SCIENTIFIC AMERICAN

JANUARY · 1932 35 CENTS

THE WHEELS START ROLLING

PROBABLY the most remarkable thing about the first Ford car as it bumped over the sill of the little brick shed on Bagley Avenue, Detroit, and out into the dawn of a spring day in 1893, was that its maker had no doubt whatever about its success!

It scared horses. It blocked traffic by attracting large crowds. It became necessary to chain it to a post to keep investigators from starting it down the street.

Since those wheels first started rolling twenty million Fords have taken to the highways of all the world, shaping modern industry and civilization . . . hundreds of thousands of tractors have speeded up industry and smoothed the furrowed ways of the farmer everywhere . . . hundreds of metal planes have scaled above the clouds to the utmost ends of the earth. And no Ford machine is permitted to go forth without the certainty of success attending it!

There is a sound reason for this! When the Ford Motor Company first went into operation to build, deliver and service an automobile for every-day wear and tear, a machine to be admired and depended upon, principles of manufacture were established which made possible the continuous success of this famous car. These principles, briefly stated, in four sentences, are vital in the Ford organization today:

1. No fear of the future and no enslavement to the past.

2. Disregard of competition, because whoever does a thing best will be accepted as the one who ought to do it.

3. Service before profit; though without profit business cannot extend, without adequate service no business can continue to succeed.

4. Manufacturing is the transforming of the best possible materials into the best possible product for the consumer on a basis of fair cost all around.

This is the reason why Ford methods have become a synonym for modern methods and successful manufacture.

FORD MOTOR COMPANY

SCIENTIFIC AMERICAN

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EIGHTY-EIGHTH YEAR • ORSON D. MUNN, Editor

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SCIENTIFIC AMERICAN DIGEST

Of General Interest

Aviation

Chemistry In Industry

Medical Science

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ACROSS THE EDITOR'S DESK

THE war on crime continues apace. More and more are the long arms of science being used to bring to book those who violate the laws of the land. Since the best results can be obtained only by the concentration of knowledge and the practical application of theories to everyday problems on a large scale, there has come into being an organization devoted solely to crime detection. This is the Scientific Crime Detection Laboratory, affiliated with Northwestern University in Chicago. Headed by Colonel Calvin Goddard, world famous authority on various phases of crime, the aim of this Laboratory is to engage in the practical application of all branches of science to the detection of crime. Under the guidance of Colonel Goddard, one of our editors recently made a thorough study of the work of the Laboratory, and has written an article, scheduled for our next issue, putting forth this work. It will be illustrated with a series of photographs taken especially for SCIENTIFIC AMERICAN.

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A piece of pure science research that may have a highly important bearing on the future of certain industries has been carried out in England by W. T. Astbury, Director of the Department of Textile Physics at Leeds University. Using the X-ray analysis system worked out for the study of crystalline structures, he has investigated the structures of wool, human hair, finger nails, silk, and other external animal growths, often with surprising results. Why will a "permanent" wave result in hair that has been stretched and steamed, but not when unstretched hair is steamed? Why will natural silk shrink but not stretch under suitable treatment? These and other problems are solved by the findings of the X ray, and an article on the research work will appear in our next issue. The fact that the work concerns things which we all use daily lends an added interest to the account.

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Although the clouds of business depression appear to be passing, it is certain that there will be many unemployed who will have a hard struggle to make ends meet during this winter. It is pleasant to note the assistance that is being extended to those in want by those who are in a position to give, but charity alone is not the answer to the problem. Throughout the country there are being established organizations known as Goodwill Industries whose efforts to aid the needy are indeed praiseworthy. One of the most complete of these units is that operating in Buffalo, and we have obtained an article telling of its work. This is scheduled for publication in our next issue. The three-fold object of these units will be explained in detail, and special illustrations will accompany the article.

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During recent months people have been asking innumerable questions concerning railroads. What is the furor all about, anyway? If railroads have failed to prosper, why? And why does that affect every person in this country? Furthermore, do railroads really merit special treatment? Should measures be taken to assure them the "fair return" that the Interstate Commerce Commission said they could have, and to prevent the unfair competition of other forms of transportation that is an ever-present bogy? To answer these questions and many others of equal importance we have prepared for an early issue an article which discusses the complete story of the railroad's problems. Condensed though it is of necessity—books would not cover the subject fully—this article covers all of the essential phases of the situation and places the facts in the open where they can be assimilated.

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Radio is stepping into another rôle, under the auspices of the United States Forest Service. Experimental work has resulted in the development of a combination radio transmitter and receiver that is satisfactory for the rough service which it must necessarily withstand in forestry work. These sets will permit extension of the Forest Service work, and provide a communication channel that should prove invaluable. An article now in hand tells of the combination set and of its application to forest fire fighting.

•

The World's Fair in Chicago in 1933 will start off in a blaze of glory. Already many of the buildings are under construction or completed, and work on the remainder is being carried on. Scheduled for our February issue is an article which tells of the project as completed to date, and of the plans which will culminate in the celebration of a "Century of Progress."

BETTER TODAY THAN YESTERDAY

THIS kaleidoscopic panorama in which we move produces more fascinating and worthwhile evolutions than did the past, rich in accomplishment though it seemed. How much better it is to live the todays than it was to live the yesterdays. Industry, Science, indeed Life itself is so much more interesting.

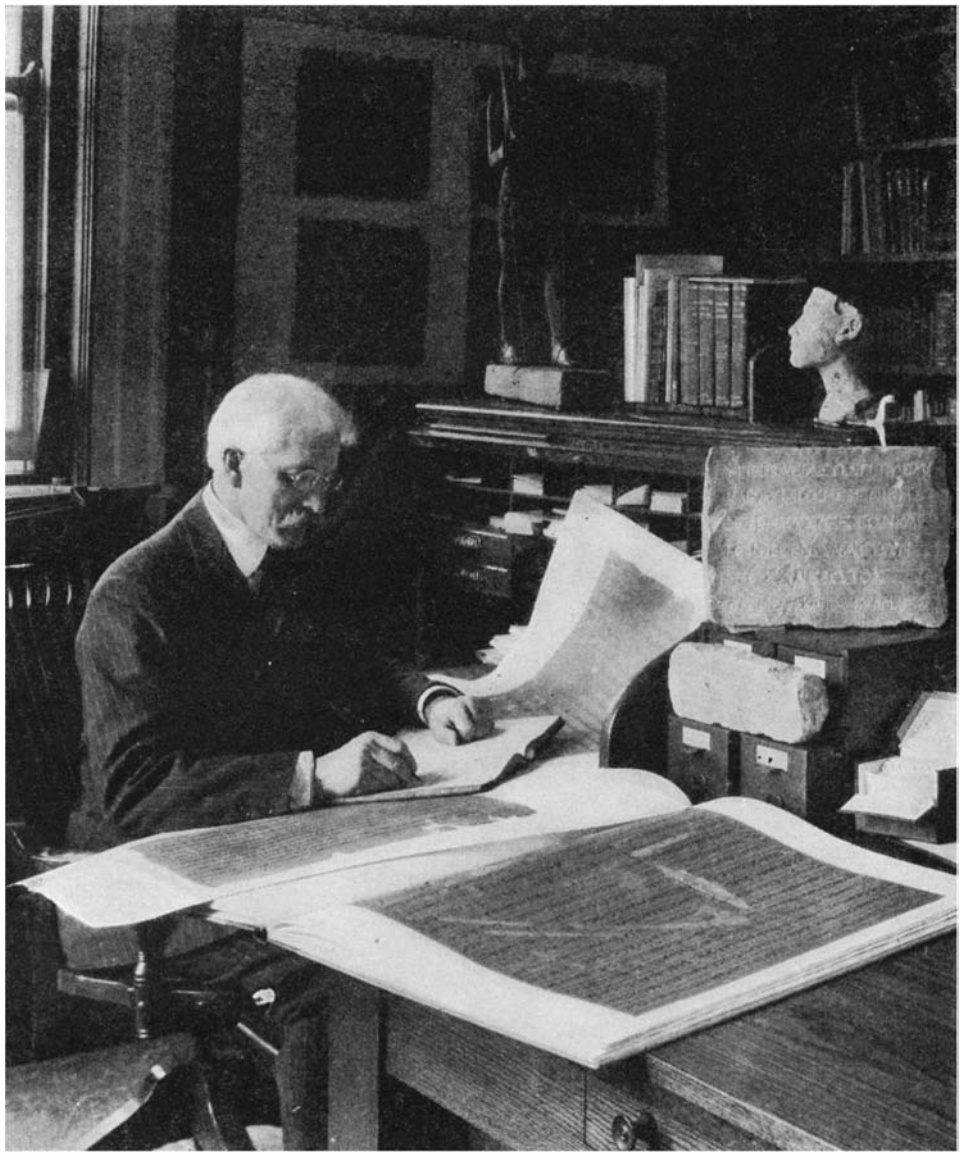
So too SCIENTIFIC AMERICAN is better today than yesterday; better in production, paper, illustrations and printing; better in editorial content—the names on our Editorial Staff represent the height of accomplishment in the various scientific lines.

Increasing prestige as the years roll on, is shown by the fact that libraries, research workers and industrial leaders turn to us more and more when their local references are exhausted. Our authority today is unchallenged, our audience is second to none in the magazine field and our high percentage of renewals attests its loyalty.

Such a combination surely warrants the thoughtful consideration of the advertiser.

L. S. Treadwell.

Vice-President—Advertising Director
SCIENTIFIC AMERICAN



JAMES H. BREASTED

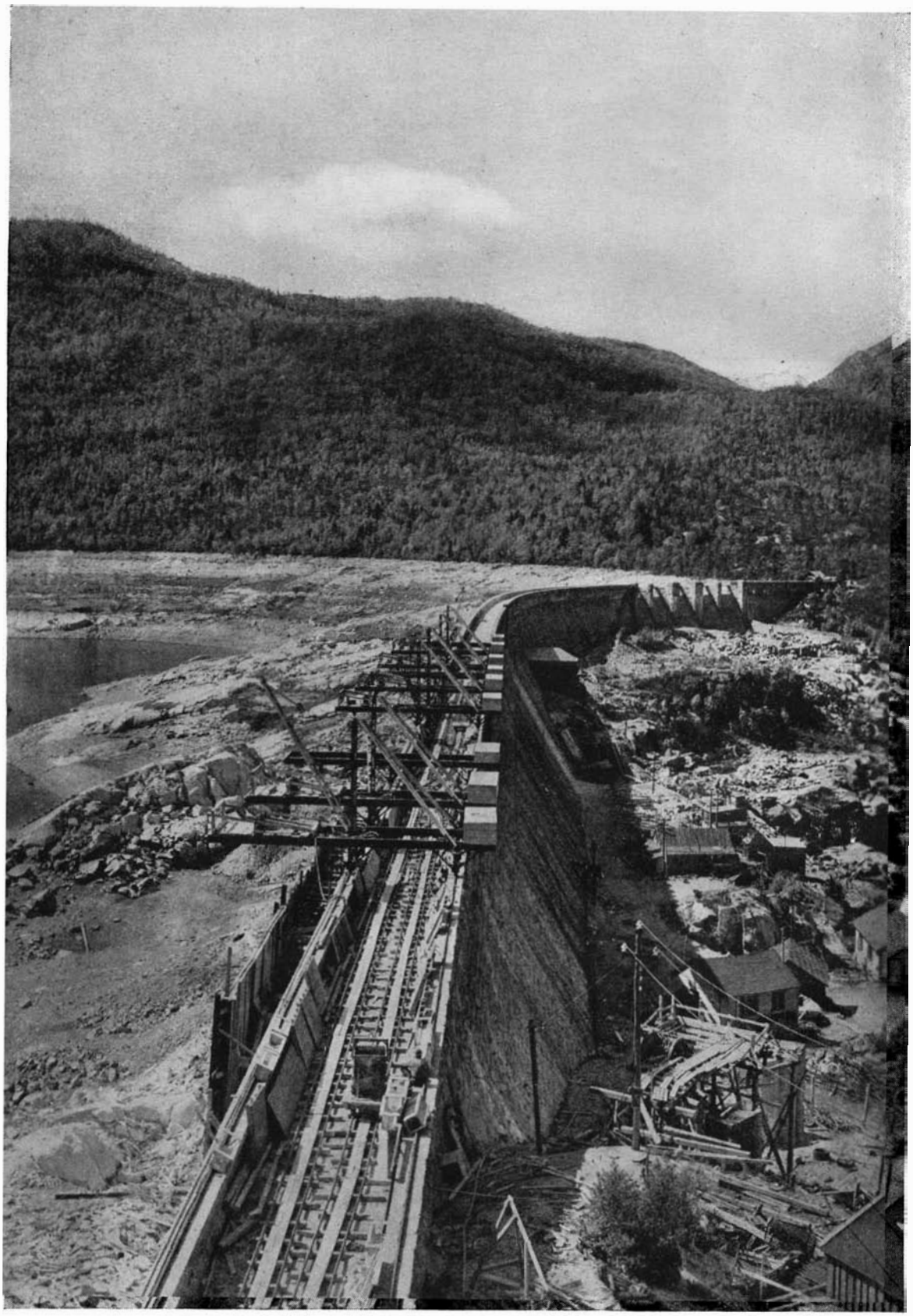
THIS noted American archeologist and historian is Director of the Oriental Institute at the University of Chicago. He was recently asked by the editor of *Nature* (London) to summarize the research in which he is engaged at present, and he replied:

"I am endeavoring to trace the course of human development from the merely physical man disclosed by the paleontologist to the rise and early advance of civilized societies, the product of social evolution culminating in social idealism.

"The scene of this evolution has unquestionably been shown to be the ancient Near East—the region folded like a horseshoe around the eastern end of the Mediterranean. The diverse civilizations which arose there are now known to have been the background and basis of European civilized development. These countries to-day constitute an almost inexhaustible storehouse filled with perishing and still unsalvaged evidence disclosing early human development. There has been no comprehensive and systematic effort to save and study this enormous body of perishing evidence *as a whole*. These facts lay a twofold responsibility on modern science: first, the task of salvaging this evidence by scientifically organized and equipped field expeditions; second, the study and constructive interpretation of this evidence.

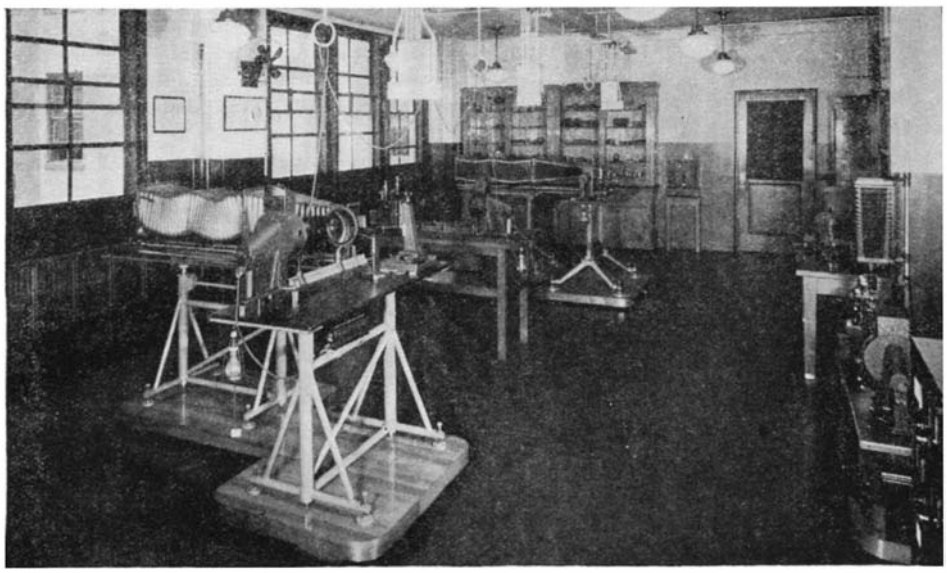
"These responsibilities adequately met will require not only scientific training and method on the part of the *individual*, but also organized effort and funds surpassing those which have been available in humanistic research hitherto. The organization which I have hoped might contribute to meet this situation, the Oriental Institute of the University of Chicago, is now 12 years old. It maintains a series of 12 field expeditions operating along a front of more than 2000 miles, from the southern shores of the Black Sea on the north, eastward to south Persia (Persepolis), and thence to north-east Africa and the Upper Nile on the south. . . .

"The subject matter of these researches both at home and abroad—the rise of man—is a process which in itself constitutes the greatest event in the history of the universe so far as it is known to us. The purpose of these researches is eventually to make possible an understanding of human origins and early human advance, based on fuller evidence than has ever been available before, and in so doing perhaps to discern more fully something of the causes and the nature of that mysterious and persistent buoyancy of the human spirit which, in spite of declining intervals, has made the direction of human movement from the beginning —and for probably several hundred thousand years—a rising line."



A LEAKY DAM GETS A NEW KIND OF FACE

THE old rock dam, Ringedalsdam, on the western coast of Norway, was leaky, so the engineers adopted the re-conditioning method described on page 12. In this general view of the work may be seen part of the new concrete slab face, on the upstream side, and some of the horizontal concrete columns which separate the slab from the rock dam



One of several microscopical laboratories at the Bell Laboratories in New York City. Thousands of scientists and technicians do research in this vast institution

SEEING WITH INVISIBLE LIGHT

By HERBERT W. FORSTER

HIS eyes are not very good. The left one, in fact, has only half of normal vision.

He was the first man to be able to see things 9000 times smaller than the naked eye can see.

On an evening in February, 1926, Francis F. Lucas was saying to a meeting of 500 engineers: "A microscope objective of given numerical aperture, when used with light of given wavelength, has some fixed limit of resolution. . . . But the ultra-violet microscope appears to have a potential resolving ability probably greater than twice that of the apochromatic system."

