent generations. Fortunately, the affliction has not reached this degree of intensity in the United States, nor is it likely that it will reach it.

The causes of simple enlargement of the thyroid gland in the throat may be conveniently classed as immediate and remote. The immediate cause of this condition is now believed to be a complete absence or marked deficiency of the iodine necessary for the normal functioning of the gland. Anything which interferes with the intake



or utilization of iodine available in normal quantities may likewise cause enlargement of the organ. Thus, infections, intoxications, faulty diets, and such periods of stress in female life as puberty, pregnancy, or the change of life, may be mentioned as remote or underlying causes of simple goiter. It is a matter of common knowledge that females are more prone to simple goiter than are males.

The most satisfactory method of administering iodine for the prevention of simple goiter is by adapting the remedy to each person in need of it. In this way accurate dosage and supervision is insured. Obviously this method is costly and cumbersome, reaching only a small portion of those requiring the protection. In order to overcome these objections, wholesale prevention by the use of iodized table salt and iodized water supplies has been suggested. While both of these methods are theoretically sound, it is not yet definitely known whether they are effective and at the same time incapable of causing harm to persons with existing goitrous enlargements. Therefore, the individual method is preferable at the present time.

It is likely that the regular consumption of foods naturally rich in iodine will aid in preventing goiter. It is known, for example, that marine algae, deep sea fish, and crustaceans are particularly rich in iodine. But here again the uncertainty of dosage and economic factors are involved. Variations in the iodine content of food and water probably account, to a considerable extent, for the differences in goiter incidence in the United States. Until more definite knowledge becomes available concerning the value of iodized salt, iodized water, and iodized foods, it appears best to individualize in goiter prevention.

Goiter prevention is most telling in its effects among children between the ages of 11 and 17, especially among girls. Even more important, is the institution of appropriate prevention before a person is born. Under the supervision of a skilled physician a prospective mother may receive protection not only for her own thyroid but also for the gland of the expected child.

Where may one turn for explicit advice? Either the family physician or the local health officer is well qualified to suggest the most effective means of preventing this rather widespread affection. Self-drugging with iodine is dangerous and should be shunned.

Tuberculin Test Harmless to Cattle

IOWA farmers who have carried their objection to tuberculin testing of their cattle almost to the point of armed rebellion have permitted themselves to become excited over a misunderstanding, and to a certain extent over deliberately spread misinformation. Such is the opinion expressed by scientists at the United States Department of Agriculture.

Tuberculin never does a healthy cow the slightest harm, declared Dr. M. Dorset, chief of the biochemic division of the Bureau of Animal Industry. It does not even hurt a tuberculous animal, but merely shows that she has the disease and ought to be slaughtered in the interests of community health. Claims to the contrary, he

(*Please turn to page* 245)

IN COUNTLESS WAYS SHE CREATES YOUR COMFORT

We wonder, reader, if in your traveling about, you have ever been aware of how much the lesser employees of a hotel contribute to the total of your comfort?

You have undoubtedly seen a Statler maid* moving down the hall with her supply cart, tapping gently on some doors, moving softly away from those behind which guests still sleep. Perhaps you have actually watched one at her work. If you have, you have surely thought, "I should like to have as deft a servant in my house."

For these Statler maids are deft . . . and for a reason. *They're taught!* They have a routine to follow that eliminates all waste motion and insures every job being done. It puts order in their work of picking up papers, making beds, running the vacuum cleaner, dusting, and replacing soiled towels and used soap.

Let's look in a room. Here is one where the maid is about to make the bed. See, she turns the inner-spring hair mattress, adjusts it on the deep box springs, smooths out the mattress protector, spreads the quilted pad. Then she puts on the sheets — snowy, white sheets that smell so clean and fresh. Then the soft blankets. She fluffs the down pillows and covers the immaculate inner slips with outer cases and lays them in their place. Now she takes the spread and covers all, tucks all in, gives the bed a final pat or two, and steps back to survey her work.

She's proud of that bed. She knows how good a bed it is and how pleasant it's going to feel because she's made it well. She takes *such* prideful interest in all her humble tasks. Her bathrooms must sparkle, her mirrors shine. For she's an inborn housekeeper and realizes that it's her job to make you enthusiastic over the cleanliness and comfort of your Statler room.

**73% of Statler stockholders are employees.*

HOTELS STATLER

where "The guest is always right"

BOSTON BUFFALO

CLEVELAND DETROIT ST. LOUIS

in NEW YORK, *Hotel Pennsylvania*

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

ABOUT a year ago in this department we referred to the risk of explosion of the silvering solution used in silvering the mirrors of reflecting telescopes, and requested any who had heard of such explosions to advise us. Although several thousands of our readers have silvered mirrors—many of them a number (!) of times (soft music here), we have heard of practically no accidents among amateurs, though professionals appear to have them. Subsequently a few reports of this nature reached us and these are published below. At worst, assuming the exercise of normal

Rev. W. F. A. Ellison standing on the roof of the Armagh Observatory

gumption in the work, they indicate the probable advisability of wearing goggles during the operation after the solutions have been mixed. It will be noted that most of the troubles came from failure to "obey the rules." As one man stated orally, he "silvered first and read the warning after the explosion." The chief warning is *not to leave the solution standing—not to make up a stock solution to keep around.* A minor one is to play safe by keeping the solutions cool.

Peter L. Martin, lens maker, of 829 East Thayer Street, Philadelphia, writes: "One day Doctor Brashear told me to empty a vessel containing the residue of silver solutions that *had been standing* (Italics ours.—Ed.) and remarked that it had the danger of dynamite. Another time I was polishing within four feet of him when he was silvering a large mirror and as he poured the solution on the mirror the liquid went up in the air and some fell on the back of my shirt.

"Every Saturday morning the professional optical worker, Mr. Octavie Petitdidier of Chicago, silvered, using the Brashear method, and it never exploded and we never mentioned goggles. Dates 1907, 1908, 1911, 1914.

"About 1921, I gave a silverer the modified solution mentioned in Ritchey's book. When I asked him how it worked, he said, 'Say, that stuff exploded.'

"I think the suggestion about wearing goggles is very good. The solutions have never exploded on me, but during the few minutes that it takes the amateur to pour on the liquid it is well worth while to take every precaution. I intend to wear goggles in future.

"I have heard of several other explosions of the silver solution. In one instance an employee, in order to see better, pulled up the window shade and the solution which *had been standing all night* (Italics ours.—Ed.) blew up, when the daylight struck it. Another time a worker was badly hurt and laid up for several weeks.

"My conclusion is that the original Brashear solution as given to the world by John A. Brashear is not likely to explode."

NEXT we get testimony from K. L. McAlpine, 223 B. Sansom Street, Upper Darby, Pennsylvania, who writes: "Although I have used this process a great many times, on one occasion only have I met with an accident. In June of last year, having finished silvering a mirror, I placed the remainder of the silvering solution in a cold room in the laboratory. This room is maintained a few degrees above zero. This solution contained silver nitrate, ammonia, and soda only, as none of the reducing solution had been added to it. In view of the temperature and the absence of organic matter in the solution I considered it to be quite safe. In August the solution was removed to the basement and *remained there for about one month.* (Italics ours.—Ed.) The bottle was moved about many times during this interval.

"The explosion took place one night, fortunately when no one was at the time in the building. Although there could not have been more than 50 cc of solution, practically every piece of glassware in the room was broken. Even a nine liter Pyrex bottle was shattered, and the white walls and ceiling were sprayed with the brown-black silvering compound.

"While the Circular-Letter on silvering prepared by the Bureau of Standards very plainly states that the silvering solution should be made up just before use, I believe that still more emphasis should be laid on this point, because otherwise I am quite sure that many, in anticipation of trouble with the silvering, will make up a stock solution."

IN Pasadena, at 88 North Delacy Avenue, is the firm of Howell and Sherburne, designers and builders of special machinery and scientific instruments, including the Hale spectrohelioscope. Waldo E. Howell, son of the senior member of this firm, writes as follows: "I am very glad to tell you about two explosions which happened recently and were by no means mild. To give you a better idea as to the danger of this kind of explosion, I am enclosing a photograph of one end of our optical shop. The shelf marked 'X' with the arrow is the spot where the bottle of solution was at the time it exploded. This shelf was blown completely off the wall. The amount of solution in the bottle, which was not confined, was 16 ounces of silver solution ready to be mixed with reducing solution for silvering. Pieces of the bottle in which the solution was contained were no larger than fine shot, when we swept the floor. Small pieces of glass were buried in the shelf. I do not think the explosions would have occurred had the temperature been lower. It was about 85 degrees when I finished silvering, and this silver *was left over.* (Italics ours.—Ed.) It exploded of its own accord in solution. Fortunately, no one was standing next to it.

"When I tell you of the second explosion I believe you will decide, as I have, that after the caustic solution is poured into the cleared-up silver nitrate solution, an explosion may occur at any time. This explosion happened in the middle of the process. I guess, before I go on, I had better stress the fact that in both cases *directions had not been followed to the letter as to temperature,* (Our italics.—Ed.) but I silver many times in the summer at 85 and even up to 100 degrees, and I really have no trouble, either with solutions or with soft coats of silver. However, in this case the temperature was nearly right, but I believe the difficulty came in after the silver nitrate solution had been cleared with ammonia. The caustic solution, having been poured into the silver nitrate

Where one explosion took place

solution, was not stirred and ammonia was not added for about ten minutes. When my friend, Mr. Seigel, did get back to the solution, after the ten minutes and started to stir and add ammonia, the explosion took place.

"Everything would have been all right, had he gone right on as the directions say,

but the interval between the clearing up of the silver nitrate solution and the pouring in of the caustic solution was too long, thus allowing the explosive silver fulminate to gather on top of the solution. Just as he started to take hold of the glass rod and stir, there was a terriffic explosion. The 2-ounce beaker, which was of heavy glass, was never found in any pieces larger than BB shot. The fragments were lodged in the wall, below the surface. Mr. Seigel nearly lost his sight from the flying solution. He was in bed for a week, and later had to wear glasses. It probably seems funny that the solution will explode in water, but this it did.

"I still use the same method, but I watch very carefully to see that no undue amount of fulminate is allowed to form on the surface of the solutions when I pour the caustic solution into the silver nitrate solution. If this fulminate does form in visible amounts when I pour the caustic into the silver, I quickly pour in ammonia. However, this will be unnecessary, even on a warm day, if ice is used."

FINALLY, part of a communication from Dr. John Albert Marshall of San Francisco, is quoted from the *Journal of the American Medical Association*. In certain kinds of work they do, laboratory biologists use essentially the same process as is used by the telescope maker:

"An explosion occurred Tuesday, March 11, which has jeopardized the eyesight of a research worker in one of the laboratories at the University of California. Sections of bone and teeth with their contained soft tissues had been stained by the so-called silver nitrate method. The dishes containing the ammoniacal silver oxide solution were inadvertently left standing in the sun from Saturday noon until Tuesday morning. There were traces of alcohol in the silver solutions carried there by the sections of tissue. The sunlight hastened a chemical reaction between the silver, the ammonia, and the alcohol, and there resulted from it a highly explosive, very sensitive and unstable compound, silver fulminate—to be distinguished from the so-called fulminating silver, which explodes on drying.

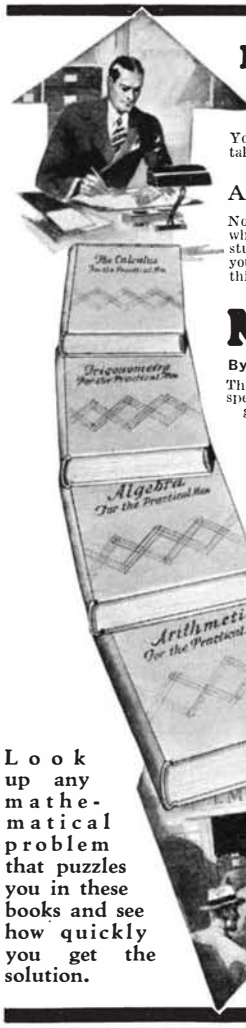
"When the dish was taken up to be emptied and cleaned, it was warm from the sun. The mere movement of the liquid was responsible for the detonation.

"Since the accident was so serious to one of the workers and endangered others in the laboratory as well, a word of caution as to the handling of these silver solutions is necessary."

WHAT, then, are the indications from all this evidence? Half a dozen explosions out of thousands of silvering jobs, and most of these due to carelessness. There is little reason to fear the job, but one ought to respect it by wearing goggles. Nature will usually patch up a complexion peppered with glass fragments but an eye is an eye.

Judging from the comments quoted above, the explosions are seldom of the full power of a typical dynamite explosion, and some of them are probably comparatively feeble. But no one craves an invitation to be present even at the time of a feeble explosion.

Here is another expedient tip—don't let the ladies at home see these pages.



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CURRENT BULLETIN BRIEFS

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

ENGINEERING ACHIEVEMENTS 1931 (Reprint 471 from *The Electric Journal*), prepared by C. K. Lee and H. N. Blackmon, describes the achievements of the Westinghouse Electric and Manufacturing Company in all branches of engineering. The 40-page pamphlet is beautifully illustrated. *Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.—Gratis.*

THE SEMET-SOLVAY KOLLER TYPE GAS PRODUCER (Bulletin No. 45) describes, with clear diagrams, the operation of this device. *Semet-Solvay Engineering Corporation, 40 Rector Street, New York, N. Y. —Gratis.*

COMMERCIAL AND INDUSTRIAL ORGANIZATIONS OF THE UNITED STATES (Domestic Commerce Series No. 5) is a revised edition of an exceedingly useful book listing over 19,000 organizations, all splendidly classified. Bound in buckram. *Superintendent of Documents, Washington, D. C.—60 cents (money order).*

UNITED STATES FOOD AND DRUG ADMINISTRATION METHODS OF TESTING ANTISEPTICS AND DISINFECTANTS (U. S. Department of Agriculture Circular No. 198), by G. L. A. Ruehle and C. M. Brewer, describes the methods used in testing material of this nature in the effort to check the accuracy of the bactericidal and antiseptic claims for such products. *Superintendent of Documents, Washington, D. C. —10 cents (coin).*

CENTRALIZATION VS. DECENTRALIZATION is a small treatise intended to present various facts concerning the advantages and disadvantages of centralized and decentralized operations in the office. It deals with the question of dictating machines, but also covers shorthand operation. *Dictaphone Sales Corporation, 402 Lexington Avenue, New York City—Gratis.*

BELT DRIVES WITH CAST-IRON PULLEYS AND PAPER PULLEYS (Bulletin No. 62), by C. A. Norman and G. N. Moffat, gives data on transmission efficiency of various types of belts on such pulleys and goes thoroughly into the transmissive power of oak-tanned and rubber belts. *Engineering Experiment Station, Ohio State University, Columbus, Ohio—25 cents.*

SUITABILITY OF BRUSH LANDS IN THE INTERMOUNTAIN REGION FOR THE GROWTH OF NATURAL OR PLANTED WESTERN YELLOW PINE FORESTS (Technical Bulletin No. 256, August 1931, U. S. Department of Agriculture) by F. S. Baker and Clarence F. Korstian, describes the many problems awaiting the forester in connection with brush lands. *Superintendent of Documents, Washington, D. C.—25 cents (money order).*

TO make this page of greater value to our readers, the editor shall be glad to consider for review papers and bulletins on any phase of science, engineering, or industry. However, we do not wish ordinary catalogs, and we will not mention what is obviously propaganda.

Material submitted should give full information as to where obtainable and the price, if any, so that the reader may obtain copies directly without unnecessary correspondence. — *The Editor.*

AMATEUR EXPERIMENTS WITH PHOTO CELLS AND RELAYS, a booklet describing a number of interesting experimental control devices which an amateur can make, is supplied by the *Allied Engineering Institute, Suite 541, 98 Park Place, New York City.— 5 cents.*

SHEET IRON, A PRIMER describes in very simple non-technical language the processes of manufacture from the ore to the finished product. Such subjects as rust and corrosion are also treated. *Republic Steel Corporation, Youngstown, Ohio.—Gratis.*

SOUTHERN WHITE CEDAR (Technical Bulletin No. 251, U. S. Department of Agriculture) by C. F. Korstian and W. D. Brush, describes a valuable timber tree of the Atlantic and Gulf coastal swamps and estuaries. *Superintendent of Documents, Washington, D.C.—25 cents (money order).*

STRIP CROPPING TO PREVENT EROSION (Leaflet No. 85, U. S. Department of Agriculture), by H. V. Geib, states that strip cropping consists of planting strips of densely growing or fibrous-rooted crops between strips of clean-tilled crops along the contours of eroding slopes. Strip cropping reduces run-off and erosion. *Superintendent of Documents, Washington, D. C. —5 cents (coin).*

DESCRIPTION OF AIRPORTS AND LANDING FIELDS IN THE UNITED STATES (Airways Bulletin No. 2) gives a description of all airports and landing fields in the United States arranged alphabetically under states. *Aeronautics Branch, U. S. Department of Commerce, Washington, D. C.—Gratis.*

ALKALINE BUILDERS COMPARED gives valuable information for laundry men. It is fully illustrated and features an approved detergent. *The Cowles Detergent Company, 7016 Euclid Ave., Cleveland, Ohio.—Gratis.*