He went on like that for about an hour. The next morning a knot of men were standing in front of his office at the Bell Laboratories. They were not engineers. They were doctors, biologists, and bacteriologists.

"Where can we get one of these microscopes?" they asked, and "Show us how to use it."

In the hands of Lucas, the "apochromatic system" had already revealed new secrets, secrets of metal on which skyscrapers stand and bridges hang. Also secrets of why lead sheathing on cable sometimes cracks and how the tiny gear wheels in dial telephones wear out. He was talking about equipment which "appears to have a potential resolving ability probably greater than twice that of the apochromatic system."

These men had heard of that overnight. They were after deeper secrets—those of life itself. They wanted this instrument, which made a speck of dust look like a mountain, to help them in their peerings at specks which move and eat, specks of protoplasm which start life as well as those which, as though possessed by the devil, occasionally run wild and stop it. They wanted to look at the cells of living brains. Perhaps they could actually see what happens when a brain thinks.

This was not as absurd as it sounds. The limit of other microscopes was to magnify things about 1500 times. Here was Lucas with photographs that showed slices of steel enlarged by as much as 5000. He had gone as high as 9000 but at that immense magnification could not be sure what he was seeing.

MATHEMATICIANS had calculated that some of the smallest dots which appeared clearly on his photographs were only 250 atoms across! The man with imperfect vision seemed to be verging upon the age-old dream of the scientist—a look at that particle from which all matter is built, the atom. For more than a hundred years the theory of matter has been constructed around the existence of that particle, yet no man has ever come near to seeing one. Scientists have had only indirect evidence that they exist at all, such evidence as they could deduce by observing how they affected other objects that were large enough to be visible. They have been somewhat in the position of a watcher who, located half a mile away from a ball field, concludes that an invisible pellet has been knocked for a home run by observing the agitation that sweeps over the stands.

Even the atom, of course, would not be the ultimate. Beyond it lies the more indefinite concept of the electron. This, theory says, makes up the atom in the first place, and consequently we must imagine that the hardest rock is composed of such abstractions as force, motion, or "a point of stress in the ether." These are the best descriptions of the electron that any one has so far ventured, and no poet could do better.

He who would penetrate still farther comes to the very borderland of the mind. He must wonder what, in turn, this ether can be made of. He begins to ask, as physicists have been asking since we left school, whether there is any ether at all or whether we have merely created one as a handy idea with which to think.

These are the riddles that lead endlessly from one into another and confront the adventurer, who has successfully taken one to pieces, only with the further question, "Then what are *these* pieces made of?" Along this endless path, Lucas had taken a step, a great seven-league stride. He had wormed his way so far into the privacy of nature that he was able to detect so small a thing as a dot 250 atoms wide. Regardless of all the riddles that might still lie behind it, a look at an individual atom would be enough to agitate the spectators for some time to come.

What a brain does when it thinks may, of course, be something in the fifth or sixth order of these riddles. It may be the flickering of electrons through the labyrinths of nerve endings and cerebral fluids. In that case, to detect it would be hopelessly remote. But a chemical action may go with it. There may be some breaking down and building up of the elaborate molecules which compose the complicated substances found in the brain. This would mean that atoms are shifting about with lightning-like rapidity. If it were possible to see that . . . !

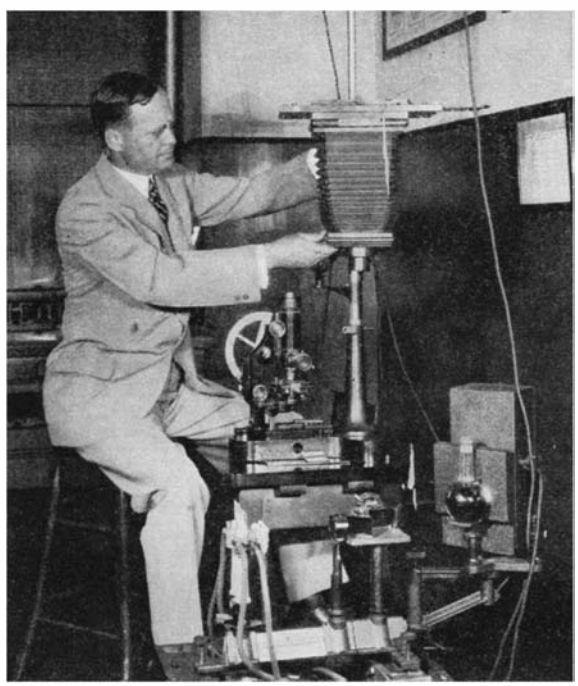
So the biologists wanted one of these microscopes. They considered it an event in the history of microscopy and, too, this has been an important history. It has contributed a large chapter to the whole book of science. It has helped to remake the world in which we live and to increase our ability to survive in that world without falling prey to the invisible organisms which lurk all about, ready to slay us and equipped by nature to do so.

LUCAS told them that the ultra-violet microscope was not new. It was, in fact, already 26 years old. Lucas had not invented it. He had, indeed, had only a share in perfecting it. But he had worked out the technique for using it, and that was essential. Until then, the invention had lain idle. No one could get the hang of it. By learning to use it, Lucas had re-discovered a good discovery for the world.

That kind of re-discovery has happened before, giving sudden impetus to events that have faltered in their march. Back in the 15th Century, Leonardo da Vinci drew up specifications for a flying machine. Four hundred years passed before the materials were developed from which such a thing could be constructed. Gregor Mendel, idling through the vegetable garden back of the Brünn monastery in Silesia, experimented with peas in 1865 and learned how heredity works. His experiments remained unknown until three botanists came along in 1900 and, working independently, confirmed them. His dusty papers were unearthed and codified into the now famous Mendelian principles of heredity, the foundation of the broad field of modern genetics.

In 1886 a German professor, Abbe, co-founder of the Zeiss Works, developed the most powerful system of lenses yet evolved—the "apochromats." Three years later he brought out the so-called "mono-brom-napthalene" objective. This was a lens which theoretically had the greatest power of all lenses for revealing detail. But it languished for want of someone who could manage it. In 1900, Koehler, also of the Zeiss Works, invented the ultra-violet microscope. It, too, all but perished and for the same reason.

Then in 1920 came the man with imperfect vision from the Bell Laboratories. He made Abbe's lens, which used visible light, do tricks which mathematics indicated were impossible. He began to bring Koehler's microscope, which used invisible light, under control.



Dr. Lucas and his microscope, with the apparatus for generating ultra-violet light in foreground

Watching Lucas manipulate these devices, complicated as a cartoonist's nightmare, you wonder what the father of them all would think if he could gaze upon these great-great-great-grandsons of his first creation. It is almost 300 years since that man was born—Anthony Leeuwenhoek, Dutch janitor, who, with infinite pains, ground lenses better than any had ever been ground before and became the Columbus who first explored a drop of water. He was amazed at the society he discovered there, and so was the Royal Society in England. He saw things that moved, wriggled, and flowed, that ate meals and reproduced their own kind by the simple process of splitting in two. We have never quite gotten over Leeuwenhoek's first amazement.

He was terribly bothered by blurring of one sort and another. Objects developed a halo around them, a halo of color like the rainbow. Daylight is made up of many lights and in passing through glass of different thicknesses like a lens these lights get separated and strike the eye in red, orange, yellow, green, blue, indigo, violet. It is pretty, but confusing.

This difficulty was slowly overcome. Simple lenses were corrected for two colors. They became "achromatic." Then Abbe developed his "apochromatic" system, which corrected them for three colors. It was a great optical achievement and it is with this system and the later mono-brom-napthalene lens that Lucas has made his amazing revelations about the changes that go on in apparently inert metals.

But a still more powerful key to the mysteries remained to be fashioned.

As you magnify an object larger and larger, its details have a tendency to become vague. You may be seeing the object 5000 times larger, but not better. To hold the advantage you must in some way bring out details just as sharply as before; in other words, show the fine points with more resolution. The microscopist calls it increasing the "resolving ability" of the microscope.

MOST of the gentlemen who had been trying to find out how to do this, had been worrying about the lenses. This time the question came up, why not worry about the light that shines through them? That started something.

Each of the many lights in daylight has a different wavelength. The long rays seem to skip over extremely tiny details just as a giant might step over a boulder. But a little man stumbles on a pebble and likewise the shorter rays reveal the tinier specks.

Red rays have the longest wavelength; blue rays much shorter. Ultra-violet rays are still shorter. So, back in 1901, Koehler was puzzling out a microscope that used ultra-violet light.

By this time it may be a little clearer what Lucas was telling the 500 engineers when he said, "A microscope when used with light of given wavelength has some fixed limit of resolution. The ultra-violet microscope appears to have a potential resolving ability probably greater than twice that of the apochromatic system."

It is a familiar story these days that you can't get sunburned through a window-pane. The ultra-violet that does the burning is stopped by common glass. Koehler had to resort to something other than glass. He constructed his lens system of quartz.

But that was only part of the problem—and here you begin to get an idea of what it means to work out one of these puzzles. Even in the ultra-violet range alone, there are many different

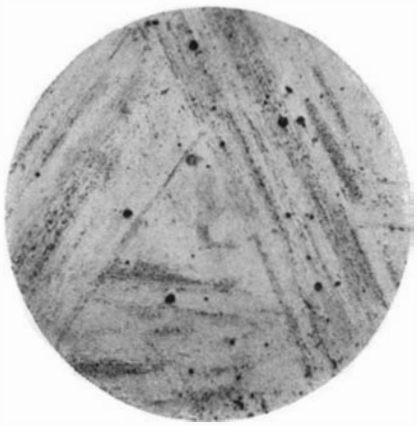
wavelengths. If he shot a lot of them through his quartz lens, they would break up just as daylight does in going through a simple glass lens and he would get the same old halo trouble with different wavelengths of ultra-violet instead of with the daylight colors —red, yellow and blue.

Why not correct quartz lenses for this trouble, just as Abbe corrected glass? Because in all the world of known optical materials there is none which will combine with quartz to correct it for more than just one wavelength of ultra-violet at a time. So even after Koehler had excluded all light but ultra-violet, he had to exclude all ultra-violet except one solitary wavelength of it. He picked the wavelength of 275 millimicrons, which is 1/100,000 of an inch long.

The material which *will* correct a quartz lens is an interesting mystery in itself. Scientists know just what it should be; they have defined its characteristics. But they have not found it yet. Maybe it does not exist. Maybe it can never be made. Like the play, "Six Characters in Search of an Author," you have the material waiting around for somebody to discover it.

OF course ultra-violet, if you are talking English and not science, really isn't light at all. Light is something you can see, and you could stand in a room all ablaze with ultra-violet light and still be in pitch darkness. That is why Lucas, in turning on his microscope, has to grope around to find his ray of invisible light. He uses a piece of uranium glass. This takes on an uncanny glow when ultra-violet hits it and then Lucas knows where his beam is and can proceed with focusing. When he was first getting his hand in on the microscope, focusing might take a month of careful work! Now he can do it in an instant.

He tells you that the source of his light is a spark which is produced by an electric current at 10,000 volts. This light is blindingly brilliant. Lucas breaks it up into the spectrum and uses that part of it where it slips off into invisibility toward the ultra-violet. To see what he is looking at, he reflects the final image on a fluorescent screen of uranium glass. It is rather a roundabout way but you often have to be roundabout in this strange world you are looking into.



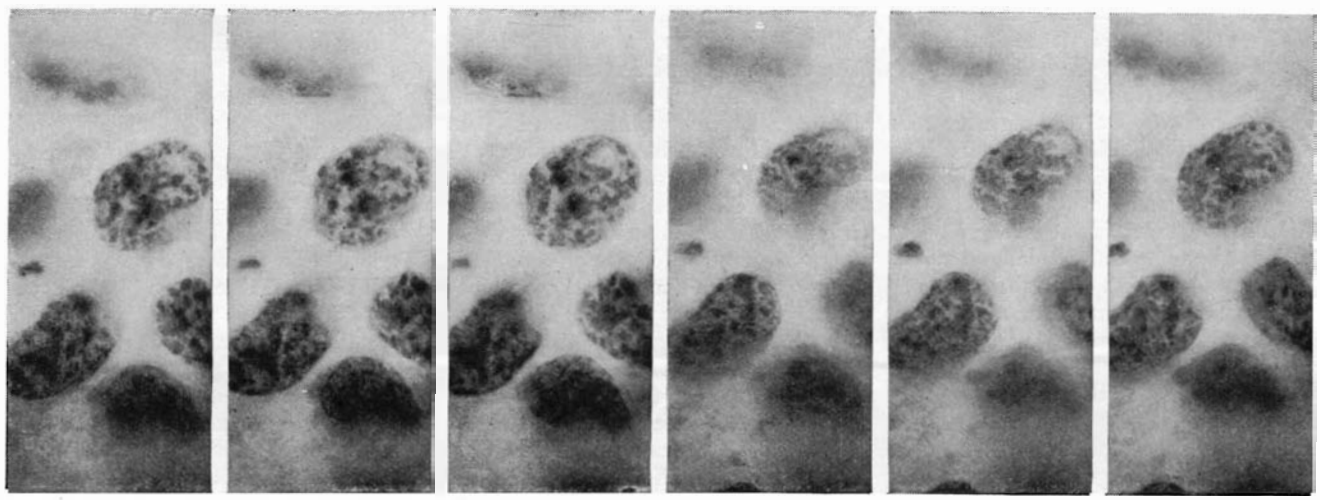
Steel magnified 3500 diameters. The black dots are the ones mentioned in the text—250 atoms wide

Lucas saw a dark streak that looked like an opening as big as the Grand Canyon of the Colorado. Yet a hair would cover it like a circus tent over a flea. How does he know such a streak is a crack and not just a dark band? He has explored it to find out. Step by step, moving the lens so grudgingly you could not notice its motion, he has crept down the crags and ledges of this imperceptible gorge and found it was a crack and not a color. Then he experimented to check up on his explorations.

He developed new ways of etching the surface of metals with chemicals that would eat away certain parts but not others. Having done this, he looked at the specimens again and found that holes look a certain way and things that are just dark, another. He had to verify appearances at every step. If there ever were optical illusions, here is where they live. There are no trustworthy parallels between the natural-sized world about us and this world of the infinitesimal. You have to start thinking and seeing over again, like Earl Musselman, the youth blind from birth who suddenly gained sight and couldn't tell a human face from a grapefruit without touching it.

Now Lucas can recognize the landscape at a glance, though he can't very well explain to you how to distinguish a crack from a dark spot. You would have to learn just as he did. How would you describe "blue" to someone who had never seen it before? Lucas can't very well tell you how he has mastered this microscope. It is largely a matter of touch, of instinct. Focusing is a movement of 1/100,000 of an inch and you have to recognize the focus the instant you see it because if you go past the point you can't go back. You have to start all over again. Ask the microscopists to tell you what this touch is, or ask Paderewski how he plays the piano or Kreisler what there is in his fingers that makes his violin sing.

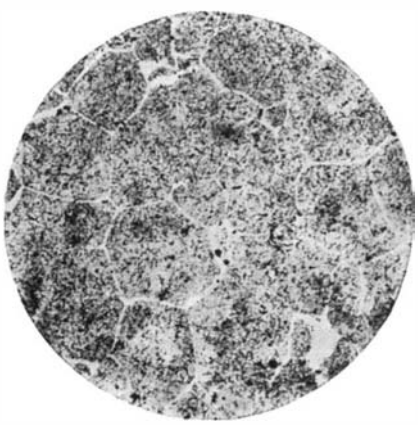
LEEUWENHOEK, the high-school boy who became a janitor, got interested in "burning glasses." Lucas, a high-school boy who became a telephone lineman, sat down with his wife one night and said, "I want to buy a microscope." That was many years ago. He was then in charge of a group of Western Electric engineers who inspected timber products such as telephone poles and cross arms. He thought he could inspect them better under a microscope. It might show cellular structure and point the way to better selection. Who ever heard of inspecting poles under a microscope? "How much," he asked his wife, "can we afford to spend for a microscope?" They spent most of their



Living tumor cells of a mouse, magnified 1800 diameters. Each view was taken at a level one 25,000 of an inch different from the last. They are not identical, as careful comparison will reveal. Compare those at ends with one another

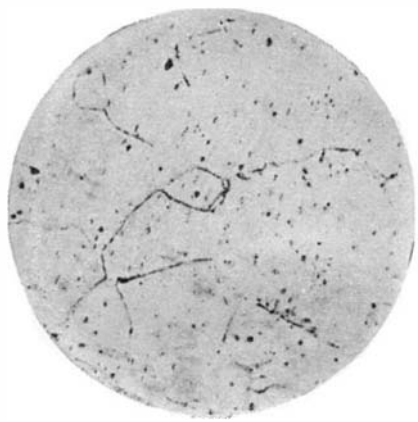
savings. He turned her kitchen into a laboratory.

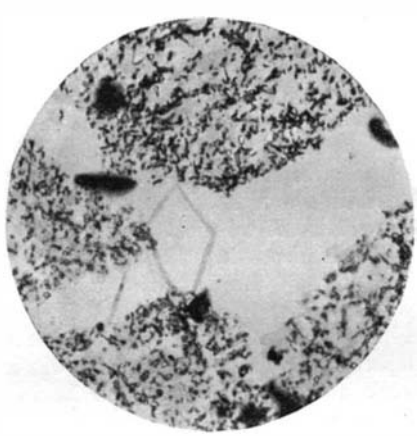
He began to feel his way along in this remote, sub-visible world. During the war, when he was engaged in developing apparatus to combat submarine warfare, he found why the submarine detector, placed under water, leaked. The detector had a diaphragm made of rubber with canvas stretched underneath. Tiny pieces of cotton lint from the canvas stuck into the rubber. Lint is made of linters. How big is a linter? Look at a tree and then at its branches and then at their twigs. Look at a piece of canvas, then look at the cotton thread from which it is made, then look at the cotton fiber from which the thread is made, and then try to see a fleck of the down which comes raveling off the fiber. If you can separate one of those flecks out, you would have a linter. Or, you might say, as a splinter is to a California redwood, so is a linter to a thread. The diaphragms stood all kinds of laboratory tests. But deep on the floor of the ocean, water seeped in. The cotton linter was its channel of entry. The microscope showed it to Lucas.



IN the kitchen at his home, his microscope magnified 400 times. Now if you could put a whole man under it, he would look nine miles high. The kitchen laboratory has long since vanished. In its place, at the Bell Telephone Laboratories, there are a group of laboratories devoted exclusively to the microscopic analysis of materials and known in scientific circles throughout the globe. The Bell institution of research has made available to Lucas and his staff every facility that will aid their work. Some 250,000 dollars worth of apparatus makes this laboratory of microscopes one that is unique in the world, capable of bringing the best equipment and technicians to bear on any problem that falls within the range of microscopy.

This range lies at the end of the scale opposite to the great astronomical observatories. The most powerful of its microscopes compare to the best of their predecessors as does the giant reflector at Mount Wilson to a pair of field glasses. Through telescopes, observers are endeavoring to shrink the dimensions of the universe, that they may clamber farther out into the black solitudes and bring back to earth some of the meaning of the constellations that illumine them. Through microscopes, observers are endeavoring to pry open the minutest apertures, that they may make a door large enough to admit them into the innermost chambers of atomic existence.





Top: **Lead-antimony solution.** *Left:* **Antimony has precipitated out and appears as small particles.** *Below:* **Bands of pure lead become vulnerable areas, along the edges of which the cable sheathing finally cracks** *(right)*, **as described in the text**

The one is an ancient science. It has reduced the sun to a star of unimportance and ennobled man by showing that the earth is a mere grain attendant upon this ball of fire which he has managed to make the scene and starting point for his great excursions into knowledge. It has taken ages to learn that this is so. Centuries have passed since Assyrian astrologers first scanned the heavens with that critical eye which meant so much more than dumb wonder. The other, the younger science, scarcely 300 years old, has likewise ennobled man by marking off the grandeur of his works against the commonness of his stature. He is, it has shown, made of common clay. His life is like other life: composed of myriads of little units of life. Yet he has done all these things; and so in the manner of that composition there is something to marvel at as well as something worthy of an eternal quest.

Here is plenty for the philosopher, and plenty for the amateur who enjoys conjecture. Here also is plenty for the practical man. The work of Lucas, microscopist, adds not only to the stuff that dreams are made of, but to the handiwork of man in building for his comfort, convenience, his pleasure, and his health.

One part of the metal antimony is mixed with 99 parts of lead to make the sheathing that goes around a telephone cable. It makes the lead many times stronger. The antimony is supposed to be dissolved throughout the lead almost like sugar in water, as shown in the top photomicrograph at the left. But after a while, if it is long exposed to certain conditions, the sheath begins to lose its strength. It may crack. What happens? Lucas has seen how the antimony commences to collect, "come out of solution," and gather in larger and larger spots. These strengthen the lead no better than pebbles stuck in a plaster wall. Large areas of pure lead begin to appear, and along these soft spots the sheath cracks. Now the Bell Laboratories, in conjunction with the Western Electric Company, are working on a different cable sheath.

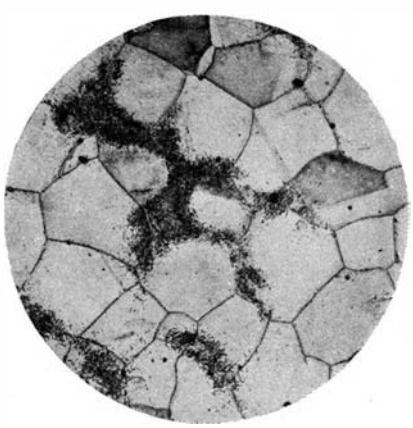
Through one of the new microscopes, the "apochromatic" one, the fine details on the surface of gear wheels in dial telephones were examined. It has been possible to improve the gear wheels so that they will live through 5,000,000 operations instead of 100,000.

Letters come in; letters from Europe, Mexico, India, China, Australia. Letters on all sorts of subjects—from the hopelessly ill, from co-workers in science, from manufacturers with puzzling problems of product or process. "Please tell us about your high-power metallography. These airplane motors . . ." or "these tools . . ." or "these rails . . ." or "these girders . . ." or "these plates. . . ." "They are subject to failure. Can your methods reveal the hidden cause?"

Or in another set of files. "Will you help us determine the structure of these bodies within the blood? Are they cells, are they crystals, are they just debris?" Dignified letter-heads from seats of learning. "We should be grateful if you would deliver a series of lectures on high-power metallography to our post-graduate classes. . . ."

Lucas had always aspired to a university career. But from high school he went to work. Thousands of students and professors have listened to the high-school graduate talk. He has lectured as far off as the imperial universities of Japan. On the walls of his laboratory hang a few of the many honors conferred by societies here and abroad. Last June Lehigh University awarded the self-educated scientist the degree of Doctor of Science. President Richards said it was "In recognition of your distinguished contributions to the science of metallurgy and technical microscopy and of your inventions which have enabled man to see and to interpret things that have not been previously seen or clearly understood."

It is now 42 years since Abbe developed the "mono-brom-napthalene" system, 31 years since Koehler invented the ultra-violet microscope and about 10 since Lucas began to make them work. What he has disclosed through Abbe's



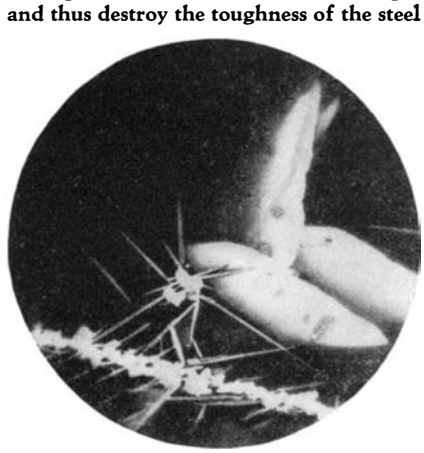
lenses about the structure of matter, and of metals in particular, has become a classic. Now bacteriologists and biologists are beginning to see the possibilities of the ultra-violet microscope and they wonder what it will show about the secrets of life.

Under high magnification it has heretofore been necessary to stain most specimens with dyes in order to differentiate various bodies and substances within a cell. To study life meant first killing it with paint and then looking at it dead and artificially colored. Ultra-violet also kills some organisms but at least their death throes can be watched and their corpses dissected optically free from chemicals and in their natural state.

The many organisms that survive ultra-violet can be spied upon in their living state and with an intimacy never before possible. The biologists are better off than the metallographers because they can look through their objects, which are partly transparent. By methods which Lucas has worked out and which he calls "optical sectioning" it is possible to get cross-sections of an organism on planes separated by as little as 1/100,000 of an inch. Lucas has described this method by likening a single cell to a house and imagining what would be seen if the house were viewed on one plane at a time.

"First we may take a photograph on a plane cutting through the attic. We do not see the roof above or the floors below. We see only the details on the exact focal plane selected. Perhaps there will be trunks, bags, boxes and things of another day placed in the attic for storage. All of these things on the focal plane are clearly defined. Perhaps our plane cuts midway through a trunk; we do not see the top or bottom of the trunk but we see the things which are stored away within it and which are intersected by the focal plane. In one compartment of the trunk our focal plane has come on some woolens. We see the texture of the cloth and observe that it shows wear, and then we come on the handiwork of the moth larvae. In another compartment are some queer-looking sections of straw and cloth and wire and we decide that it must be a hat on which the sun has

Why is manganese steel brittle when reheated after tempering? *At left:* What is revealed through an ordinary microscope. *At right:* Two views at 3500 diameters, showing how reheating caused brittle carbide plates to work into the cleavages and thus destroy the toughness of the steel



risen and no doubt set for the last time. And so we could investigate the contents of all the trunks, bags and boxes without opening them, disturbing their contents or doing the slightest damage.

"The next optical section intersects the sleeping and bath rooms of the second floor. At a glance, we note the number and arrangement of the rooms. We recognize the furniture and its disposition about the room. One room we conclude is a nursery because children are at play with things which we identify as toys, and we observe the play and movement that goes along oblivious of the scrutiny from above. In another room, our optical section coincides with the top of a dressing table. We see all the toilet articles and they have apparently been put down in haste as things are in disorder. In a jewel case cut by the sectioning plane, are many pieces of jewelry which we pause to admire. A large diamond ring which has been itself sectioned strikes our fancy because we look within and see a black carbon spot which we surmise the owner does not know is present.

"And so we may go from room to room and from floor to floor observing the life and habits of the occupants. If we take photographs as we go, they may be laid out in proper order from top to bottom and a working model of the house constructed."

Within the thickness of a sheet of paper, the ultra-violet microscope would see 400 such cross-sections. Thus through the eye-piece the investigator steps farther into the minute plan of architecture on which life is patterned, and not only that but into the secret

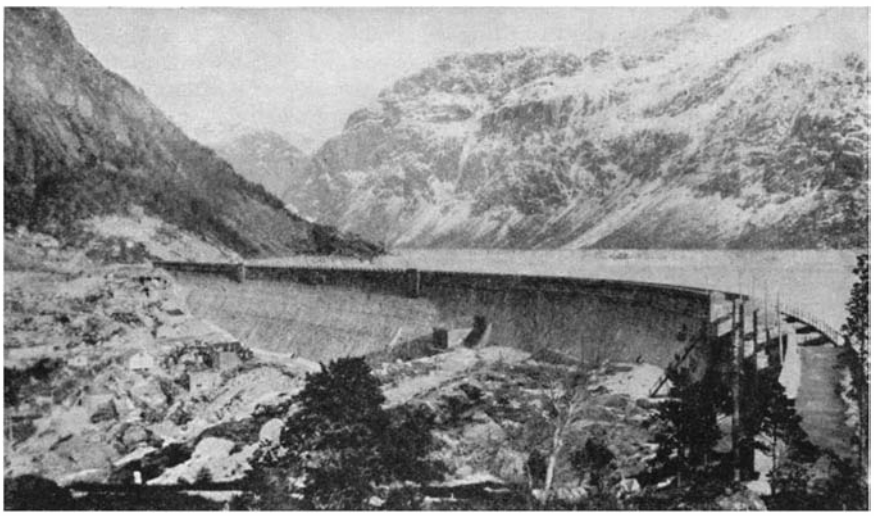
processes by which it actually is carried on.

In the study of those cells which become possessed of the devil, run wild and bring life to an end—the cancer cells—lies perhaps the greatest adventure before the ultra-violet microscope. What it reveals in this field may make it a humanitarian contribution finer than any yet made by the Bell Laboratories, finer than the artificial larynx, which gives speech to the speechless, or the Audiphone, which gives the deaf hearing.

As that journey of inquiry commences, Lucas, who once had to leave school because of eye trouble, is pointing out things about the structure of matter, both animate and inanimate, that no human eye has ever seen before.

A NEW DAM-RECONDITIONING METHOD

By DR. ALF B. BRYN

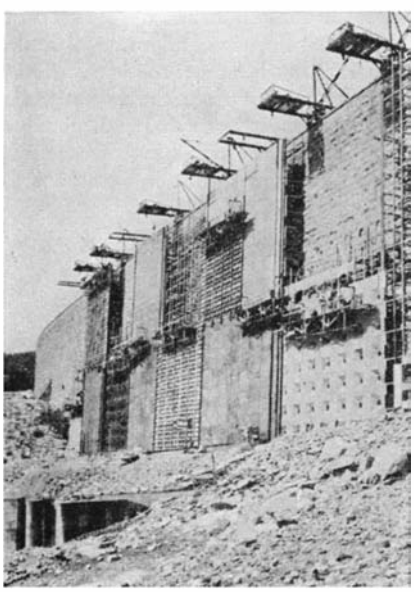


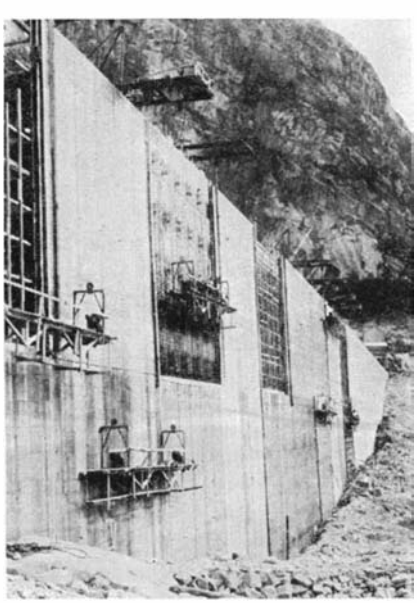
The large dam in Norway as it appeared before the reconditioning work

A NEW method for repairing or reconditioning leaking rock or concrete dams has been invented by the Norwegian consulting engineer Chr. F. Gröner and has been practically used for reconditioning one of the largest dams in Scandinavia, the Ringedalsdam at Tyssefaldene in Hardanger, on the western coast of Norway. The work in connection with this dam was carried out by the firm of contractors, Höyer-Ellefsen and Company, Oslo.

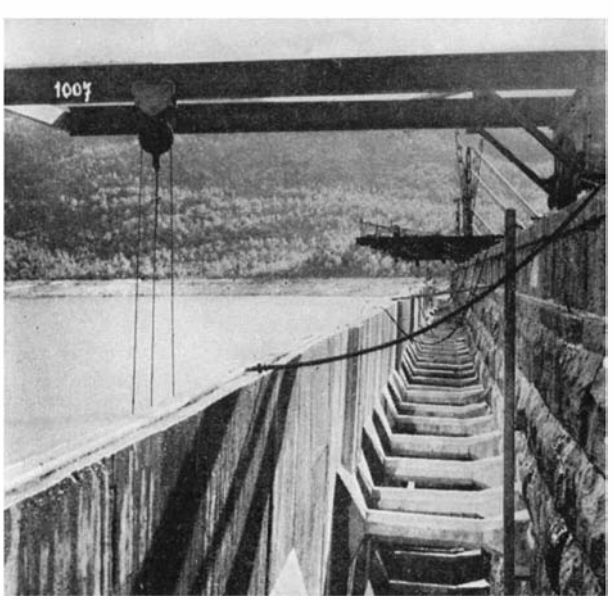
The method consists in providing at a short distance from the upstream face of the dam a thin plate or slab of reinforced concrete, this slab being supported against the pressure of water by means of a large number of pillars or columns, extending between the slab and the upstream face of the dam and substantially perpendicular on the latter—that is, in a horizontal position. These columns have sufficient elasticity to permit the concrete slab to expand and contract freely in its own plane with regard to the main body of the dam, whereby all risk of fissures in the concrete slab is avoided.

The Ringedalsdam serves to provide the reservoir for the water-power plant Tyssefaldene, supplying electric current to the aluminum, zinc, and carbide works at Odda. The length of the dam measured at the crown is approximately 2952 feet, and the height of the dam is about 115 feet at the middle. The concrete slab erected at a distance of about 6.5 feet from the upstream face of the dam has an average thickness of slightly less than one foot, the size of the slab being approximately 32,117 square feet.





The two photographs at the left and our frontispiece show the erection of the concrete slab at the upstream face of the dam



At the right, the two illustrations show the space between the old rock dam and the concrete slab, with the connecting columns by means of which the new slab is supported

OUR POINT OF VIEW

Synthetic Rubber

COAL, limestone, salt, and water—few people would see in these prosaic "actors" the elements of a mighty industrial drama. Yet they have played their parts well in the laboratories of the duPont Company and the climax is a new synthetic rubber which more closely approximates rubber in composition and usefulness than any other man-made rubber.

The discovery described in the Digest in this issue, of a process for making synthetic rubber with these four commonplace, abundant materials, is of outstanding importance. Some writers, commenting on the development, have even suggested that it might repeat the story of indigo; the artificial product might, as the man-made indigo did, force nature's product off the market. Such a consequence is hard to conceive at this time when there is a greater production of plantation rubber in the world than can be used and it is selling at about a third the actual cost of production. Furthermore, although the new synthetic rubber has some important properties that give it a decided advantage over natural rubber in certain applications, its field of usefulness is as yet too limited for it to take the place of the natural variety. The duPont Company, however, is aware of the limitations and has made no unreasonable claims for its new development. A plant is being constructed to produce the new rubber and doubtless in time many new uses will be found for it.

As conditions are at present, the new artificial rubber is significant principally because it assures a satisfactory supply of rubber for us in the case of a national emergency. Should war limit shipments of natural rubber from distant plantations to this country or cut them off entirely, the duPont rubber would be used. As for its present limited applications, our chemists showed during their World War work with helium what we might expect of this rubber under a similar stress of great necessity.

Studies in Sex

WE hear a great deal these days about changes in moral standards with regard to sex. The world is rapidly going to the bow-wows, for young people actually know all about sex—more at least than their elders know—and this of course is very, very bad. They ought to be kept innocent and ignorant. Prepare them for every other kind of life but leave this aspect blank. Then they can innocently and ignorantly fall into some of the pitfalls their elders have fallen into, especially sexual maladjustment in married life about which the inner facts are only now being revealed to science.