COMBATING CORROSION WITH ALLOYS, by Clayton E. Plummer and Richard K. Akin, gives a new alloy classification which groups together those trade names having the same chemical composition. The system outlined is very valuable and the folder gives a wealth of information about modern alloys. *Robert W. Hunt Company, 2200 Insurance Exchange, Chicago, Ill.—Gratis.*

ULTRA-VIOLET IN THE POULTRY INDUSTRY, by L. C. Porter and J. P. Ditchman. Tests and data on the ultra-violet lamp as a source of added profit in chicken raising. *General Electric Company, Sales Office, Schenectady, N. Y. or any of this company's local sales offices.—Gratis.*

THE NATIONAL RURAL ELECTRIC PROJECT (Report No. 1. October, 1931) describes an educational organization dedicated to the betterment of American farm income and living conditions. Electrical equipment is being used extensively on fine farms between Baltimore and Washington and a laboratory is maintained. *National Rural Electric Project, College Park, Maryland.—Gratis.*

AUTOMOBILE OPERATING COST AND MILEAGE STUDIES (Bulletin No. 106), by Robley Winfrey, presents the operating costs of 1675 automobiles and gives much data not obtainable elsewhere. *Iowa State College, Ames, Iowa.—Gratis.*

GENERAL AIRWAY INFORMATION (Airway Bulletin No. 1) gives detailed maps of all the airways showing the locations of all beacons and airports and should be used in connection with Airway Bulletin No. 2. *Aeronautics Branch, U. S. Department of Commerce, Washington, D. C.— Gratis.*

THE INFLUENCE OF WEATHER ON CROPS: 1900-1930 (Miscellaneous Publication No. 118, U. S. Department of Agriculture) is a selected and annotated bibliography and is mainly concerned with the influence of weather on crops in connection with the germination, growth, development, susceptibility to disease, and final yield. It contains references to laboratory, field, and statistical studies. It is a 245 page pamphlet. *Superintendent of Documents, Washington, D. C.—40 cents (money order).*

THE CO-OPERATION OF THE UNITED STATES WITH THE LEAGUE OF NATIONS AND WITH THE INTERNATIONAL LABOR ORGANIZATIONS (International Conciliation No. 274, November, 1931), by Ursula P. Hubbard, is a pamphlet offered to the public in the hope that the information it contains may be found useful by all students interested in the development of intelligent international cooperation. *Carnegie Endowment for International Peace, 44 Portland Street, Worcester, Mass.—5 cents.*

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 241)

indicated, are the results either of lack of information as to its real nature or of hostile propaganda.

Tuberculin is essentially the clear, sterilized fluid derived from broth cultures of the tuberculosis bacillus, he said. It is entirely free of tubercle bacilli and of harmful bacteria of all kinds.

The test is administered in a way that will cause no discomfort to healthy animals, and but little to sick ones. A single drop of the fluid is injected into the thin skin on the under side of the tail. After from 48 to 72 hours this point of injection is examined. If the animal is healthy, no trace of the injection will then be found. If there is a small, inflamed lump, it is judged due to the reaction of the tuberculin upon the animal's tissues which have been made hypersensitive by the presence, somewhere in the body, of tubercular infection.

The fluid used by the testing officers is essentially the same as that used in determining whether or not a human patient has tuberculosis, Dr. Dorset said. In fact, tuberculin was originally made in the hope that it would be a cure for tuberculosis, and when it was found that it could not do that it was also learned that it could be made very useful as a sensitive agent in diagnosis.

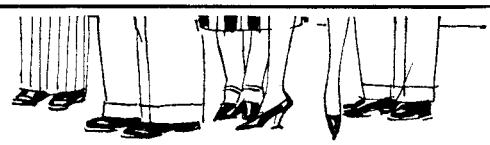
The work of tuberculin testing of cattle all over the country is carried on co-operatively by the Department of Agriculture and the various state governments. Field men representing both the Department and the states work together, and both federal and state funds are used in reimbursing farmers for cattle which it is found necessary to have killed. There have been some lawsuits against the official bodies concerned, by disbelievers in the efficacy of tuberculin testing, but these have all been decided in favor of the Department of Agriculture and of the states.—*Science Service.*

Russians Claim New Source of Rubber

RECENT rather sensational dispatches from Russia announce the discovery of a plant named "towsagis" which is said to yield a rubber latex with great industrial promise. While scientifically-minded folks keep their minds open to the possibilities of something new, they are frankly sceptical of the glowing predictions which intimated that Russia would soon control the raw rubber market of the world by virtue of towsagis. They point out that after years of investigation and study Edison reached the conclusions that there are at least 1500 plants that can be milked for rubber with some hope of commercial success. Probably 10 times that number of plants contain gums of some sort. Considering the fact that the whole world has been combed for trees, vines, and shrubs that will yield rubber in commercial quantities and of industrial quality, it seems highly improbable that towsagis is a species new to botany.

The Russians have never made any secret of their need of rubber. Before we ever

Feet Hurt?



If they do, you probably "hurt all over"! But you can avoid this misery if you wear shoes that fit your feet properly. An old shoemaker, J. H. Finn, tells you how to select comfortable shoes, in an article in the April HYGEIA, "The American Foot and Its Covering".

Although he does not recommend high heels, he claims that they are blamed for more foot troubles than they really cause. From his wide experience he has discovered that nine tenths of the foot ailments are due to other causes—mainly lack of room!

This is a sensible article by one who knows what he is talking about. If your feet hurt you will find it worth while to read what he has to say. And if your feet never hurt—well, you're just one of a fortunate few!

Also in the April HYGEIA:

Other articles of wide interest in the current issue of HYGEIA, the Health Magazine of the American Medical Association, include: "Keeping the Creative Mind Up to Par", by Joseph M. Creamer; "What Science Knows about Cancer", by Dr. Elliott C. M. Cutler; "Physicians' Fees and Their Collection", by Dr. Douglass W. Montgomery; "Cross Country Running in the High School", by George R. McCormack; "Heart Murmurs in Children", by Dr. Gustav F. Weinfeld; "Sanitation Goes Modern", by Dr. W. W. Bauer; and "Equipping the Nursery", by Katherine S. Blakely.

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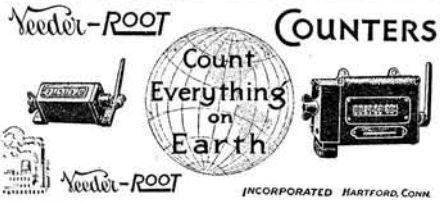

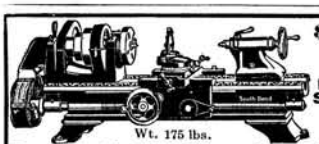

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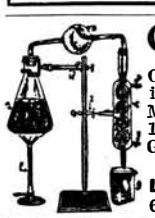

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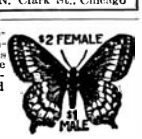

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heard of the Five-Year Plan the Soviet Union offered a first prize of 50,000 dollars and a second of 25,000 dollars for a commercial synthetic rubber process but apparently nothing came of it.—*A. E. B.*

New Machine Solves Riddle of Cohune Nut

THE kernels of the cohune and similar varieties of palm nuts which grow in great profusion in the tropics, contain a high grade of vegetable oil which, for general use, is superior to coconut oil since it is odorless and tasteless and less likely to turn rancid. This oil is in great demand in the manufacture of soap, candies, butter substitutes, paints, varnishes and lacquers, in the blending of salad oils, and as fat for general cooking purposes. It is also much prized in the tin plate industry as a flux. The oil is especially well suited for use in airplane engines instead of castor oil and as a fuel for Diesel and semi-Diesel engines; many other important uses have been found for it.

After the oil has been extracted from the kernel, the residue of the kernel may be used as a high grade cattle food. The husk produces materials considered excellent in the manufacture of burlap, rope, twine, and so on. From the shell is produced a coke that is superior to the coke produced from mineral oil. The charcoal of the palm nut is unsurpassed in smelting iron and other ores and is a deodorizing, decolorizing, and gas-absorbing agent. The shells, made into fuel briquettes, give greater heating power, at lower cost than coal. The shell, when ground into powdered "Palmite," is considered a superior product, when used in the plastic and ceramic industries, for the manufacture of automobile, electrical, telephone, and radio parts and household appliances. Other by-products include paper, wall-board, buttons, explosives, and rayon.

In the past it has been impossible to utilize these valuable nuts commercially, due to the fact that nature has provided them with almost impenetrable shells. Hitherto, in crushing the shells, the husks and kernels were crushed also, permitting the oils from husk and shell to mix with the oil from the kernel and producing an inferior quality of oil.