Things have changed a great deal, but are they worse or only different? When judged by the old standards, appearances are worse, without doubt, but we think things are better when judged by the only criterion by which morals may rationally be judged—whether the general adoption of a type of conduct would conduce to injury to the real well-being of the race as a whole. The younger generation is more frank, which is to say its attitude is more scientific, than the previous ones were. Sex is a part of biology and psychology, and is as natural as eating or sleeping or thinking. Why not regard it in that same light, instead of regarding it from a warped point of view?

Several years ago we informed our readers of the availability of Dr. Katharine B. Davis' book, "Sex Factors in the Lives of Twenty-two Hundred Women," and hundreds acquired this published summary of a piece of remarkable scientific research. Another outstanding advanced book has now become available, the title being "A Thousand Marriages, A Medical Study of Sex Adjustment," and we take occasion to inform the same readers of this. We see no reason why the insight and background provided by such advanced studies should not be placed before intelligent, serious lay readers, and many reasons why it should. We shall continue to act in matters of this kind as an intermediary between the smaller professional world of science and the larger body of scientifically minded lay readers; knowing that each of these lay readers in turn will act as a local center of dissemination of such knowledge. In time the human race may come to know, as a whole, as much about the sex life of its own species as animal breeders now know about the sex life, for example, of cattle.

We Build Ships

WITH four large modern liners, built and building, American shipping is making a strong and determined effort to regain some of the laurels of the sea that once were ours but were lost many years ago. Two of these have been completed, the third was launched December 5, and the fourth is scheduled for completion next July. Several American shipbuilding records are held by these four ships which are the pride of our renascent merchant marine.

The *President Coolidge*, which started on her maiden trip to the Orient in the autumn, is the world's greatest electric liner. Her sister ship, the *President Hoover*, went into service last summer. The ship launched on December 5 and named the *Manhattan*, is the first to be built in this country for North Atlantic service since 1897, and she takes over the record of the *President Coolidge* of being the largest commercial vessel of any kind ever built in American shipyards. The fourth ship, known temporarily as *No. 405*, is to be a twin of the *Manhattan*.

The *President Coolidge* is 654 feet long and has a beam of 81 feet, a speed of 21 knots, and a registered gross tonnage of 22,000 tons. The *Manhattan*, however, has a length of 705 feet and a beam of 86 feet. Her registered gross tonnage is 30,000, and she will make a speed of 20 knots. Her design marks an achievement of some note in shipbuilding since her engine room space is but half that required five years ago for a ship of her size. Three large boilers will generate steam at a pressure of 400 pounds to drive the triple series turbine which, in turn, will drive the propellers. Four electric generators are to supply the necessary auxiliary power. Oil is to be used as fuel.

The construction of these vessels and others yet to come according to present plans, was made possible by the Merchant Marine Act of 1928. Under this act, the ship-owner may borrow from the government at a low rate of interest as much as three fourths of the cost of a new vessel. Eleven ships have been built under this plan, 15 more are being built, and 34 more are still to be built in American shipyards. It is planned to make at least one of these a running mate of the *Leviathan* but we are not sure that this plan has been definitely decided upon.

We do not expect any of the ships yet to be built to be comparable to the 73,000 ton Cunarder or the new superliner of the French Line, both now being built, or even to the existing monsters in North Atlantic service, but they will elevate the United States merchant marine to a new and important position in world commerce in the very near future.

IS SPACE EXPANDING?

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

THE extra-galactic nebulae are remarkable for many other things besides the enormous distances of which we wrote a month ago. They are themselves the greatest material things —in size, in mass, and in brightness— of which mankind has any knowledge, and their motions are as far out of the ordinary as any of their other characteristics.

It has already been told how hard it is to photograph their spectra. With a faint star the observer profits to the full if he has a large telescope, for all the star's light is concentrated into a point-image which, if only the air is really steady, can be set on the slit of the spectroscope so that all the light collected by the telescope enters its auxiliary instrument. But a nebula appears as an extended surface. With a great telescope its image is brighter, to be sure, but is also larger and the slit of the spectroscope covers only a part of it, so that a great deal of the light is inevitably lost. The small amount of light that gets through when it is spread out again by the prisms—which is of course absolutely necessary if it is to be analyzed—forms an excessively faint streak. To avoid prohibitively long exposures it is necessary to use a camera of very short focal length.

THE first observer to realize this possibility was Slipher, whose pioneer work at the Lowell Observatory opened a wholly new field of astronomical study. The photographed spectra, though short and narrow, suffice to determine not only the spectral type of the nebula and hence its composition, but also the shift of the lines produced by motion toward or from the earth.

The Andromeda nebula, the first which was observed, is approaching us at the rate of about 300 kilometers a second but all the 40 others which Slipher observed are receding, except a companion to the Andromeda nebula which obviously shares its motion. Several of the 40 are moving at more than 1000 kilometers per second and one at 1800, a speed sufficient to pass from the earth to the sun in slightly less than a day! In 1929 Hubble found that these observed motions depend upon the distances of the nebulae, which by that time he was in a position to estimate. The remotest nebulae were receding the fastest, and the rate of recession was closely proportional to the distance, increasing by 160 kilometers or roughly 100 miles per second for every million light years.

If this proportionality still held good for the more distant nebulae their velocities should be enormous. But it was no easy matter to observe them and find out, for the remoter nebulae are exceedingly faint and can be observed only by combining a very large telescope and a spectroscope with a very short camera. With the Mount Wilson nebular spectrograph even a 3-inch focus proved too long and a special lens had to be designed. This resembled a gigantic microscope objective and is two inches in diameter with an effective focal length of only an inch and a quarter. The spectra photographed with this lens are usually about a tenth of an inch long from the green to the violet and less than 1/200 of an inch wide. For the faintest objects one prism is used instead of two, and the spectra are only half this size. To the unaided eye they are mere specks but the spectral lines can be clearly seen under the microscope. With this very powerful instrument attached to the 100-inch reflector, spectra of more than 40 faint nebulae have been obtained and measured. Through the courtesy of Mr. Humason, who has made nearly all the photographs and all the measures, we are able to show just what the results are.

THE spectra shown in the figure have been widened by a photographic process to bring out the lines more clearly than they can be seen in the very narrow originals. Both they and the photographs of the nebulae to the right are negatives. Above and below each nebular spectrum is the comparison spectrum of light from a helium tube attached to the instrument, the bright lines appearing dark on the negative. The line farthest to the right is λ 5015, in the green; that on the extreme left λ 3888, at the extremity of the violet.

Beginning with the spectrum of sunlight (reflected from the sky) at the top, we observe two strong dark lines (showing reversed, of course, as bright lines) at the violet end. These are the familiar *H* and *K* lines of calcium, the strongest in the whole solar spectrum. The numerous fainter lines in the violet and blue are "burned out" by the exposure required to bring out the violet end and do not show on the print, though several could be seen on the original negative.

In the next spectrum below, the same pair of lines is visible, strongly shifted toward the blue. Such a shift means that we are receiving fewer light waves per second from the nebula, which is receding from us at the rate of 3000 miles per second. The third nebula is much fainter and shows a still greater shift; while the fourth, the faintest and most distant object yet investigated, shows a huge shift corresponding to the amazing velocity of 12,000 miles a second. This displaces the calcium lines from the violet almost into the blue, and would shift the yellow sodium lines into the orange red.

Here at last is the realization of the old prediction of Doppler, the first physicist who realized that the approach or recession of a star could alter the wavelengths in its light. He stated that if a star was receding fast enough its color would become redder, and this glaring "Doppler effect" is now made plain before our eyes. (For the very much smaller velocities of ordinary stars the effect, though it displaces the spectral lines by a measurable amount, is too small to produce any perceptible change in color.) More than half the nebulae in Humason's list belong to recognized clusters. In each cluster the nebulae are receding at nearly the same speed, which differs greatly from one cluster to another. The nebula N.G.C. 385 belongs to a group in the constellation Pisces, N.G.C. 4884 to one in Coma Berenices. The other two clusters are very faint nebulae in Ursa Major and Leo. The distances of these clusters as derived by Hubble are given in the figure.

IT is evident at once that the velocities are very nearly proportional to the distances, at the rate of a little over 100 miles per second for every million light years distance. This relation is fully confirmed by Hubble's studies of the extensive material of which the data illustrated form a small part. For the Virgo cluster, the brightest and nearest cluster of nebulae, the velocity of seven nebulae averages 550 miles per second,

at a distance of 6,000,000 light years. Three other clusters at 24, 29, and 36 million light years show average velocities of 2400, 3000, and 3300 miles per second.

All these values agree strikingly with the general relation. The averages for two groups of isolated nebulae are also in as good agreement as might be expected. Hubble's final result is that the velocity is strictly proportional to the distance, at the rate of 106 miles per second for every million light years.

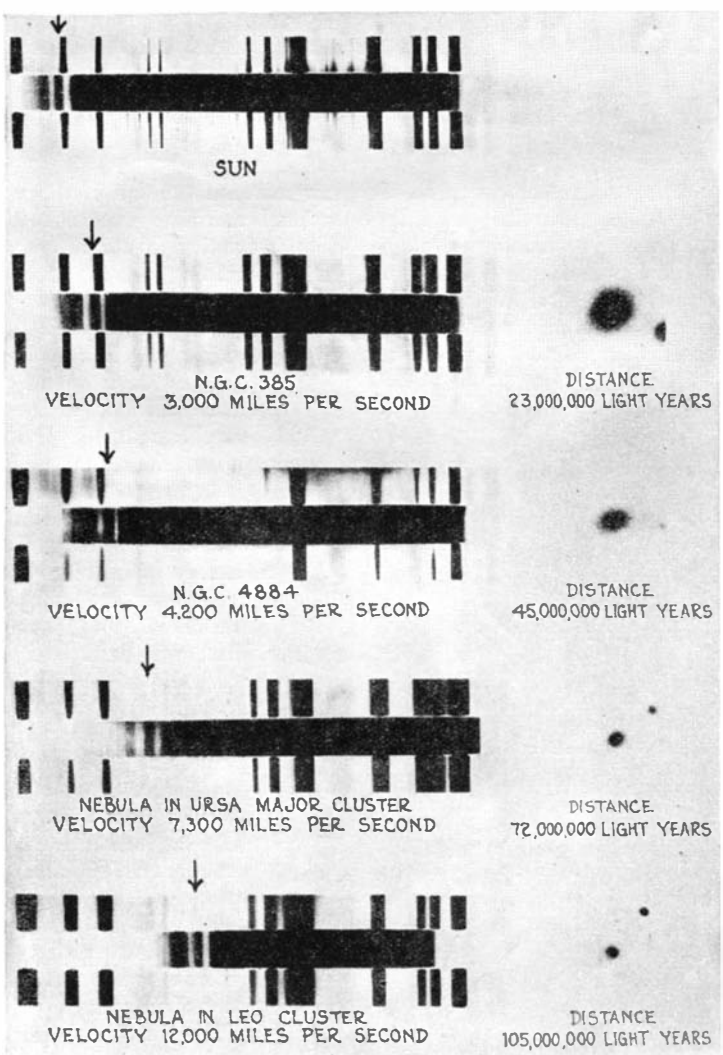
The agreement for individual nebulae, while not perfect, is so good as to suggest that from a single photograph of the spectrum we may be able to find the distance of even a very remote nebula within the average uncertainty of about 6 percent. There is only one apparent exception: one of the nebulae in the cluster in Coma Berenices has a velocity of 3100 miles a second, against 4600 for the average of eight others. In this case we very probably have to do with a foreground at a distance of 30,000,000 light years which appears by chance in front of the cluster 15,000,000 light years farther away. This would explain the discrepancy.

The possibility of being thus able to map out the distribution of the nebulae in space—isolated objects as well as clusters—is fascinating and no reason appears why this should not be done. The limit of distance at which this method may be applied with present equipment is about 150,000,000 light years. Remoter nebulae can be photographed with long exposures but they are so faint that their images cannot be seen on the slit-plate of the spectroscope and it is impossible to guide on them. Could they only be seen, the length of exposure would not be really prohibitive. For the faintest nebulae yet observed (with the velocity of 12,000 miles a second) the exposure was only 13 hours.

What do these tremendous velocities mean, and what forces can be imagined to have brought them into being?

Most of us have got used by this time to the idea that space is "curved" and may return into itself without extending infinitely far; just as the surface of a sphere obviously does—though of course no one is any better able than before to make a picture on paper or in his mind what such a curved space of three dimensions *looks like*. Fortunately we do not have to be able to draw pictures of everything that we can reason about by mathematical analysis. Einstein enunciated years ago certain fundamental properties that must be possessed by any sort of space (with of course its associated time) which is to satisfy the demands of relativity. But these restrictions do not suffice to define the space completely; they may be satisfied by any one of many solutions of the equation.

The "static" solutions worked out by Einstein himself and by de Sitter admit of the possibility of red shift of spectral lines of remote objects (which is what is really meant by talking about their "velocities"); but they do not agree in detail with the observed facts. A few years ago, however, a Belgian clergyman, Abbé Lemaître, found another non-static solution which promises better. In this solution as in the others, space returns into itself and is of finite extent, but as time goes on this extent is continually increasing. To get some kind of picture what this may mean let us return to the two-dimensional image of a sphere and imagine that this spherical (and entirely superficial) space is continually increasing in diameter. Objects which remain at the same points on the sphere (measured by latitude and longitude) will get farther and farther apart and recede from one another steadily and more rapidly the farther distant upon the sphere they are. We can thus get a sound idea of the notion that space itself is expanding and carrying the nebulae with it.

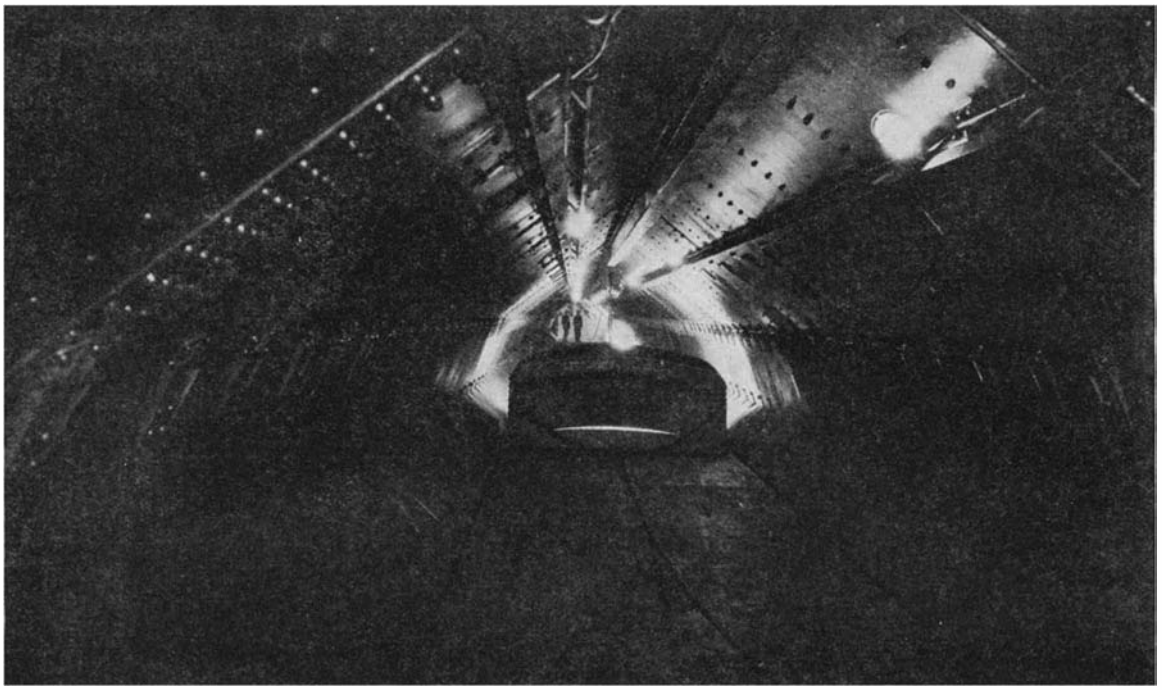


Some concrete evidence that space is expanding—spectrograms from distant spiral nebulae showing increasing shift of lines

THIS hypothesis, bold as it is, appears to give much the best interpretation of the apparent motions of the nebulae which has yet been suggested.

One difficulty about it, however, is that it makes the universe and even space itself inconveniently young. At the present rate of motion it would take a nebula only 1700 million years to reach its present distance, whatever that may be, since speed and distance are proportional. Of course space may have been expanded more slowly in the past than now, and Lemaître's solution indicates this. But even so, the time available for the whole past history of the process amounts to but a few billions of years, and the earth is almost as old as this!

How this difficulty may be resolved must be left to the mathematicians. It may be that still other solutions of the fundamental equations may be found which will account for the present motions of the nebulae and allow a much longer past history for space and its contents, but here we must "wait and hope."—*Mount Wilson Observatory.*



One of the two tunnels that run the entire length of the cargo holds. Bulk cargo, such as coal or ore, pours from the side doors shown, into the tunnel, and the drag-scrapers carry it to a hopper

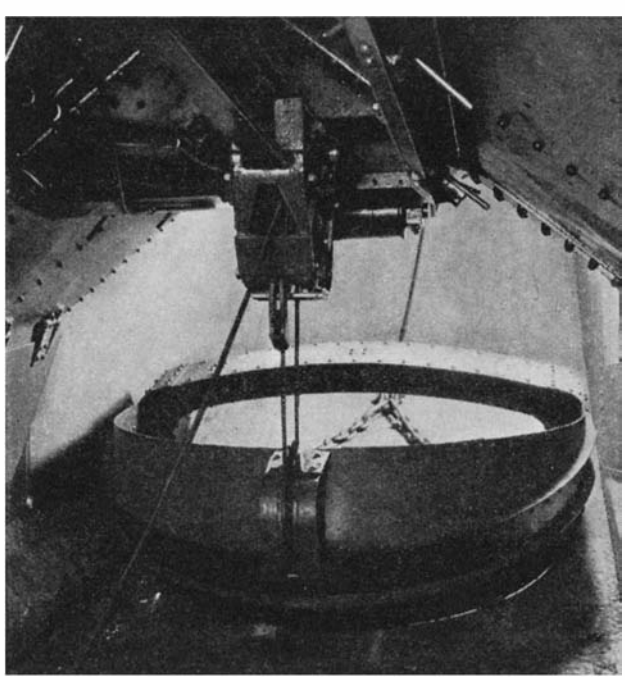
MECHANICAL STEVEDORES ABOARD SHIP

By G. H. DACY

DAWN of a new era in southern shipping has been introduced in that seaboard section which owes its origin to the Gulf of Mexico with the advent of the pulverized coal burning steamship, the *H. F. Debardeleben*, which is equipped with mechanical mules that work automatically as substitute stevedores in unloading cargo.

The swan song of the process of cargo-discharging by southern darkies—the choral leader was always the best-paid member of the crew—has been sung so far as this particular freighter is concerned. She is the pathfinder of an extensive fleet to follow in her wake which is expected to usher in a new era in water transportation in this particular part of the South. Equipped with self-discharging, bulk-unloading automatons, this steel freighter disgorges cargo at the astonishingly high speed of 1000 tons an hour. She is the first vessel provided with such interesting labor-saving devices to ply the coastal waters of the United States.

This ship was owned formerly by the United States Shipping Board, having been built according to government specifications and design with the customary masts, booms, cargo winches, five cargo hatches, and four holds: a typical two-deck, three-island style of freighter. The southern coal corporation which now owns her purchased this ship as raw material for one of the most sensational maritime experiments in the South's nautical history. That particular coal mining company appreciated that it must expand its marketing if it was to increase output profitably. Such a program demanded a new type of carrier which would perform more efficient work at measurably reduced costs.



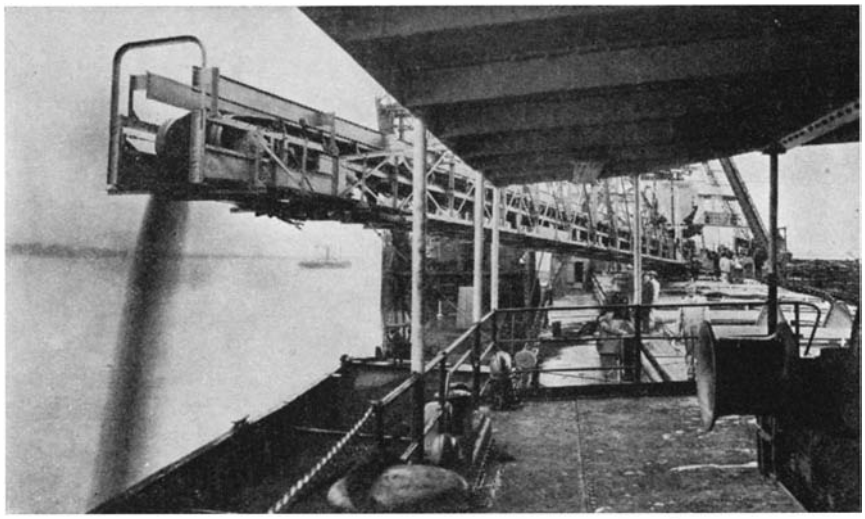
Close-up of a steam-winch-operated drag scraper that unloads heavy bulk cargo from the remodeled freighter

An eminent naval architect and marine engineer, E. C. Bennett of New York City, was commissioned to provide satisfactory plans for the re-arrangement and equipment of the steel ship so that she could discharge bulk cargo automatically in record time and at minimum cost. The supervision of the remodeling program was delegated to the American Bureau of Shipping and the United States Steamboat Inspection Service. Upon completion of the revision campaign, the S. S. *H. F. Debardeleben* was awarded the highest rating in the records of the American Bureau of Shipping.

The marine builders who worked on the steamship in drydock did not "turn her inside out," but they did make

over the freighter so thoroughly and skilfully that none but a seasoned sea dog would recognize the new ship from a picture of the old one.

An impressive transformation was consummated below-deck. Bulkheads of solid steel were installed so that the huge hold could be split up into five compartments for bulk cargo. Each compartment, according to the commodity carried, will accommodate from 1100 to 2000 tons. The decks of these compartments are provided with a series of steel doors that open into a pair of steel scraper tunnels which penetrate the vessel longitudinally underneath the cargo holds. Two metal-muscled scrapers, each with a capacious maw which holds eight cubic yards of bulk cargo to the mouthful, travel on a strong beam of steel which is mounted at each tunnel top as a guide rail. Big steam winches placed in a strategic position in the hull operate the drag scrapers by means of supplementary wire cables that travel in a third and smaller tunnel constructed especially for that purpose.



Coal, delivered into a hopper at the bow of the ship by the drag scraper, is dumped into a barge by the ship's endless belt conveyor on its 140-foot boom

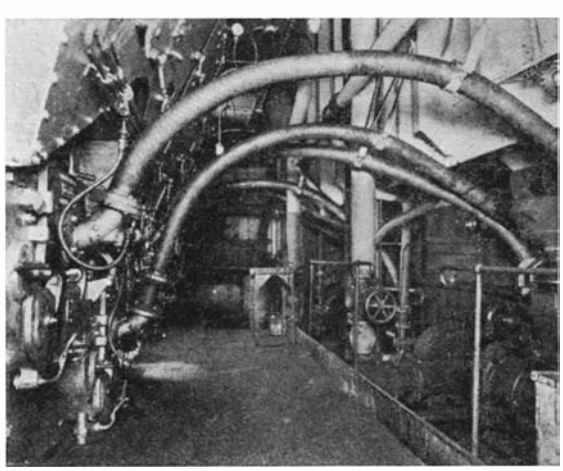
THESE steam-run cargo "mules" snatch the bulk cargo of coal, phosphate rock, gravel, slag, sulfur, ore, or similar material from its place of deposit in the tunnels and transport it swiftly to a large hopper near the bow end of the ship. The drags dump their loads into the hopper which, in turn, delivers the cargo under mechanical control to a sloping rubber belt conveyor about a yard wide. This herculean "stevedore" actuated by mechanical power "marches forward" tirelessly, carrying ponderous loads of cargo at a fixed gait of 3.97 miles per hour, equivalent to 350 feet a minute.

The endless belt conveyor deposits its burden of coal, coke, or ore, as the case may be, upon the swiftly moving belt of the unloading boom which is considerably longer than the loftiest ship's mast. The second conveyor—somewhat smaller than the first—runs at a regular speed of 5.1 miles per hour, or 450 feet a minute, being operated by steam power with its engine seated at one end of the swinging boom. This boom, which measures 140 feet over all, is so arranged that it can swing through an arc of 90 degrees and will deliver cargo on either side of the ship to a maximum distance of 113 feet from the hull directly into railroad cars, storage warehouses, or in piles on the wharf. The boom is also equipped with controls in such a manner that it can be elevated, if desired in unloading, to deposit cargo 50 feet above the main deck of the freighter.

The patented unloading devices now in use on this ship are available to mariners and ship builders, being inventions which have been perfected to reduce labor and save time in discharging bulk cargo. The mechanical set-up on this southern ship is such that the cargo is weighed automatically by use of an accurate weightometer.

Several different kinds of bulk cargo can be unloaded simultaneously without conflict. Five diagonal bilge tanks are situated above the broadest part of the hull adjoining the scraper tunnels. They accommodate water ballast and, by regulating the amount of water in them, are also used as counterbalances to hold the ship in proper position when the discharging boom is swung from ship to shore to the limit of its arc. Tests by government inspectors demonstrated that under such conditions the stability of the ship is perfect even when the boom is fully extended. The vessel is provided with unusually large pumps for the discharge of this ballast water as rapidly as necessary during loading or unloading. The bilge tanks can be pumped dry in a few hours when necessary. It requires one and one half times as long to load this ship by standard practices as to unload her with the self-discharging bulk cargo apparatus. Twelve hatches facilitate the flow of bulk cargo into the compartments of the hold.

One novel feature of this interesting ship is the provision of adequate storage space in the forecastle between the decks for 500 tons of bale, crate, and package freight such as perishable citrus fruit and vegetables from Florida for the northern markets.

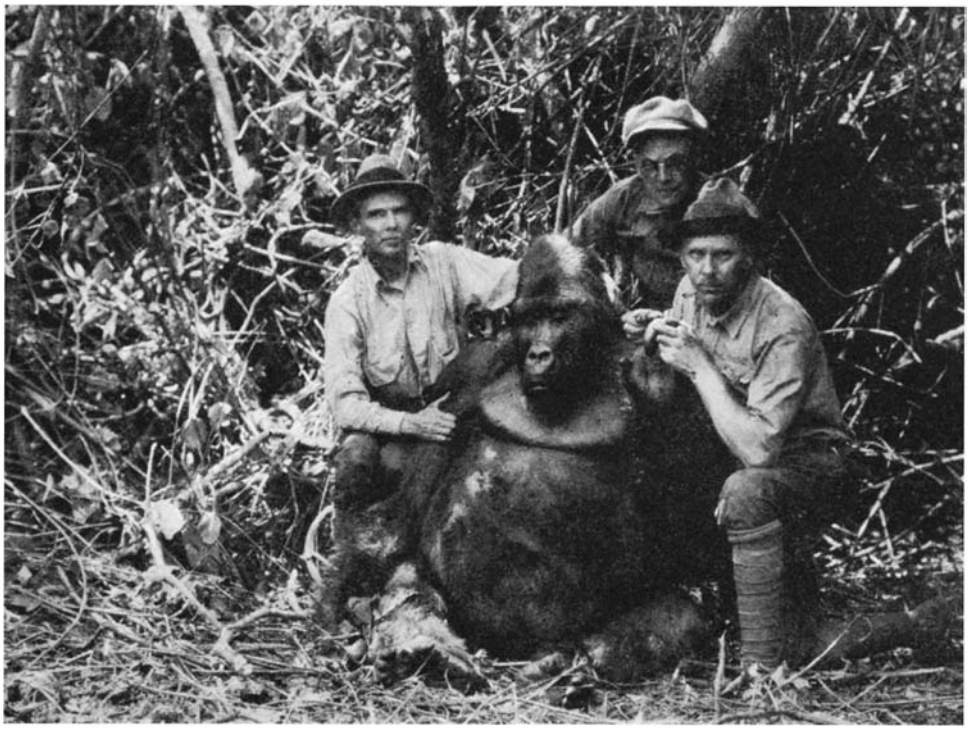


Coal pulverizers and pulverized coal burners in the boiler room of the *H. F. Debardeleben*

THIS remodeled ship, which is self-trimming as well as self-discharging, is the first sailing in the Gulf of Mexico to use pulverized coal as fuel. Stoking labor has been reduced measurably since a single fireman now operates the three boilers. The coal bunkers deliver fuel under automatic control directly into the pulverizers located below. The largest coal is ground to a powder, before use, in a powerful coal crusher and thence is dumped into the central fuel bunkers.

Because of navigational difficulties encountered in certain southern ports and harbors, the rudder of this ship is streamlined in order to increase her operating efficiency. A screw gear operated by telemotor was installed in place of the original steering gear of the freighter. The power plant of this cargo ship—she is 380 feet long with a beam of 53 feet—consists of a triple expansion engine and three special boilers.

The justification for this modernized freightship as an advance guard of a new fleet is had in the fact that the South annually mines 260,000,000 tons of coal, 3,000,000 tons of phosphate, 2,000,000 tons of sulfur, and 600,000 tons of salt, among other commercial commodities.



The second gorilla, mentioned near the end of the account. Left to right are: Dr. McGregor, zoologist, Dr. Gregory, anatomist, and the author of the accompanying article

GORILLA: GREATEST OF ALL APES*

By H. C. RAVEN

Associate Curator, Comparative and Human Anatomy, American Museum of Natural History

THE present range of the mountain gorilla is in the highlands of the eastern Belgian Congo and the Kivu volcanoes. Our camp in this country was west of the southern end of Lake Kivu, at an altitude of 7000 feet, on the slope and facing eastward over the cultivated country toward the lake. On a clear day we could see the hazy outline of the mountains on the far side, and on one occasion I could even see the volcanoes north of the lake. The forest began just behind our tents. This was mountain forest with rather low trees interspersed among a mass of succulent vegetation which was from six to fifteen feet high. Many of the trees on the highest slopes were covered with moss.

As soon as our camp was established I made daily excursions in the forest, accompanied by two or three natives whom I obtained in the neighborhood. We found traces of gorillas, elephants, harnessed antelope, duikers, wild pigs, and buffalo, but we did not get close to any of the gorillas. The natives were not good hunters, and when we came upon signs indicating where gorillas had been feeding or walking, they were unable to say whether these signs were fresh or a few days old. Finally I managed to get some Batwa pygmies, professional hunters, to help me. It was delightful to go into the forest with these little people who understood the forest, whose home it was.

One morning when I had started out with a couple of Bantu natives, two pygmies joined us and told us that gorillas had been feeding in a valley not far away.

WE proceeded very cautiously, one pygmy going before me with a peculiar combination sickle and hatchet, quietly cutting away the vegetation so that we could follow. We had gone along a densely covered ridge for perhaps one hundred yards when we heard a slight movement of the vegetation. On the advice of the natives I took the rifle from the boy behind me and went ahead more cautiously than ever.

Suddenly and without the slightest warning there was the most terrific combination of screech and roar, stamping of feet and thrashing of underbrush, as a gorilla rushed at us. The vegetation here, except for a few trees, was dense as could be, and from ten to fifteen feet high. In order to get through we had been crouching down, often going on our hands and knees. I was crouching when the gorilla began to rush, but in order to raise the rifle in his direction I had to back up against a thick mass of vines and weeds. The gorilla came like a cyclone until he was perhaps 30 or 40 feet from us, when he suddenly stopped and was silent. The vegetation was so thick we could not see more than ten feet in that particular direction. We hesitated a moment, then I motioned the hunter before me to part the vines quietly and go forward. I followed, holding the rifle ready to fire. We came to the spot where the gorilla had stopped, but he was not there. He had turned about, retraced his steps a short distance, then taken a new course, and disappeared—all without making a sound. By this time he was probably some distance away. We followed the trail as quickly as we could, first up along the ridge, then down the side of a steep ravine, until I was dripping with perspiration.

As suddenly as before, the gorilla rushed at us and stopped, and precisely as we had done the first time, we followed. On the brow of a ridge we came upon a very fine bed where this or another gorilla had slept the night

*Courtesy *Natural History*

before. It was about three feet in diameter, and was made of bamboo leaves. I would have stopped to photograph this had we not been in such hot pursuit.

That gorilla made seven similar rushes before he went down a very steep hill, across a small stream and over another hill nearly 1000 feet high. The pygmies then gave up and turned back, saying, "There is no use following him; he has gone too far."

ANOTHER day we had come upon the trail of a band of gorillas among some bamboos perhaps three miles from camp. We followed them for a long way until about 11 A.M. when we came upon the place where they had slept the night before. In an area 20 yards across there were nine beds, all on the ground on the steep hillside. It was easy to see how they had made their nests. The gorilla simply sits down among the dense foliage and with his long arms grabs a small sapling, pulls it down, twists it under him, sits on it, and reaches for another. If it breaks off, he takes the piece, arranges it around him and continues to pull off and twist around until he has made a nice nest or bed. Sometimes they undoubtedly walk a few yards to get the material for a bed, but as a rule, where the foliage is so dense, they simply sit down and pull the material about them.

After carefully examining the sleeping-quarters we followed on, dividing into three groups as the gorillas seemed to have done, but we had much difficulty in trailing them because elephants had been tramping all about.

Not more than a half mile farther on we could look across a little valley. On the opposite side a boy had seen the vegetation move and he was sure gorillas were there. We watched closely and, finally, with the binoculars I could see a black arm reaching up to pull down the bushes.

We stole quietly down into the valley and then worked around so that we could come up-wind toward the feeding gorillas. We had first sighted these gorillas about noon, but it was 2 P.M. when we approached them. There were several, perhaps nine, as we had seen nine nests. They were quiet except for an occasional short grunt, indicating, I believe, that they were feeding quietly or perhaps telling their whereabouts to others of the group. They had moved slightly from where we first saw them and now were in low forest, the trees of which were fairly buried by lianas, many of whose stems were six inches in diameter. Underneath was a tangle of stems of thick undergrowth, so that in some places we could not be sure, on account of the irregularity of the terrain, whether we were looking at the ground or into the trees. There were many fresh signs of gorillas and we could see the place where one had sat down to eat. We felt the earth and found it warm; the animal had been there just a few seconds before. We were now right among them, and could hear them in three directions. Then I caught a glimpse of one in a tree, perhaps 30 feet from the ground.