After years of experimentation, C. B. Repp has perfected a machine, shown in the accompanying illustration, which actually separates the kernel from the husk and shell, with no injury to the kernel. The Repp de-kerneling machine handles nuts of any size and cracks them open regardless of shell thickness.

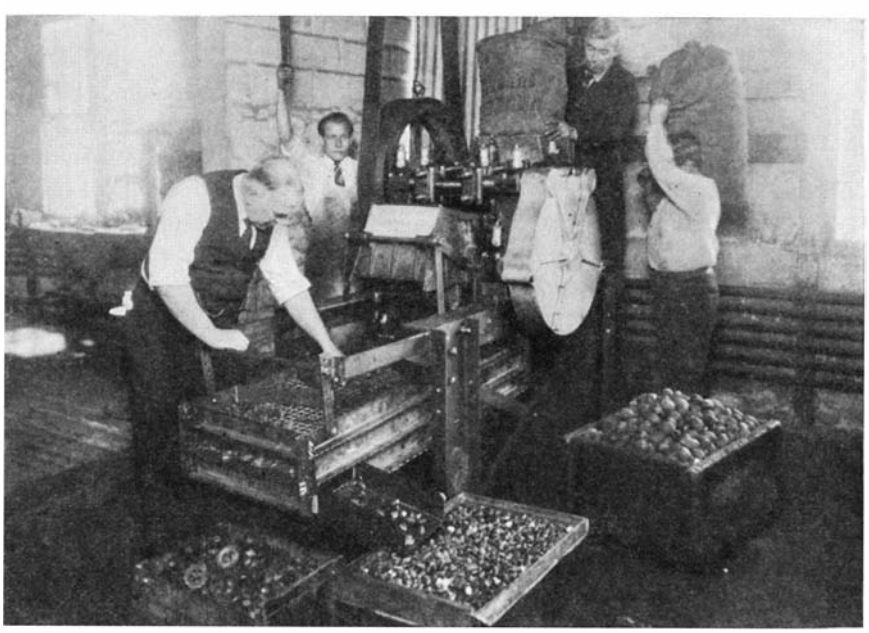
The machine is capable of cracking more than 3400 palm nuts per minute, equal to a production of about 20,000 pounds of palm kernels and 180,000 pounds of by-product per day of 10 hours.

As the mechanism is started, the nuts pass from a hopper through feed tubes into correct position within the machine. Heavy plungers rise and then descend rapidly, driving sets of tungsten-steel cracking chisels into the shells with a pressure of from 8000 up to 16,000 pounds per square inch. As the cracking chisels rise again, the broken shells are automatically spread out and shells, husks and kernels are thrown on a sieve-like table, which moves backward and forward in a horizontal plane, instantly separating the kernels from the husks and shells.

A Nuisance Converted to Profits

PROBLEMS arising from the disposal of industrial wastes, especially the pollution of streams and rivers, constituted one of the main topics for discussion at the recent meeting of the American Institute of Chemical Engineers in Atlantic City, New Jersey. One interesting phase of the subject was brought out by Prof. Edward Bartow, of the University of Iowa, who told how an effort to eliminate a nuisance has resulted in a marked economy in the operation of corn starch plants in Iowa.

Early day starch factories recovered only the starch from the corn, amounting to perhaps half of the total, but today, with by-product utilization an accomplished fact, the yield of corn products has increased to 95 percent. A few years ago the remaining 5 percent, discharged to the streams as an industrial waste, became the



The machine that opens cohune nuts without harming the kernels

cause of serious complaint from cities and property owners on Lake Michigan, the Illinois River, the Cedar River of Iowa, and the Mississippi River.

Co-operative research by the Corn Products Refining Company and the Sanitary District of Chicago, coupled with investigations at the starch factory of Penick and Ford, not only did away with the pollution but made possible the recovery of a large quantity of gluten and starch which was formerly wasted. In one case 87 to 91 percent of the waste matter was recovered, and now, by using the corn hulls, oils, and even the water in which the corn is steeped, there should generally be more than 99 percent recovery of the dry substances in the original corn.—*A. E. B.*

New Lens Eliminates Crane Shots in Professional Movies

A DEVELOPMENT of first importance to everyone interested in the technical side of professional motion picture making, the new Varo lens, has been announced by the Bell and Howell Company. This totally different lens makes it possible to "swoop" or "zoom" down on a subject and to recede from it without moving the camera or scene. "Close-ups" can be taken in sound photography work without danger of extraneous noise. "Zooming" scenes from far back to close-up can be taken of actors on a cliff or other inaccessible locations. The new effects that skillful camera men will work out with it are many.

The "zoom" lens which, used with a movie camera, makes possible new effects hitherto unattainable

The new Varo lens is set to focus on a definite position and is not focused like the ordinary lens by moving the lens unit nearer to and farther from the film. It is set normally to focus at 150 feet to infinity. Supplementary lenses, screwing into the front of the lens, are available for changing the focus for other distances.

After focusing, various elements in the lens are moved in a synchronized relation, the *focal length changing in smooth progression* as the position of the elements are shifted. Even though these elements are changed continuously in zooming, the definition is critical at all points.

Shifting is by means of cams designed and cut to an extremely fine degree of accuracy. Since changing the focal length or magnification involves changing the iris continuously to correspond, the iris diaphragm is also operated by a cam at the same time as the lens elements. A locking arrangement and dashpot device in the iris mechanism avoids any possible damage to the iris due to incorrect operation. A "breather" takes care of displacements of air occasioned by moving the lens elements.

Photographing Protons in Atoms

FOR the first time successful photography of the tracks of the proton of hydrogen, the nucleus of the hydrogen atom, is revealed in a preliminary report in the *Physical Review*. The report was submitted by M. A. Tuve, L. R. Hafstad, and O. Dahl of the Carnegie Institution of Washington, who for the past several years have been developing a 2,000,000-volt X-ray tube, for which they received the prize of 1000 dollars given annually by the American Association for the Advancement of Science.

For several years scientists have been able to study and photograph the track of the electron, the negative particle of electricity, which inhabits the outer part of the atom. The proton, the positive particle of electricity which resides within the nucleus of the atom, has presented a much more difficult problem. It is only within the last year that scientists have reported the first penetrating glimpses beyond the wall of mystery which still largely surrounds the core of the atom.—*A. E. B.*

Business-Pleasure "Yacht" Built for Buick Executive

DESCRIBED as a business and pleasure "land yacht," a private motor coach has been built for E. T. Strong, president and general manager of the Buick Motor Company. It is completely equipped with sleeping accommodations for six, dining facilities for 12, desk, radio, and bathroom.

Two compartments have berths, and sleeping space for the crew of two is provided above the forward section. Between the sections are the kitchen, bathroom, and clothes closets. The kitchen is equipped with a monel metal sink, hot and cold water, ventilating fan, and a stove burning a high combustion fuel. An automatic refrigerator is run by a motor operating from the coach's electrical system or by another motor which is plugged into a light socket when the coach is parked.

Reasons for Loss of Memory

MEMORY is one of the most important functions of the mind. It is the faculty by which man is able to recall experiences of his past. It is developed very early in life. The infant's recognition of its mother is dependent upon memory. It persists throughout life in the healthy person and enables an old person to recall vividly occurrences of early childhood. Lower animals also have memory, although less developed.

Memory depends upon the proper functioning of certain parts of the brain. It is impaired or lost if these parts are destroyed through disease or through changes accompanying old age. Memory is usually good, however, even in advanced mental disease if the brain is not organically weakened.

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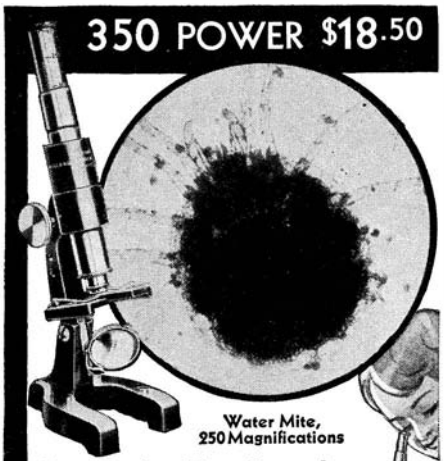

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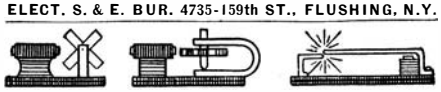

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Many persons fear loss of memory. They think of it as an early symptom of a general nervous breakdown, along with fatigue, nervousness and other symptoms. Contrary to this common belief, true loss of memory is not usual except in elderly persons. Although often feared by those who are nervous and worried, there is practically never true loss of memory in these cases. Loss of memory is not caused by emotions and fears. It is true that some persons throughout life are absent-minded and preoccupied, and therefore appear to have a faulty memory. This condition is due to lack of attention and not to any true disorder of memory.

Some persons past middle age find that they do not remember as well as formerly. Fortunately this condition is not progressive as a rule. It is only a part of the general decline in mental vigor and keenness of attention which often occurs in advancing years. Such elderly persons should be dealt with patiently and should not be held responsible for these frailties.

If loss of memory occurs suddenly and is accompanied by confusion, the condition is apt to be serious, according to Dr. Sanger Brown, who discusses this question in the *United States Daily*. It may be rapidly progressive and accompanied by other symptoms which necessitate treatment in a hospital. In instances of this nature, a physician's advice should be sought at once.

Misleading advertisements of certain medicines may lead nervous persons to fear loss of memory. Such persons who also fear they may lose their mind, should be reassured. They should have advice along mental hygiene lines, not because of any failure of memory but because of their anxiety and fears which makes them dread mental disease. Often the underlying cause of the nervous condition may be discovered and successfully treated by skilful physicians.

World's Largest Testing Machine

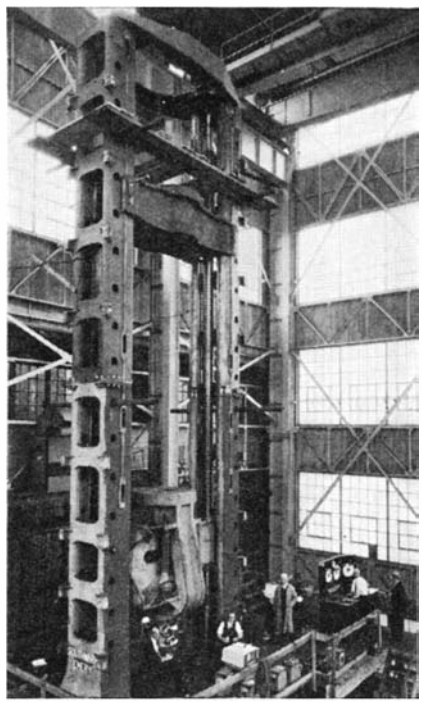
THERE has just been completed in the shops of Baldwin-Southwark Corporation, and shipped to the University of California, a testing machine which, in point of dimensions, is by far the world's largest.

It is able to test columns up to 33 feet 6 inches long in compression and up to 4,000,000 pounds load. In tension it accepts specimens up to the same length and will apply loads up to 3,000,000 pounds. The spread between the columns is 10 feet and the table is 12 feet long. Since the table is level with the laboratory floor a truck may drive between the columns and the specimen be lifted directly from the truck body by the testing machine itself.

There are many unusual features in this Southwark-Emery testing machine in addition to its great size and unprecedented capacity. Since the principal load application is hydraulic it is necessary to provide a cylinder and ram and a pressure-producing fluid pump. The ram on this testing machine is 46 inches in diameter and the hydraulic pressure is about 2500 pounds per square inch when operating at capacity.

The machine stands 46 feet 9 inches above the floor line and the foundations extend to about 25 feet below. The depth of the pit is 19 feet—a concrete tank of nearly 1000 barrels capacity! Total weight on the foundation is about 475,000 pounds.

In both compression and tension testing, the heavy lower cross-head moves downwards. In order that this weight—about 200,000 pounds—may be returned to position preparatory for a new test it is necessary to provide two pull-back cylinders, 13 inches in diameter, which are supplied with pressure from the same source as the main



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cylinder and ram. These pull-back cylinders have another very important function to perform. In the failure of specimens either in tension or in compression there is an enormous store of energy released in a fraction of a second. These cylinders and rams, together with four nests of heavy springs, absorb this "shot" of free energy and damp it out without damage to the structure, acting like gun recoil chambers.

Recently, in the process of testing this machine, engineers pulled in tension and broke the largest specimen ever used in a tensile test. This specimen was 8 1/16 inches in diameter and failed at 3,095,000 pounds. Elongation was 19.6 percent in 30 inches; reduction of area 22 percent; unit stress (original section) 60,700 pounds per square inch. Also, there was crushed a concrete cylinder 30 inches diameter by 60 inches high at 2,950,000 pounds.

Uses For The Rarer Metals

ONE of the features of the modern developments of metallurgy is the extent to which small quantities of the less common metals, either in the pure state or as alloys, are finding employment in various branches of industry. Many of the so-called rarer metals exist in combination in abundance in the earth, but are extracted with difficulty from their ores. When a sufficiently great demand for a particular metal arises, however, it is often found that methods can be developed to produce the metal at a reasonable price—an economic proposition which has proved to be true in the case of aluminum, in particular. In commenting to this effect, *The Chemical*

Age (London) cites several of the interesting new uses for the rarer metals.

Metallic barium (99.95 percent) has recently been produced as a commercial article, and is supplied to manufacturers of ignition equipment in the motor car industry, where it is used in a high-nickel alloy. In the radio industry, the metal is used to clean up the last traces of gas in vacuum tubes. It is expected that the consumption will increase to a substantial amount in the near future.

The electrical and radio industries now employ pure molybdenum metal in the form of rod, sheet, and wire. Cerium, when alloyed with iron, zinc, or other base metals, produces pyrophoric alloys, which are used in pocket-lighters. Cerium metal and ferrocerium are also powerful reducing agents, and offer excellent opportunities for industrial research. Both the metal and its alloy can now be produced at a relatively low cost, and abundant sources of raw material are available. Cæsium and rubidium are used in the manufacture of photoelectric cells. Cæsium is also useful for eliminating the last traces of air from vacuum tubes. Recently, metallic lithium has found use as a deoxidizing agent in refining copper; it does not appreciably reduce the electrical conductivity of the copper.

Metallic tantalum is now available. Because of its resistance to corrosive action it has already found extensive use as a cheaper substitute for platinum and platinum-gold alloys in spinnerets for rayon manufacture. Tantalum carbide is proving to be an excellent cutting-tool material. It is claimed that it will do work which even tungsten carbide cannot do. Columbium is a beautiful metal, resembling platinum. It takes a handsome finish, and may be colored by electrolytic methods in numerous iridescent hues. Further, columbium is inert to most chemical reagents. A promising future is predicted for this interesting metal in the manufacture of jewelry.—*Industrial Bulletin* of Arthur D. Little.

Rubber-lined, Sand-carrying Pipes

OFFHAND, the layman would probably decide that steel or iron would be more resistant to the abrasive action of hard particles such as sand than would rubber. A writer in the *Engineering and Mining Journal* tells, however, of experiments that were carried on at a mine in Cuba, with standard steel pipe, extra heavy steel pipe, and rubber hose for passing the sand to the stopes.

In these experiments the standard pipe was worn out after about 1000 tons of sand had been passed; the extra heavy pipe lasted for about 2000 tons; and the rubber hose was unsatisfactory because of trouble at couplings and bends. Rubber-lined pipe furnished by the B. F. Goodrich Company proved entirely satisfactory, and has been in service since February, 1929. Two main lines of three-inch pipe, lined with one quarter of an inch of rubber, and 2½-inch effective inside diameter, have been installed to transport sand, and have been so designed that valves and tees were eliminated.

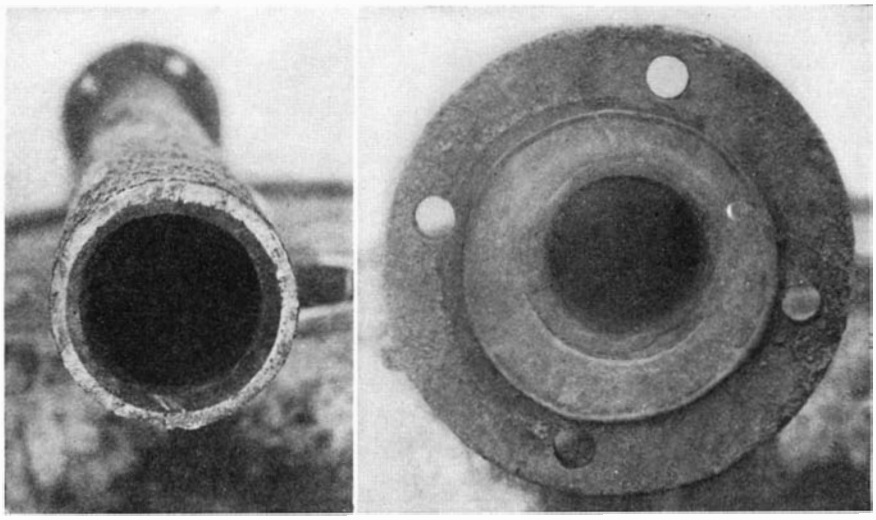
These lines have handled 35 tons of sand per hour without difficulty and the capacity is apparently still higher. During the period from February, 1929 to June, 1931, inclusive, 205,400 tons of sand have been sent through the pipe. Wear on the rubber, as shown in the accompanying illustrations, is practically negligible on straight lines. One curved length recently removed had a small hole worn through at the bend. Some 200,000 tons of sand had passed through the pipe at this point. (See also page 196, March, 1931 SCIENTIFIC AMERICAN for further data on similar uses of rubber.)