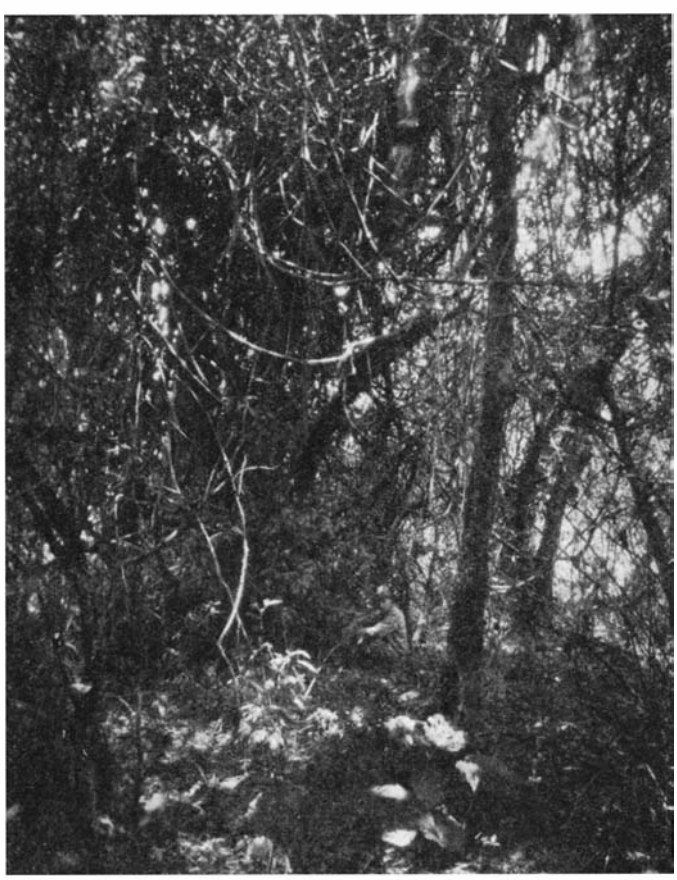
I had with me a .30-30-caliber Savage rifle and also a .22-caliber rifle, the cartridges of which were less than an inch in length. In these tiny .22-caliber bullets I had drilled a hole and put in a small dose of highly poisonous potassium cyanide. If this actively poisonous substance could be introduced into the gorilla, whether his hand or head or body, he would drop dead within a few seconds. However, it was a question whether the heat generated in the bullet would not disintegrate the cyanide so that its poisonous action would be lost.

Using the .22-caliber rifle, I fired at the arm of the gorilla in the tree. Immediately there was a bark, screams, and wild commotion through the vegetation, as the gorillas rushed away. We rushed after them and found a few drops of blood from the one that had been hit. This one we carefully stalked. None charged or rushed at us; they were apparently thoroughly frightened. We followed cautiously until about 5 P.M., when we had to give it up in order to find our way to a trail before dark.

IT was evident that the cyanide had not worked on the animal, but the question arose as to whether it probably would die before morning. Early next morning, therefore, we took up the trail again and followed all day. The gorillas had gone on feeding, including the one that had been hit. He was apparently none the worse for the wound, which of course was not bleeding on the second day. Probably that wound did not do as much harm as a bite from one of his friends, received in play, or a stab from a broken branch.

After several days of hunting near camp I de-

THE Columbia University-American Museum Expedition to Africa was sent out from the department of anatomy of the College of Physicians and Surgeons of Columbia University, and from the department of comparative anatomy of the American Museum of Natural History, to secure entire well-preserved adult gorillas and other African primates for anatomical study. The expedition was under the leadership of Mr. Raven, and included Dr. W. K. Gregory of Columbia University and the American Museum; Dr. J. H. McGregor of Columbia; and Dr. E. T. Engle of the College of Physicians and Surgeons. Two adult gorillas were obtained in the Kivu, and the party proceeded down the Congo to West Africa, where they hoped to collect additional gorillas and chimpanzees. In West Africa Mr. Raven, who remained longer than the others, collected three adult gorillas and three chimpanzees, all of which were embalmed entire and shipped to New York.—*The Editor.*



Where the gorilla shown on the opposite page was secured, after the locality had been cleared to permit photography

The hand of a gorilla, contrasted to that of an adult negro. In spite of the shortness of the gorilla's thumb it can be brought into contact with the fingers without effort

cided to go farther up into the mountains to reach a place called Nakalongi. This was an all-day walk. I had with me several pygmies and a personal boy as well as a few porters. It rained most of the afternoon and was raining when we stopped at a little bee-hive-like hut high on the side of the mountain in a bean patch. To the west were hills covered with grass but in every other direction the hills and gullies were covered with dense forest. The natives immediately set to work to build for me a little dome-shaped hut of the coarse grass that grew round about. Its diameter was about the same as the length of my bed-roll but it shed the rain. Cold gray mist filled the valleys and often shut off everything more than 20 yards away. I ate my dinner at night crouched beside the fire with all the natives that could crowd in, then went into my own hut to sleep.

As soon as it was dawn we were up and shortly afterward set out to hunt. Most of the men remained in camp, but four pygmies accompanied me. We first climbed up the mountain through a mass of cold, wet bracken, then descended into a ravine through virgin forest so dark that it seemed like twilight. After about a half hour of walking, very difficult on account of the steep and slippery ground, we came upon gorilla tracks and saw the remains of chewed-up stems. The forest had been so cold and wet that it was impossible to tell whether the material had been chewed that morning or the day before. We followed on, however, and soon found tracks that had not been dripped on from the branches above. Farther on we saw signs that we knew were not more than a half hour old.

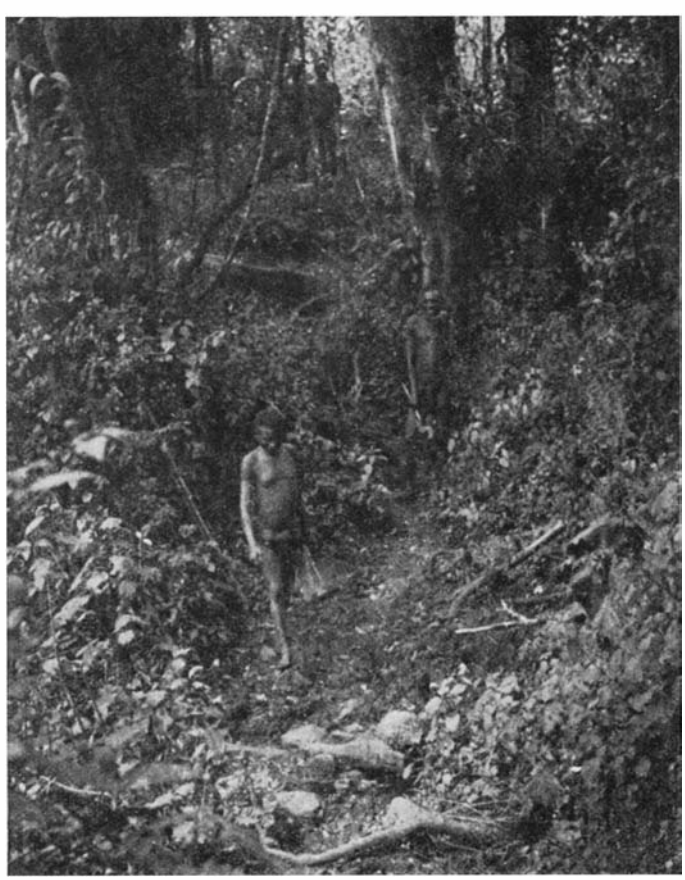
About an hour from the time we began to follow the trail we were passing diagonally down a steep slope toward a tiny stream. Across the ravine 60 or 70 yards away, we saw the vegetation move and we caught glimpses of an animal between the branches. Then we must have been seen or heard, for there was a sudden short bark. We followed across the stream and up the steep slope, climbing with difficulty where the gorillas could pass with ease. It was much more difficult for me, with shoes, than for the bare-footed, strong-toed, unclad natives, and still easier for gorillas with powerful bodies, short legs, and long arms. Man's long legs are suited to the erect posture and not well adapted to going through underbrush, where he must be doubled up much of the time.

We were now getting close to the gorillas; we knew there was not a large troop, perhaps only three or four, but there was one big male among them, as we knew from the tremendous power in the bark he had given. The pygmies were nervous, saying that he would rush at us. We had gone less than 300 yards from the stream and were still going through dense underbrush when suddenly the rush materialized with a terrific roar and shriek. The pygmy who was crouched down ahead of me, cutting the vegetation, sprang back and raised his spear, while I stood ready to fire. But like the other gorilla, this one stopped short, and did not come into sight, although there seemed to be more ferocity in this animal. We continued on the trail and in a short time he rushed at us again. This time he was directly at our left, not ahead of us. Here the forest was a little more open and we could see perhaps 10 or 15 yards, but still he did not come within sight though we could see the vegetation move.

FINALLY we started up the slope. One pygmy went ahead of me, holding in one hand his spear and in the other his little sickle. He passed beneath a fallen tree and I had just stooped under this tree when the gorilla, closer than any time before, gave a terrific roar. I was afraid I was going to be caught under the tree but I managed to step forward and raise myself. As I did so I could see the great bulk of the gorilla above me and coming straight at me. I fired at his head as I might have fired at a bird on the wing. The impact of the bullet knocked him down and I wheeled to the pygmies, yelling at them not to throw their spears. I feared they would spoil my specimen. But they in turn shouted to me, "Shoot! Shoot!" The gorilla was not dead. When I looked around he was standing up like a man; it was plain to see that he was stunned. I fired again and he dropped lifeless exactly 15 feet away.

This animal was the most magnificent I had ever seen, weighing 460 pounds. He was black and silver-gray, a powerful courageous creature, determined to drive off intruders from his domain. Upon closer examination I found this giant primate as clean as could be. The long, shaggy hair on his head and arms was as if it had been combed only five minutes before. The silver-gray hair on his back was short and rather stiff.

Then came the time for quick action, for the specimen must be embalmed



An elephant trail used by gorillas. The latter do not make trails because they do not regularly follow the same paths

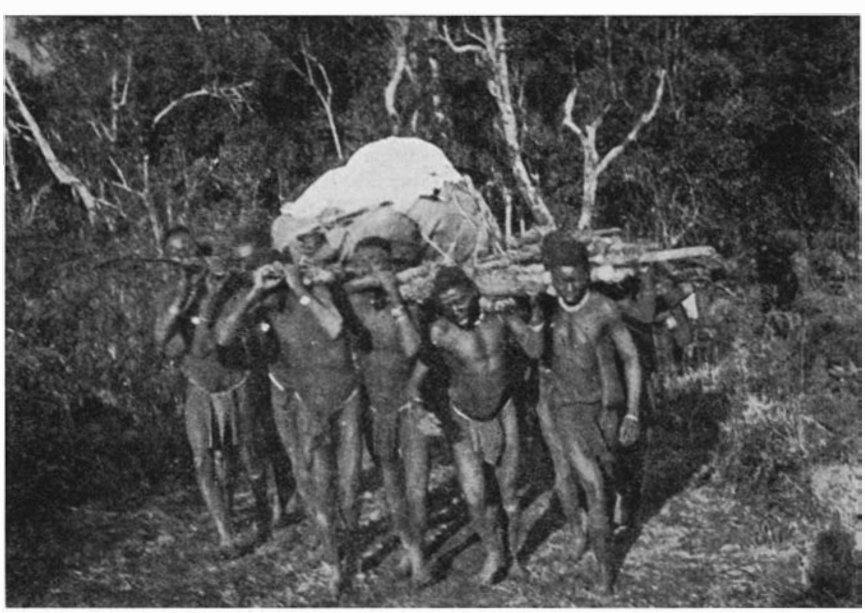
within a few hours. It must be got on to the trail, the trail must be widened from a foot to ten feet up and down steep mountains for about 12 miles. I sent a note to my companions in camp, telling them that I had secured the gorilla and asking them to send more porters. I sent another boy to call up the natives who had come into the mountains with me. While I examined the fallen gorilla, some of the pygmies were starting to make a bed or framework of saplings on which to carry him. These saplings were of strong, hard wood and very heavy. Three long saplings were placed about 18 inches apart and numerous cross-pieces then lashed to them with vines. The gorilla was lashed on the top of this litter.

BY about three in the afternoon we had the gorilla out on the trail where I could embalm him. We then wrapped him in a large canvas tarpaulin and made him more secure on the litter. The gorilla and litter together weighed more than 600 pounds. However, the natives started off chanting and went along for some distance at fairly good speed. After getting my paraphernalia packed in the loads, I followed and caught up with them as they were trying to get up a very steep incline, where there was scarcely any foothold among the rocks and mud. I had told them that we must reach camp by nightfall, but it was soon evident that this would be impossible. As a matter of fact, it took two and a half days, during which there were several severe electric storms that the natives claimed were caused by my having killed the "king of the mountain forests." They said the same thing happened when someone killed a very large elephant. At night we simply had to sleep in the forest in whatever shelter we could make of leaves and branches, but it was always wet and cold.

Over large areas the forest trees grow so closely together that they shut out most of the light from the ground. One seldom gets a glimpse of the sun

Many of the natives ran away as soon as it got dark and I never saw them again, but as this was the main trail between Lake Kivu and Nakalongi, there were natives passing along at intervals, and some of these were persuaded to help carry the gorilla. When we arrived at camp we continued the work of preservation and all took part in the making of photographs.

The second gorilla was secured only 300 yards from our main camp six days later. All members of the expedition took part in the various details of preservation of the specimen. There was material to be preserved for histological purposes, casts to be made of the hand, foot, and head, detailed measurements to be taken, and so on. When we considered that the embalming fluid had penetrated the body thoroughly, the animal was bandaged, wrapped in blankets, and sewed up in burlap bags, these in turn coated with paraffin wax, and the whole again rolled in heavy canvas tarpaulin. A litter was again used to carry this specimen from our camp about four miles, and it was then placed in a motor truck and taken to Uvira, where it was shipped by steamer across Lake Tanganyika, then by rail from Kigoma to the coast, and put on an ocean steamer for America.

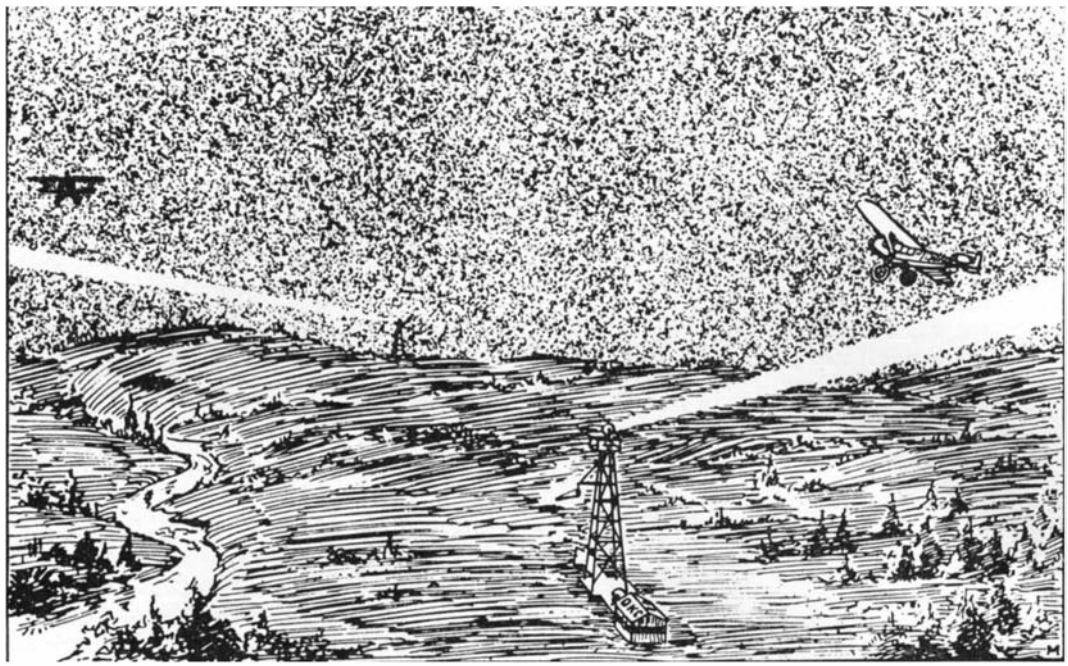


Carrying the first gorilla to camp, over a distance of twelve miles, on a trail two feet wide which had to be laboriously widened to ten feet most of the way

LIKE the fine hunters that they are, the pygmies with whom I hunted are always on the alert to procure any food available in the forest. On one particular day, one of them who was ahead scouting called back to us, and when we came up to him he was standing still, looking up at the trunk of a tree about three feet in diameter. He told us that he had seen bees go into a crack in the trunk and that there must be plenty of honey inside.

Well, the gorilla hunt was over for the day. The pygmies simply could not think of leaving all that honey there. First they cut a sapling about four inches in diameter at the base; this they stood against the big tree, and then tied it with vines to the tree at intervals of several feet all the way up. While two or three were doing this, another had found and shredded some bark which he lighted and waved about, making it smoke furiously. One man then climbed to the top of the sapling, waving the smoking bark, and reached his hand into the crack.

The bees were buzzing all around, but he brought out sections of comb and gorged himself, before he started to pass pieces down to his comrades.



The traffic rules of the air state that aircraft in flight along an airway must keep to the right of the course which may be determined by the positions of the beacon lights used as markers

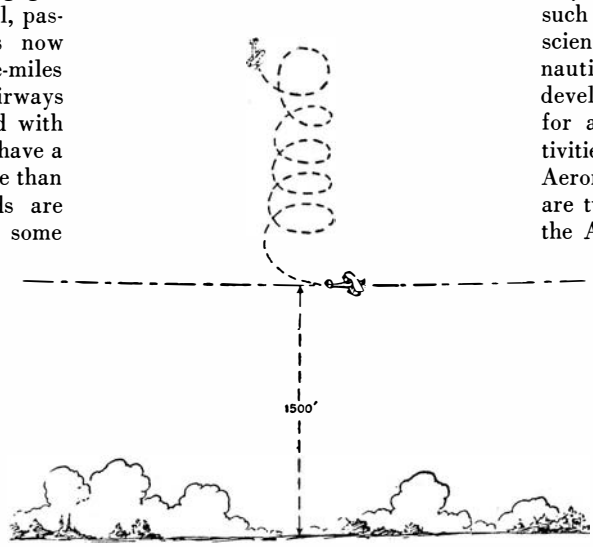
SAFETY RULES FOR THE AIRWAYS

By COL. CLARENCE M. YOUNG
Assistant Secretary of Commerce for Aeronautics

AIRCRAFT operators in this country are carrying passengers at the rate of about two and three quarter millions a year. Of these air passengers, nearly a half million are patrons of the scheduled air lines which are operating on a basis comparable to that of railroad, steamship, and motor bus transportation. There are 16,709 licensed pilots and 7653 licensed aircraft in the United States. Many of these airmen and aircraft are engaged in commercial operations; airmail, passenger, and express operations now involve 150,000 scheduled plane-miles of flying every 24 hours. Airways equipped, or now being equipped with facilities for day and night flying have a total mileage of 17,500 miles. More than 1900 airports and landing fields are available for aircraft operations, some 650 of them equipped with lights for night operations.