Important New Products of Chemistry

SOME of the remarkable achievements of chemical research in making new products available were reviewed by Dr. A. D. Little, eminent consulting chemist of Cambridge, Massachusetts in an address at the recent Chemical Industries dinner.

"By way of indicating what chemical industry may do to reduce costs," said Dr. Little "let us consider for a moment what it has accomplished. Aluminum once sold at 90 dollars a pound; the Castner process brought it down to 4 dollars, and the Hall process stabilized it around 22 cents.

"Ammonia takes its name because sal ammoniac was once procured by burning camels' dung at the temple of Jupiter Ammon in Egypt. Research has enabled us to do much better today, and while anhydrous



Rubber lined pipe after passing 205,400 tons of sand, showing negligible wear. The view at the right is of a flanged end, showing how the liner is spread out

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ammonia not so long ago was 30 cents a pound, it may now be had for about 5 cents.

"Ultramarine blue was once made by grinding lapis lazuli, and its value was of an order that might place it on jewelers' shelves. Today it is made chemically and is one of the cheapest of our pigments. A very few years ago tertiary butyl alcohol was a laboratory curiosity, and a few cubic centimeters cost many dollars; recently it has been sold in tank-cars at 50 cents a gallon.

"Princes once paid 600 dollars a pound for linen dyed with Tyrian purple; now the cost of tetrabrom indigo in a pound of fabric is a negligible amount because tetrabrom indigo is made in the laboratory instead of by a mollusk. Rayon, which has contributed so greatly to the resources and profits of the textile industry, sold in its earlier years for six dollars a pound; today it is selling at 65 cents.

"Chemical research has brought the products of the plastics industry from 14,500,000 dollars in 1914 to over a quarter of a billion dollars in 1929, and in doing so has doubled the production of phenol and formaldehyde in the five years beginning with 1924. The production of phenol resins went from 4,000,000 pounds in 1924 to 33,000,000 pounds in 1929. In another five years beginning with 1922 the production of ethylene glycol rose from 10,000 pounds to 12,000,000 pounds. New solvents and new types of soluble cotton have enormously extended the field of lacquers and created new and profitable industries. We have seen the production of synthetic ammonia develop in a few years from nothing to many hundreds of thousands of tons a year. Now we are at the beginning of a new series of developments in chemical industry based on syntheses utilizing water gas and the waste gases of the oil refineries.

"What chemistry has done in the past to broaden and stabilize industry and open up new avenues of profit and employment it can do again."—*A. E. B.*

Amateur Seismology

THE article entitled "Amateur Seismology," in our November, 1929, issue told how to make a small earthquake shock recorder, and a number of these instruments were constructed by amateurs. Those who are further interested in this subject will find specific instructions for making a vertical or wall model of the Jaggar shock recorder in the January 14 number of *The Volcano Letter*, a scientific journal published by the Hawaiian Volcano Observatory, National Park, T. H. The price of *The Volcano Letter* is 10 cents, and it is suggested that copies be obtained from the Observatory.

Alcohol From Wood, But Not Wood Alcohol

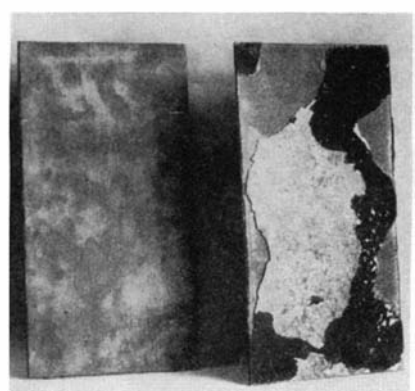
ALCOHOL made from wood—"real" alcohol, too, not wood alcohol—by an improved method in England, is declared commercially practicable where sawdust can be obtained at a dollar a ton or less, and a supply of 200 tons a day is available. The process, which will recover from 35 to 40 gallons of alcohol per ton of dry sawdust, was worked out by Dr. Harold A. Auden and Dr. Walter P. Joshua, of the Distillers' Company Research Laboratory at Epsom.

The process consists in forcing acidulated water, containing two parts of sulfuric acid per thousand, at a temperature of 180 degrees Centigrade and a pressure of 12 atmospheres, through sawdust packed in lead-lined vessels. Under these conditions nearly half of the sawdust is changed into fermentable sugars. The molasses thus obtained is fermented with yeast in the usual way to obtain the alcohol.

A preliminary treatment of the sawdust with superheated steam has been found advantageous, since it removes resins and other undesirable constituents.—*Science Service.*

Stainless Surface Welded to Steel

STEEL with a rust-proof "veneer" of stainless steel is one of the latest developments of welding. The new material, known as Plykrome, is made by welding a sheet of stainless steel to a mild steel slab and then rolling the slab into plates or sheets.



The welded stainless surface, *left*, was unaffected, while the mild steel backing, *right*, was oxidized, after an extended test involving alternate heating and cooling of the metal

Many problems were encountered in the development of this unique product. Oxidation, the great detriment to welding, had to be prevented. The weld between the two had to be so constructed as to permit the expansion of the alloy under the influence of increased temperature without breaking its bond with the steel. Welding had to be accomplished at controlled temperatures which would be effective with the alloy metal but not harmful to the mild steel.

The primary uses to which Plykrome will unquestionably be applied for the chemical process industries is to prevent the enormous loss to industry in the destruction of steel by corrosion and oxidation.—*A. E. B.*

If You Smoke, Keep Watch For Lip Cancer

A RECENT study of 173 cases of lip cancer treated more than five years ago at the State Institute for the Study of Malignant Disease, Buffalo, New York, showed that 169 were males and only 4 females. This contrast is so marked that some causal factor common to males as compared with females was sought. It was found that of the 169 males, 123 smoked pipes or cigars, or both, and 13 smoked cigarettes only.

Cancer of the lip is common among

males. It is believed that smoking in excess, especially pipes and cigars, is a contributory cause. The first symptoms are usually chapped or cracked lip, a thickened whitish scaly area, or a pimple, wart, or cold sore, existing from two months to three years. If patients would seek competent medical advice in the early stages of this type of cancer, permanent healing in from 75 to 90 percent of the cases could be hoped for.—*Health News.* New York State Department of Health.

Reads Print Through Five Metal Thicknesses

NICKEL has been made in such thin sheets that it is possible to read print through five thicknesses of the metal placed a few millimeters apart.

These nickel sheets were displayed at the Royal Albert Hall, London, during a recent exhibition.

The thin sheets were made by electrodepositing nickel upon copper and then plating copper upon nickel—a nickel sandwich. The copper was then dissolved away, leaving the nickel. Copper was required on both sides to equalize the stresses caused during the dissolving of the copper, which might have ruptured the nickel film.

Steeloscope Detects Elements

A STEELOSCOPE has been perfected in England which can estimate the metallic elements in steel by spectrum analysis, according to the magazine *Automobile Engineer.* The instrument is capable of detecting nickel, chromium, molybdenum, manganese, titanium, tungsten, cobalt, copper, tin, cadmium, and vanadium, and it is even possible to distinguish steels containing various percentages of these elements.

AIRCRAFT AND NAVY TREATY STRENGTH

(*Continued from page* 208)

the attack. Rear Admiral William A. Moffett, Chief of the Navy's Bureau of Aeronautics, has even gone so far as to express the opinion that one of the platform cruisers could defeat any eight-inch gun cruiser now in existence.

There are other advantages in having landing deck cruisers. The ordinary cruiser can carry only three or four planes at the most. There is no difficulty in catapulting this number of planes while the ship is engaged in performing other work, but recovering the planes is another matter. The vessel must first make a "slick," smoothing off the tops of the waves so the planes can land, and then must stop to pick them up. Planes can take off and land aboard a platform cruiser, however, without interfering in the least with any mission she may be carrying out. In addition, the platform cruiser affords an element of safety in the operation of aircraft attached to other vessels in that it furnishes a landing field at sea.

There is no question that we should build as many platform cruisers as possible. The argument that we should not commit ourselves to a policy of building this type of vessel until its value has been determined by experiment strikes me as being rather absurd. After all, the *Lexington* and *Saratoga* are nothing more than large flying deck cruisers. Owing to the fact that we have 10 light cruisers of 7050 tons each at the present time, our full quota of 80,750 tons of landing platform cruisers cannot be kept entirely within this category, but we can and, I am firmly convinced, should build 70,000 tons available.

Mention might be made here of the development work conducted by the Navy in the lighter-than-air field. In several respects this branch of aeronautics has advanced beyond the point reached abroad, as the result of orders placed by the Navy with American airship constructors. Lighter-than-air craft offer great possibilities for commercial as well as naval purposes, and this field should not be neglected. As an economy measure, the Army plans to maintain only enough lighter-than-air equipment for training purposes. This makes it all the more imperative that the Navy continue its work. Government support in this field must be continued if even the nucleus of a lighter-than-air craft industry is to be maintained.

A one-year building program, which included the construction of another aircraft carrier similar to the *Ranger* and one flying deck cruiser, was submitted to Congress last year. It could not be brought to a vote since the term was short and the calendar crowded.

A complete plan for building the Navy up to treaty strength, which would include the construction of four 13,800-ton aircraft carriers and a number of flying deck cruisers, as well as the purchase of planes to outfit them, should be authorized.

As Assistant Secretary of the Navy Ingalls has stated:

"Aviation has become so integral a part of the Navy, and is so principally based upon the vessels of the fleet, that a reasonably sound method of determining the building program of the planes seems to lie in associating that program with the actual shipbuilding program. Therefore the Navy Department, during the last session of Congress, endeavored to have passed an act that would make the number of planes directly dependent upon the number of planes necessary to adequately equip commissioned ships of the fleet, excepting that at no time should the number of planes be less than the 1000 provided for by the original five-year building program. . . ."

Now, construction of floating bases for our naval air area may be authorized, yet national security placed in jeopardy if provision is not made at the same time for the necessary flying equipment. The relation of such definite procurement program to the aircraft industry is apparent. The aircraft industry needs definite assurance of continued Government support not for a period of one or two years but for at least five. Those opposed to the construction program should remember that we cannot create an aircraft industry capable of meeting the nation's wartime needs on a moment's notice any more than we can build ships over night. We tried both of these things at the time of the last conflict at appalling cost and with but little success.

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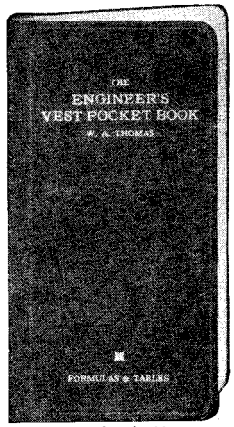

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COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY

Member of the New York Bar
Registered Patent Attorney

Trademark "Dry-Ice" Held Descriptive

IN actions brought by the Dry-Ice Corporation of America against the Louisiana Dry Ice Corporation and several other defendants, the United States Circuit Court of Appeals for the Fifth Circuit, reversing the decrees of two lower courts, held that the term Dry-Ice as applied to solid carbon dioxide was not susceptible to exclusive appropriation. The defendants had used the term Dry-Ice in their corporate names, and while they had not as yet commenced business at the time suit was instituted, threatened to use the name in referring to the solid carbon dioxide which they were planning to manufacture.

The court held that: "The term 'Dry-Ice,' being descriptive of qualities or characteristics of solid carbon dioxide, the product with reference to which it was used, the plaintiffs had no right to prevent the defendants or any of them from using that term in corporate names or in designating solid carbon dioxide produced or to be produced and marketed by them, if the latters' so doing was unaccompanied by any wrongful conduct having the effect of falsely representing the origin or source of their product or attempting to palm it off on the purchasing public as the product of the plaintiffs. . . .

"It is only when the adoption or imitation of what is claimed to be a trademark amounts to a false representation, express or implied, designed or incidental, that there is any title to relief against it. True it may be that the use by a second producer, in describing truthfully his product, of a name or a combination of words already in use by another, may have the effect of causing the public to mistake as to the origin or ownership of the product, but if it is just as true in its application to his goods as it is to those of another who first applied it, and who therefore claims an exclusive right to use it, there is no legal or moral wrong done. Purchasers may be mistaken, but they are not deceived by false representations, and equity will not enjoin against telling the truth."

Oil-Well Patents Held Valid

CLAIMS of the Halliburton patents, Nos. 1486883 and 1500385, relating to oil-well cementing, have been held valid and infringed by the United States Circuit Court of Appeals for the Tenth Circuit in its decision affirming that of the District Court for the Western District of Oklahoma, according to a report in *The United States Daily*.

The first-mentioned patent covers a method of hydrating cement, and the latter a method of hydrating cement and conveying the mixture to the point of use, with the speed of the mixing process and the speed of the conveying operation so synchronized that no substantial setting of the mixture takes place before it is deposited at the place it is intended to remain, according to the opinion of Circuit Judge Phillips.

The inventions of the patents in suit, while not so limited, are primarily intended to provide a new method of mixing and conveying cement and a new means for employing the same in the cementing of oil wells, it is stated. Prior to the Halliburton inventions, the opinion states, it was standard practice to mix such cement by hand.

Other patents and prior uses relied upon in the defense of anticipation were held by the court not to employ a high velocity stream of water to proportion and mix the cement and water, and not to anticipate the claims under consideration of the patent in suit.

The court also over-ruled the defense that the claims of the second patent in suit are mere aggregations and not patentable combinations. It was found that "the result produced is more than the aggregate of mixing and conveying; it is mixing and conveying in synchronous relation so that the cement is put in place with its quality unimpaired. While the result is old, it is accomplished in a new and more facile, economical, and efficient way."

The defendant was found to employ the process and operation of the two patents and therefore to infringe them.

The decision was handed down in the infringement suit of the patentee and its licensee, Halliburton Oil Well Cementing Company against the Independent Oil Well Cementing Company.

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.

"Vera-Coca" Denied Registration

IN the case of the Coca-Cola Company versus George W. Steinreich, First Assistant Commissioner Kinnan held that the latter is not entitled to register, as a trademark for soft drinks, the notation "Vera-Coca," in view of the prior use and registration of the notation "Coca-Cola" as a trademark for non-alcoholic beverages.

The ground of the decision is that the marks are so similar that their contemporaneous use upon goods of the same descriptive properties is likely to cause confusion in the mind of the public who purchase such beverages.

In his decision the First Assistant Commissioner said:

"Both marks include the word 'Coca'; the applicant places the notation 'Vera' before the word and the opposer places the word 'Cola' after the common word, and both parties separate their words by a hyphen. It is at least reasonable to suppose that customers in ordering goods of this kind might abbreviate the entire name or notation and if this were done the goods of the opposer and those of the applicant might well be called for by the word 'Coca.' At any rate the goods are of the character to be ordered carelessly without much thought or consideration and it is deemed at least probable there would be some confusion of goods as well as of origin. Those familiar with the opposer's trademark and goods might be led to think, even if the difference in the trademarks were noted, that the applicant's goods had their origin with the opposer; and that the latter was putting out a new kind of beverage."

Photo-Cell Sound Reproducing Patent Claims Allowed

THE defendant, Thomas E. Roberts, Commissioner of Patents, in a case recently heard before the District of Columbia Supreme Court, refused to issue a patent on a sound reproducing device to plaintiff, American Tri-Ergon Corporation, *et al.*, because the Patent Office tribunals found that plaintiffs' claims were for subject-matter disclosed in prior patents and publications. Many patents and publications are cited to support this conclusion. Defendant's principal contentions may be considered under two heads, as set forth in the opinion, following in part, by Associate Justice Adkins:

1. That prior to plaintiffs' invention a patent had been issued to Fritts for the reproduction of sound, which invention involved the use of the selenium cell; that other patents and publications known to the public referred to the selenium cell as an available instrument for translating light variations into electrical current for sound reproduction purposes; that the photo-electric cell accomplished the same purpose as the selenium cell, and that it was, within the meaning of the patent law, a mere equivalent for the selenium cell.

2. That the use of the photo-electric cell had been suggested in patents and publications as an alternative for the selenium cell in the sound reproducing art.

First: In my judgment the use of the photo-electric cell was not a mere equivalent of the selenium cell.

The photo-electric cell successfully performed a function which the selenium cell was unfitted to perform, and did not perform.

Fritts' application for patent was filed in 1880, the patent being allowed in 1916.

Fritts was the first who claimed the use of the selenium cell in the reproduction of sound. His application was filed 14 years before the photo-electric cell was known. . . .

In fact the selenium cell is seriously lacking in respect to the essential require-

ments of any light responsive cell in the successful reproduction of sound.

For these reasons the selenium cell was not successful in the accurate reproduction of sound.

Prior to plaintiffs' invention it was not known that the photo-electric cell had the essential requirements for reproduction of sound, and of course it was not known how to reproduce sound accurately by the use of the photo-electric cell.

Plaintiffs by a long course of study and experimentation demonstrated that photo-electric cells in actual practice are able to meet all the requirements for sound reproduction and they were the first to publicly exhibit talking motion picture films utilizing photo-electric reproduction of sound.

This was not the substitution of a known equivalent. . . .