The list of activities and assets of civil aeronautics might be enumerated at great length, but those mentioned are sufficient to indicate the extent and complexity of this phase of modern life, which is at once an industry, a transportation system, a sport, and an adjunct to other types of business. Naturally, if aeronautics is to play so important a part in the nation's affairs, there must be standards of quality, performance, and experience to guide those engaged in its various lines of endeavor, and also to safeguard the interests of the flying public. In other words, it is necessary that there be regulation.

This was recognized by the Federal Government in the passage of the Air Commerce Act of 1926. The establishment of the Aeronautics Branch of the Department of Commerce was a direct result of this legislation. Regulation is one of the primary functions of the Branch, and one of the major divisions in this organization is the Air Regulation Service.



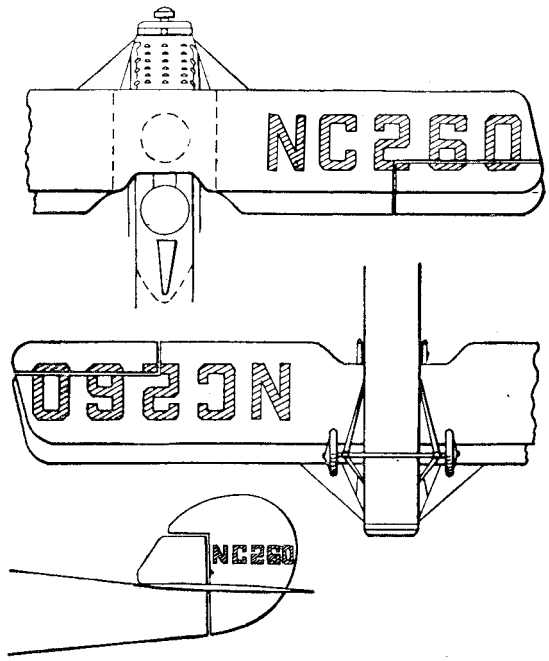
Acrobatic or stunt flying, when permitted, must be concluded at not less than 1500 feet altitude

All of the regulatory activities are founded upon provisions of the Air Commerce Act. The Act also gives authority for other functions, including establishment and maintenance of airways, and general promotional work such as dissemination of information, scientific and practical research in aeronautical subjects, fostering of airport development, and compilation of maps for air navigation. The latter are activities of the Airways Division and the Aeronautic Development Service, which are two of the three major divisions of the Aeronautics Branch—the other being the Air Regulation Service. Both the Airways Division and the Aeronautic Development Service have some functions which are of a regulatory character, but these are incidental to their primary duties.

However, since regulation of civil aeronautics in general is the province of the Air Regulation Service, it is that agency's activities that will be discussed in detail. These include licens-

ing of airmen and aircraft; enforcement of the Air Commerce Regulations and the Air Traffic Rules; approval of aircraft, engines, and accessories; approval of flying schools and repair stations; promulgation of rules for entry and clearance of aircraft crossing the national boundaries; regulation of interstate passenger air lines; and maintaining of standards in connection with alterations and repairs to licensed aircraft.

ALL of these activities are based upon the fundamental purpose of the Aeronautics Branch in regulation, which is to make certain that civil flying is conducted by competent airmen in airworthy aircraft. The regulations are designed to be of benefit to persons and property in general, as well as those engaged in aeronautics, and particular attention is given to the interests of the air traveler.



The markings displayed on the wing and the rudder of a commercially licensed airplane

Among the various regulatory functions exercised, the basic one is examination and inspection of airmen and aircraft, and issuing of licenses to those who qualify. The procedure and rules governing licensing of airmen are included in the basic Air Commerce Regulations: Aeronautics Bulletin No. 7, "Air Commerce Regulations."

The Aeronautics Branch, in referring to airmen, means both pilots and mechanics. Pilots are licensed in four grades: private, industrial, limited commercial, and transport. Private pilots are privileged to fly licensed aircraft, but not with persons or property carried for hire. Industrial pilots may carry property for hire, but are not permitted to carry paying passengers. Limited commercial pilots may carry persons and property for hire, but are restricted in the carrying of paying passengers to specific areas mentioned in their licenses, except that they may act as co-pilots on air-line planes when working with transport pilots. Transport pilots may carry property or persons for hire in licensed aircraft, and are not limited to specific areas. Both limited commercial and transport pilots, however, are required to qualify for ratings on airplanes of various classes and may carry paying passengers only in airplanes of the classes for which they have qualified. Transport pilots may act as flying instructors or for hire; and pilots of only this grade have this privilege.

In addition to these, the regulations also provide for three classes of glider pilots: student, noncommercial, and commercial. Recently, a special class of pilot's license for unconventional types of aircraft has been authorized.

Licensing of airplanes also is governed by the basic Air Commerce Regulations. They require that aircraft engaged in interstate commercial operations be licensed; those planes used for pleasure only, or for commercial flights within the borders of one state may be licensed if the owners desire it and the craft are eligible under the set of regulations in Aeronautics Bulletin No. 7A: "Airworthiness Requirements of Air Commerce Regulations for Aircraft."

The basic Air Commerce Regulations require that all licensed aircraft shall be maintained in airworthy condition, inspected frequently by the owner or some one acting for the owner, and be made available for inspection by the Aeronautics Branch when required. If an accident to the craft occurs, a report to the Aeronautics Branch is required, and major repairs are always checked by an Aeronautics Branch inspector before the airplane again goes into service.

All aircraft display identification marks. In the case of an unlicensed aircraft, the identification mark consists merely of a number, assigned by the Aeronautics Branch. For a craft that is licensed, the identification mark includes, in addition to the number, a prefixed letter, or letters, indicating the type of license. Letters used for this purpose are as follows:

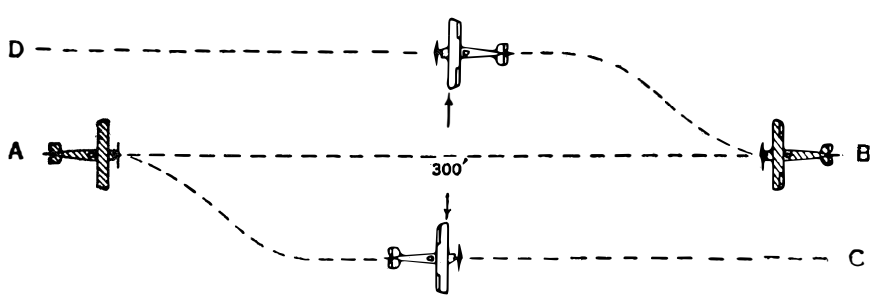
The Roman capital S (meaning State) for aircraft used solely for governmental purposes and belonging to states, territories, possessions, or political subdivisions.

The Roman capital X for an aircraft engaged in experimental work.

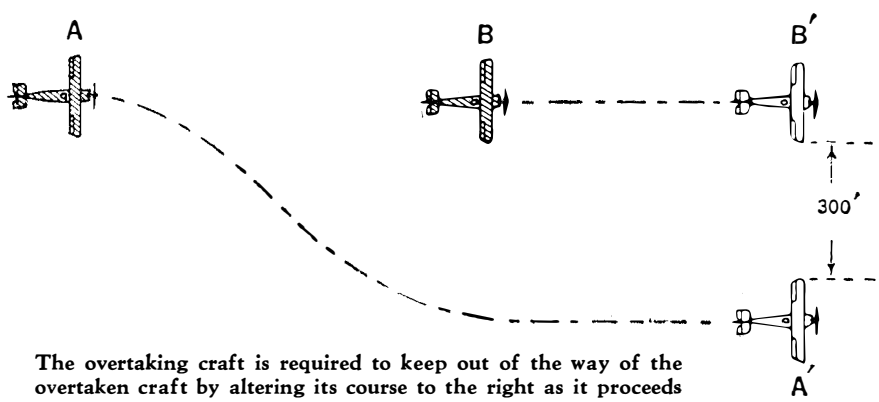
The Roman capital C for all commercially licensed aircraft except gliders. Licensed gliders display the Roman capital identification letter G.

The Roman capital letter R for aircraft which are licensed only for restricted purposes.

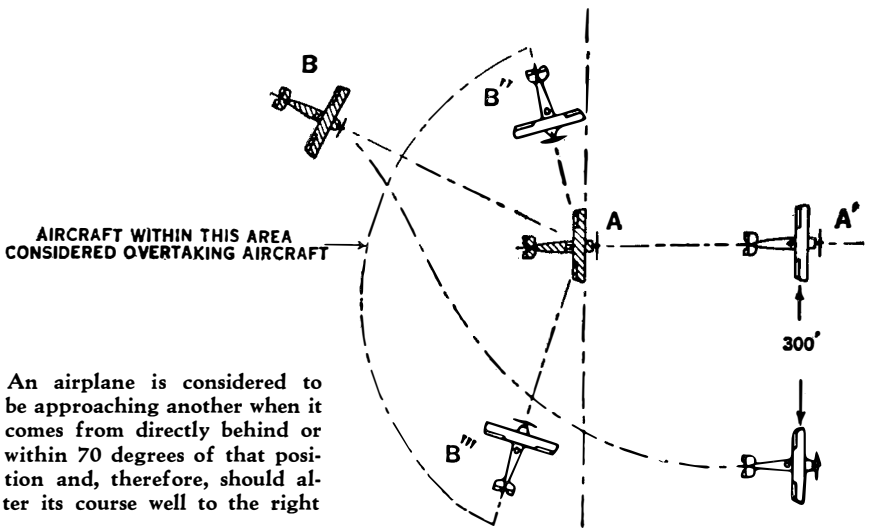
In addition to the foregoing, the Roman capital letter N may be displayed preceding the license letter and number, by all commercially licensed aircraft of the United States, except those licensed for experimental purposes. The letter N, which denotes that it is an aircraft of the United States, is required on licensed aircraft navigated beyond the con-



Engine-driven aircraft approaching each other in the air head on are required by the air rules to alter their courses a safe distance to the right of each other



The overtaking craft is required to keep out of the way of the overtaken craft by altering its course to the right as it proceeds



An airplane is considered to be approaching another when it comes from directly behind or within 70 degrees of that position and, therefore, should alter its course well to the right

tinental limits of the United States, and, at the option of the owner, may precede the license letter and number on other licensed aircraft, except aircraft licensed for experimental purposes.

All civil aircraft, whether licensed or unlicensed, are required to observe the Air Traffic Rules, which also are a part of the basic Air Commerce Regulations. The Air Traffic Rules, as their title implies, serve for the airways the same purpose that automobile traffic rules serve for streets and highways. Proper procedure for flying along the airways, for passing and overtaking other aircraft, for taking off and landing, and restrictions as to acrobatic flying, and as to flying over towns and assemblies of persons are set forth.

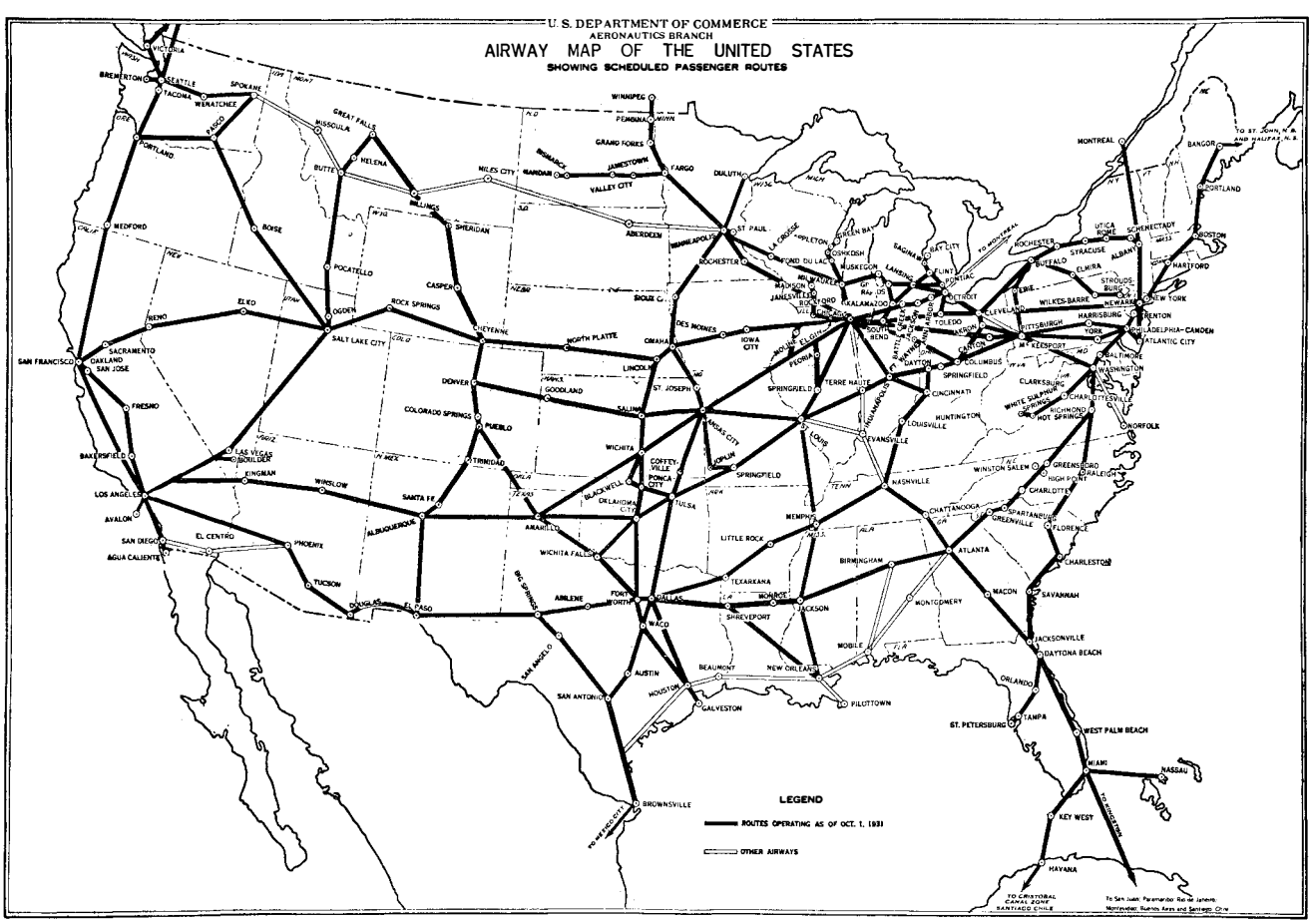
Aeronautics Bulletin No. 7A is one of a number of supplementary sets of regulations dealing with special subjects; and a second set of supplementary regulations is that pertaining to flying schools: Aeronautics Bulletin No. 7B, "School Supplement of Air Commerce Regulations" (See SCIENTIFIC AMERICAN, May, 1930.—*Editor*).