Plaintiffs were compelled to engage in a long course of study and experimentation before they ascertained that the photo-electric cell was suitable to their purposes, and further experimentation was required to determine how to use the photo-electric cell.

They did discover that the photo-electric cell performed a function which the selenium cell had failed to perform.

Their discovery was a great step forward in the accomplishment of the purposes desired. It made possible what had not been done theretofore. It meant the difference between failure and success. Within the meaning of the patent law it was invention, and was not the mere substitution of a known equivalent.

Second: In my judgment the patents and publications cited by defendant do not anticipate the use of the photo-electric cell in reproducing sound. . . .

Defendant has offered in evidence certain United States patents issued after March 3, 1919, plaintiffs' effective date. In my opinion these are not proper to show anticipation, even though they were based on applications actually filed in the Patent Office prior to March 3, 1919. But in my judgment, assuming that they are admissible in evidence, they are not material. I, therefore, overrule the objection to their receipt, as well as the motion to strike them out.

Ash Tray Design Patent Invalid

THE United States District Court for the Southern District of New York has held invalid the design patent No. 83080, covering a design for an ash tray, reports *The United States Daily*. The use of figures to decorate an ash tray is not new, it was held.

"There is nothing new in presenting a figure of a nude girl in a pose wholly natural. The fact that the exact pose may not have been used before does not indicate any exercise of the inventive faculty."

Patent Pool for Outboard Motors

OFFICIALS of the Outboard Motors Corporation of Milwaukee and the Johnson Motor Company of Waukegan, Illinois, have announced a co-operative patent pool by which the participating companies will have access to each other's manufacturing discoveries. This move is regarded as a decisive forward step by leaders in the outboard motor industry. The decision follows a similar decision made by the automobile industry a few years ago.

Under the patent pool motors will not lose their individuality and the engineers of both companies will find it possible to devote themselves to refinements and improvements. The arrangement ends a period of prolonged litigation which has had a disturbing effect upon the outboard industry.

The Patent Office Speeds Up

THE Patent Office passed on 20,128 more applications last year than it received, accomplishing 14 months' work in 12 and reducing by an average of two months the time an inventor had to wait for official action on his application for a patent, according to information made available by the Department of Commerce.

The increase in work accomplished was attributed by Commissioner Thomas E. Robertson to an increase in the staff of his organization a year and a half ago and to the introduction of a new supervising system that makes for accuracy and better handling of applications.

No more work is being obtained per man, the amount having remained about constant for several years in spite of the fact that every year it requires a longer time to pass on a patent and a longer search of the files and records is required because of the additional patents granted, it was stated.

On December 31, 1930, there were 110,402 applications awaiting action, whereas on December 31, 1931, this number had been reduced to 90,274. This progress was made in the face of an influx of 20,000 amended applications per month, an increase of 2000 monthly or 24,000 yearly over the number received two years ago. This increase in amended applications more than compensated for a drop in patent applications of around 10,000 from 1930 to 1931.

Last year applications numbered 79,513 as against 89,397 in 1930 when a record for any single calendar year was established. These figures include only applications for new patents.

The Patent Office has 63 divisions with about 10 or 11 examiners in each. At the beginning of last year only seven of these divisions were less than six months behind in the handling of applications. This number was increased to 48 at the end of the year, while 29 divisions were less than five months behind. All work is now less than seven months in arrears, whereas a year ago it was nearly nine months behind.

Flexible Wall Anchor Held Patentable

IN a case recently heard before the Patent Office Board of Appeals, the applicant, Ivon S. Pieters, appealed from the decision of the examiner finally rejecting claims 10, 23 and 24. Claim 10 is illustrative of the subject matter on appeal:

10. In a furnace, a retaining wall, a lining, and an anchor for holding said lining to said wall, said anchor comprising two members embedded in the lining and the wall, respectively, and connected by a joint adapted to permit relative movement between said members substantially parallel to the wall, and a packing about said joint to prevent said joint from becoming clogged and comprising of a quantity of loose fibrous material.

No references are cited against the appealed claims, said claims being rejected as indefinite and functional in the statement that the members of the anchor are "connected by a joint adapted to permit relative movement between said members substantially parallel to the wall."

The applicant contends that he was the first to provide an anchor comprising two parts, one lodged in or attached to the retaining wall of the furnace and the other lodged in the lining, said parts being joined together loosely, whereby the lining is held firmly to the retaining wall, but allowing for expansion and contraction thereof relative to said wall, and that the specific construction devised by him does not constitute the broad feature of novelty on which he depends for patentability.

We are of the opinion that if the applicant was the first to devise an anchor so formed as to allow for the expansion and contraction of the lining with respect to the retaining wall, he would not be given full protection for his invention by confining his claim to the specific structure disclosed for effecting the desired result.

We regard the appealed claims as definite and allowable.

The decision of the examiner is reversed.

Door Mark Upheld

IT has been held by First Assistant Commissioner Kinnan that the Overhead Door Corporation, of Hartford City, Indiana, was entitled to register, under the Act of 1905, the notation "Over Head" Door, the word "Door" being disclaimed, as a trademark for garage doors, and that Barber-Colman Company, of Rockford, Illinois, had shown no sufficient ground for the cancellation of that registration.

The ground of the decision is that the registrant was the first to use the name, that it is not merely descriptive and had not been commonly applied to doors of the general type sold by both parties prior to the registrant's application for registration.

In his decision the First Assistant Commissioner said:

"The notation 'Overhead' indicates location in the first instance rather than construction or a characteristic of the door. As set forth in the respondent's brief, doors are frequently referred to by the names front, back, side, trap, and so forth, which names indicate position or location. It is likewise common to use the word door to indicate the opening as well as its closure and indeed to indicate an opening for ingress and egress which has no closure. The operations of doors are frequently described by the terms sliding, folding, hinged, and so forth. . . . It is conceivable that to one having no knowledge of the particular kind of door to which the respondent applies the word 'Overhead,' he would upon hearing the term think that the door was located in the ceiling; that it was possibly a trapdoor. While the respondent's mark is highly suggestive, truly enough, yet it is deemed not to be merely, only, descriptive. The respondent has built up a large business under its trademark and has evidently spent considerable sums in advertising and obtaining a good will as an asset of its business."

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PRODUCTS are nearly always put on the market before they are advertised. Quite frequently, changes have to be made in an article before the public generally will accept it. Color, design, flavor—those are some of the things the public has to be consulted about. Sometimes a product won't sell at all and simply has to be discontinued. As soon as people show that they welcome an article, and as soon as all refinements and improvements have been added, then you could hear the manufacturer say, "Now we can advertise."

When you buy advertised goods, you may know they have gone through the experimental stages. You may be sure that the manufacturer knows they are right and that he is willing to stake his reputation on them. You may be confident that you are buying goods that have sold and that would continue to sell without any advertising at all. For advertising merely lets all of the people know—now—what considerable numbers would find out by word of mouth ten years from now.

Of course, advertising goes a step farther. Word of mouth hardly ever tells all the uses of a product. It often doesn't give the real reasons for its superiority. Advertising tells people all about a product and the numerous ways in which they can use it.

Let the advertisements be your guide. When the manufacturer says, "Now we can advertise it," you know that you can safely say, "Now we can buy it."

WHY DO YOU POSTPONE STUDY?

You can not get too much knowledge. Education opens a vista of beauty for one person, and fills a gap in the practical training of another. It helps in every way of life, increasing opportunity and the ability to grasp it. ❧ Education enlarges the power of the business executive as well as the worker in the ranks; it increases the capacity of the teacher; it assists the mother in many of the problems that she faces. It broadens the power to serve. ❧ Through a wide range of home study courses Columbia University offers a richer and more satisfying life to adults as well as to youth, to men and women, to workers and students. ❧ These courses reward well the effort and time they require.

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Business Organization	Marketing
Business Psychology	Mathematics
Chemistry	Music—Harmony
Child Psychology	Personnel Administration
Classics	Philosophy
Contemporary Novel	Physics
Corporation Finance	Playwriting
Drafting	Poetry
Economics	Psychology
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English Literature	Public Speaking
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Fire Insurance	Religion
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In this country, we are in the midst of an adult educational movement. Home study courses are being taken by about 1½ million people which is nearly twice the total number of students in our universities, colleges and professional schools. University home study courses are especially important in this movement because they offer careful guidance under experienced educators. ❧ Columbia courses have been prepared to meet the special requirements of study at home. They are sufficiently elastic to be adapted to the students' individual needs. Everyone who enrolls is personally taught by a member of the University teaching staff. ❧ In writing, mention subjects which interest you, even if they are not listed, as additions are made from time to time. ❧ A bulletin showing a complete list of home study courses will be sent upon request. In addition to the general University courses this bulletin includes courses that cover complete high school and college preparatory training.

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