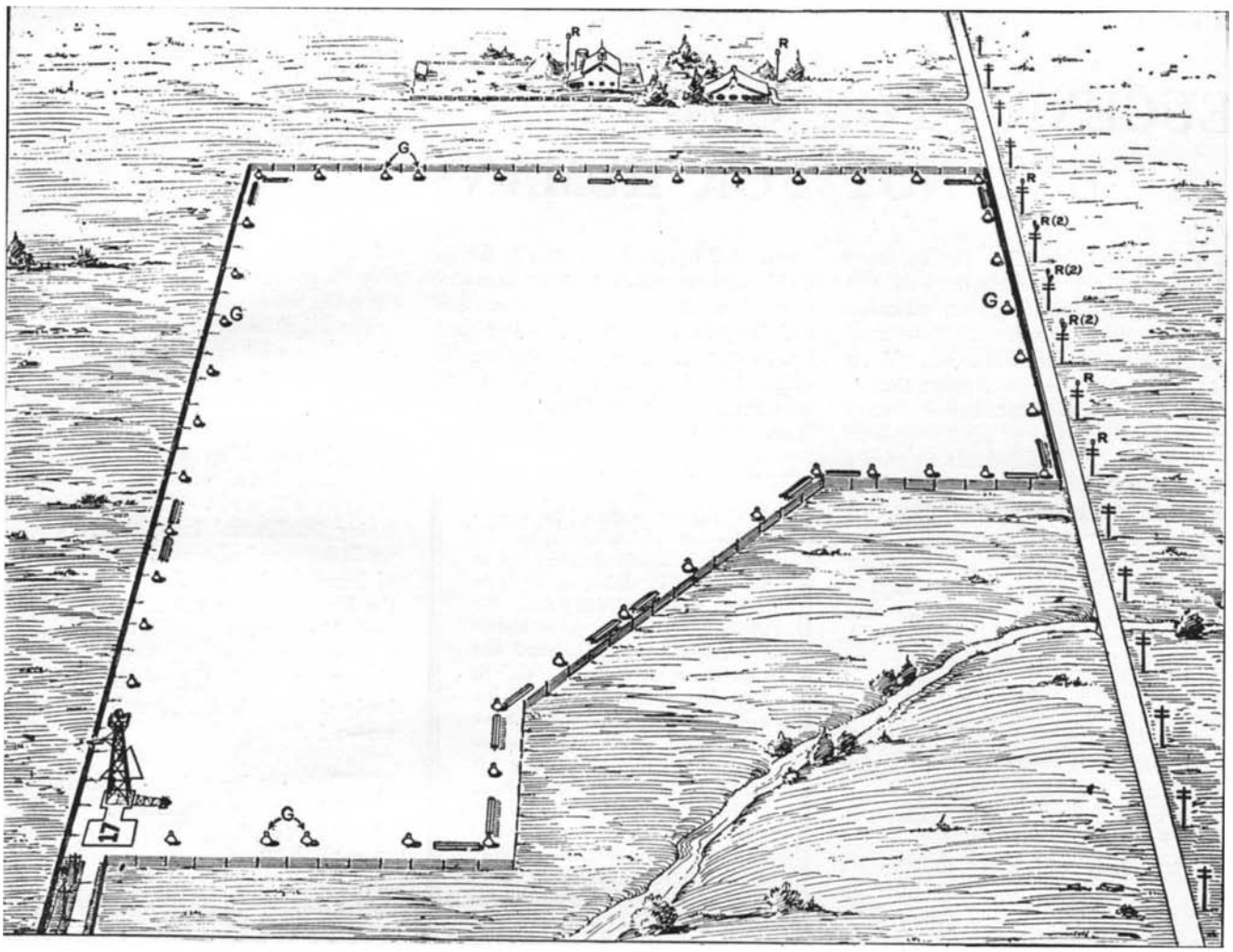
With respect to parachutes, there are airworthiness and maintenance requirements to be met for approval just as in the case of aircraft, and manufacturers may obtain approved type certificates for parachutes. Parachute riggers are licensed if they demonstrate that they are qualified.

The certificate of authority to operate interstate air-transport services is issued by the Aeronautics Branch only to those operators who comply faithfully with the regulations. These regulations are designed to aid operators in maintaining and increasing safety and reliability in this phase of civil aeronautics.

The inspection of the air lines that apply for the certificates of authority is minute in every detail. Especially qualified air-line inspectors inquire into every phase of air-line operation that would have a bearing on the public safety. Perhaps unknown to the pilot or crew of an air liner, one of the inspectors will take his place in the cabin of a passenger airplane and, from the vantage point of a passenger, but from the viewpoint of a skilled airman, he will observe the operating methods of the crew. Furthermore, the inspector makes it a point to fly with every pilot who operates between division points, and to observe not only his technique, but his general judgment, experience, and ability to handle air-line transportation.

At the terminals the inspector closely observes ground operations, such as clearance, methods of handling weather information, and other factors entering into a successful cross-country flight. At maintenance points, the inspector is





Typical Department of Commerce intermediate landing field. Green lights, G, indicate the best available runways; red lights, R and R(2), show obstructions. A beacon is at lower left; boundary lights and markers at edge of field

particularly anxious to determine the methods employed in keeping the aircraft and engines in perfect running order. The competency of the employees, the adequacy of the shop equipment, the local inspection systems employed on aircraft and engines—all are inquired into for the purpose of seeing that they do not fall below the standards specified by the regulations.

Approval of engines and propellers for use on licensed aircraft is based upon the requirements appearing in Aeronautics Bulletin No. 7G.

Technical requirements for various types of repair work are outlined in Bulletin No. 7H. Aircraft repair stations may be approved by the Aeronautics Branch if they request it and can qualify. Approval is based upon the type or class of work which the stations are equipped to undertake. When an application for approval is received from a repair station, the station is inspected to determine whether it is equipped properly to make certain types of repairs. It then is approved to do work of those types for which it meets the required standards. When a repair station has been approved, it is required to furnish an affidavit with each complete job of major repairs stating in effect that the particular aircraft has been repaired in full accordance with the Air Commerce Regulations, and when complete components are replaced, that such components are products of the original manufacturer of that aircraft.

IN addition to assisting communities in the selection of airport sites, the Aeronautics Branch issues ratings to those airports that are eligible, and whose owners apply for ratings. The rating of airports is primarily an aid to air navigation, in order that pilots and aircraft operators may know at a glance that certain minimum requirements have been met as to general equipment and facilities, effective landing area, and aeronautic lighting equipment, and that certain essential features from the standpoint of safety of operations are available.

The various regulatory functions outlined represent the activities that have made the Federal Government the recognized leader in regulation of aeronautics in the United States. However, a number of the states also have undertaken programs of regulation within their own borders, and in most cases they require that pilots and aircraft operating within their jurisdiction hold Federal licenses.

This seems to be a desirable method of handling the situation; it is essential that there be uniformity throughout the country. An airplane may fly over several states in a single day, and if the laws of these different states are at variance, this presents a difficult problem in operation.

Any aeronautical regulation, whether state or national, must necessarily be in the interests of safety—safety of the airmen and aircraft, of the traveling public, and the public in general. However, it must not retard the normal advance of the industry, or hamper the growth of aeronautics along any practical line.

The promulgation and enforcement of regulations that would provide the necessary standards for designing, building, and operating aircraft and would at the same time encourage initiative and originality on the part of those identified with aeronautics, has been the aim of the Aeronautics Branch since its establishment. And the rapid and substantial development of the science and industry of aeronautics would seem to indicate that this aim has been, and is being, realized.

EUGENICS FOR COWS BUT NOT FOR HUMANS

By T. SWANN HARDING

BREEDING up the human race probably is a charming and certainly a fascinating occupation but one that should be restricted to armchair biologists. Unfortunately, this is not the case. The assumption that it would be quite as easy to breed humans up to the level of our "best" people as it is for men to breed cattle or horses with desirable qualities is frequently invoked. This assumption is not only unscientific; it is ridiculous.

To begin with, animals have a breeder capable of supervising their matings to his own end. Men have no such breeder. Animals are bred for points, not with the idea of making them nobler and better animals. A breeder knows just about what he wants—at least if he is in the dairy business—whether he is able to secure what he wants by breeding or not. The dairy cow, as a cow, is not a very successful animal. For ordinary bovine purposes she is really a rather grossly malformed creature—a sort of monstrosity suffering from an hypertrophy of the lacteal glands. This can do her very little good personally. As the process proceeds to perfection (from the dairyman's standpoint) she becomes more and more an animated milk-secreting machine, but purely as a cow she is a far worse bovine than when the process began. These basic facts are often overlooked.

TURNING from cows to the lowly guinea pig, it is probable that Dr. Sewall Wright, the Chicago zoologist, knows about all that there is at present to be known concerning the genetics of this comparatively simple rodent. He has bred guinea pigs all sorts of ways, backwards, forwards, crosswise, and otherwise, and incidentally has secured some relatively "pure" lines which narrowly escape being monstrosities. For this fact is again overlooked: biological theory holds that inheritance travels by way of the chromosomes of the germ cells which contain many genes or determiners which link in all sorts of ways and carry all sorts of potentialities. In certain fortunate matings weak links in the chain, or genes containing detrimental factors, are masked, their bad potentialities having been neutralized. *But they are passed on, none the less,* and are ready to be uncovered and give a bad heritage in certain later matings. Millions of us, as certainly as guinea pigs and no matter how normal and moral and noble we happen to be individually, are carrying within us a heritage of weak genes just now masked and dominated by genes of better quality. In certain matings we are capable of passing along the most disastrously unfortunate gene combinations. There is no way at present known to sterilize the several million of us who might do this, because no way is known of finding out in advance exactly what gene heritage we carry. Only our actual matings can reveal that.

IN the accompanying article the author rather holds the over-enthusiastic eugenist up to scorn, but in doing so he is in good scientific company. Sir Arthur Keith, the great anatomist, has recently pointed out much the same thing. "Call it by what name you will," he says, "the eugenist must have a stud-farm where he can secure control, isolation, and purity of blood." Assuming that the most desirable subjects for this human stud-farm experiment would thus surrender their liberty (will the eugenists?), it would take at least one hundred generations to breed a race of supermen. Again, the noted physiologist, Professor A. V. Hill, not long ago pointed out in *Nature* (London, Vol. 127, page 22) that "there are many common fallacies about inheritance, derived from imperfect experimental knowledge or by false deduction from experience. Much of so-called eugenics is based upon such fallacies." Less tactfully stated, much of the content of eugenics is little more than half baked.

—The Editor.

In his guinea pigs Dr. Wright sought to uncover all these weak genes. He did this by making brother-and-sister matings and by building up so-called pure lines. In such lines all sorts of potential or inherent weaknesses develop and the lines, so long as brother-and-sister crosses continue, breed true for their weaknesses. It might be possible, given many years, to breed a given colony of guinea pigs in such manner as to secure nothing but pure line progeny. That done, the objectionable animals could be killed or permitted to die out and the valuable ones mated to secure a finer race of guinea pigs than ever existed since the world began.

You might do that with guinea pigs. It is done with corn and wheat right along. It is the only method known to biologists of accomplishing that purpose. Yet it would be all but impossible to apply such a method to human beings, and to breed monstrosities deliberately, even if we knew the factors governing intellectual inheritance (which we do not), or had agreed upon the type of human being which is undoubtedly the best and most valuable (which we probably can not).

So far, then, we have only got far enough along to believe that you—a lowly sinner—should become more like me—a holy eugenist speaking.

WE do not know how to control the inheritance of mental and emotional factors in a horse, much less a man. Certain stallions are very refractory. But dispositions are not the product of heredity alone; they represent a sort of resultant of three forces—heredity, environment, and training, and no one knows which predominates or which factor is governed by each force. Refractory stallions are repeatedly retained for breeding purposes and the progeny, properly trained, are as frequently mild and tractable. Through its inheritance the animal obtains a certain capacity for something or other and it is the function of training and environment to develop that potentiality. What the animal or man is depends upon his training and his environment; what he may become depends upon his inheritance. In some cases the refractory disposition has been traced to bad training and probably has no breeding significance whatever. In any case the point I should like to emphasize is that no breeder today knows enough to know how to control the dominance or recession of mental and emotional traits in stallions, and it is therefore rather early to begin to assume that this can readily be done with human beings.

Returning now to the cow who has, in her patient manner, been quietly awaiting us—she has in her germ cells 37 or 38 chromosomes, the vehicles of inheritance, depending upon whether she is a "he" or not. Human beings have 48. Stop and consider the enormous number of permutations you might get by alternative rearrangements of even

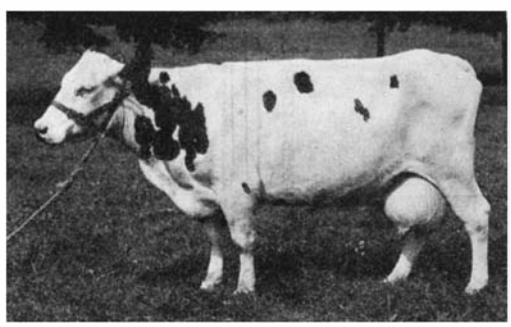
37 chromosomes. Then remember that each chromosome is made up of several genes and that gene rearrangements can also produce different heritages, and it will occur to you that the problem of breeding efficient dairy cows is at least somewhat complex statistically. Now it is known that many genes, not one alone, are concerned with milk production, although the exact number has not yet been determined. The inheritance of milk production therefore involves multiple factors and only a careful study of results obtained in an enormously large number of matings will enable definite conclusions to be drawn.

Furthermore it is not yet known which of the many genes that affect milk production are present in any single cow. She may have a production level of 12,000 pounds of milk annually due to a certain gene complex, while another cow with an altogether different gene complex may have exactly the same milk production level. Hence it is quite possible to have a number of cows with the same level of milk production and yet each of very different genetic composition from any of the others. Let it be remembered, also, that we are working here with a comparatively simple physical quality, milk production in the cow, and not with such a hazy concept as high human intelligence. Moreover, some of these cows might breed true for high milk production and some might not.

TO continue with our bovine illustration, which throws light on the futility of eugenics for humans, suppose that a breeder has a heifer whose dam produced 10,000 pounds of milk and whose sire's dam produced 16,000 pounds. There is as yet no satisfactory means of determining with any accuracy what the production of her daughters will be. To make the attempt would be to put the cart before the horse because the only recognized method of procedure in such cases is to test the heredity of a sire by breeding him to cows which have a certain definite milk production in order to measure his transmitting ability by the milk production level of his daughters. Dairy breeders can raise the level of milk production in purebred herds only by using tested sires which transmit the genes for high milk production.

This little survey of animal breeding was necessary in order to emphasize the complexity of the factors governing breeding where, according to biological enthusiasts, it has already been so successful that we need merely to emulate such methods in order to breed up the human race. Instead of that what have we found? That cattle breeding is endlessly complex. That a great deal remains to be learned. That results are as yet uncertain. That the basic biology of the inheritance of milk production has not been worked out scientifically and methods remain rather empirical than otherwise. Even the lowly guinea pig is not yet completely understood and scientific investigators have so far insufficient information upon which to base an experiment in breeding up the guinea pig race.

Now we confront a human being with 48 chromosomes instead of the bovine 38. A cow must pass through a period



The sad product—from the cow point of view—of the "cow eugenists'" best efforts

of but three years before it becomes possible to ascertain whether a single mating has been successful or a failure from the standpoint of milk production. It requires 12 to 25 years to find out whether a human mating has or has not transmitted high intellectual attainments. At the outset, then, and even assuming that we knew what factors govern intelligence and what the best types of human beings are, we should face a considerable chronological handicap in breeding the human race up to any desired standard. Incidentally the human race is not so tractable as the bovine and seems destined for a long time to offer more resistance to compulsory matings than the cow.

While at least something is known about the genetic character of the inheritance of bovine milk production, practically nothing at all is known about the number of the genetic factors involved in transmitting human intelligence. If we confine our attention to intellect alone—and it must be remembered that unruly emotions can make very intellectual people most undesirable in many ways—several things might be said. For one thing, ability as such is not believed to be inherited; biologists of scientific standing assume that what is inherited is a capacity for learning. Secondly, there are very probably millions of people walking around with valuable potential capacities entirely undeveloped because of chance environmental obstacles. Third, there are many levels of human intelligence: the idiot, the imbecile, the moron, the low-grade normal, and the normal. Some of these levels may definitely be inherited; for example, the first three. These may represent fairly pure genetic types and their elimination from the breeding human stock seems advisable as a step in improving average human intelligence, but such a step is always and at best only a step.

Millions of our most respected and highly educated citizens carry about within them a few undesirable genes. Occasionally, when just the right—or rather the wrong—combination is brought together at some mating, an individual of low grade intelligence results. Much has been written by the eugenic wing of the biologists about preserving the intellectually superior. We are regaled with the unfortunately low birth rate among college graduates, as an argument to show that we shall be overwhelmed by masses of low intelligence unless we pass a law or do something about it. Perhaps it is very desirable to reproduce our educated classes. Perhaps, again, we already educate abstractly too many individuals who should be educated manually. Perhaps some of our present unrest is a direct result of educating the wrong kind of people with the only sort of education which we happen to have on tap in our public schools. But the further fact should not be overlooked that the college educated class of the population has in the past produced and probably will for a long time in the future produce only a small percentage of our college students. The majority of these students come from the less educated masses, so to speak, and the mere fact that men and women are college educated does not necessarily fit them to produce children of superior intelligence, any better than if they had never attended college at all. For inheritance probably counts more here than does environment, assuming learning capacity to be inherited.

Would it be easy, then, to breed the human race up the level of "intelligence" of the "best" human beings of today? In the first place we do not know what the "best" human beings are. "Intelligence" is also a poorly defined term. But, assuming that we know what intelligence means, we do not know the genetic factors which control its inheritance. Some of our best people certainly carry around weak genes that might work havoc in their progeny.

THE conclusion therefore becomes inescapable that biologists of no matter how great prestige who claim we could easily increase the quality and intelligence of the human race by selective breeding are talking practically at random. That they still further mislead the fallacy-ridden human race is a misfortune.

MAKING THE NATION'S BOUNDARIES

By GUY ELLIOTT MITCHELL
United States Geological Survey

HOW would you like to live in a certain section of Kentucky where, owing to a double bend in the Mississippi River, there is an area about ten miles square belonging to Kentucky that cannot be reached from the rest of the state without passing through a part of Missouri or Tennessee?

This is only one of almost innumerable peculiar and interesting facts just revealed in their entirety by E. M. Douglas, geographer of the United States Geological Survey, in a book on American boundaries. Mr. Douglas goes back to the earliest history of the nation to trace in detail the story of the great game of give and take which has resulted in radical changes in our state boundaries and in the creation of entire new states out of old ones.

Virginia, for example, gave birth to something like 10 states; Connecticut used to own about a fourth of Pennsylvania; New York, Indiana, and Utah were slashed, bit by bit, into sections far smaller than their original size.

JUST a rough idea of the importance of boundaries is found in the fact that as a result of errors in the location of its boundaries, Tennessee gained about 2500 square miles of territory that it would not have had if the lines had been correctly located.

Well established and well marked boundaries are highly desirable and are often a means of avoiding trouble, though sometimes when state boundaries are changed there is bitter controversy if money matters are involved. Oftentimes the owner of property which has changed hands from one state to another finds to his chagrin that his land actually has been cut in two by the new boundary. This happened to several farms in the recent Texas-Oklahoma boundary change.

In very similar fashion, in changing the boundary line between Minnesota and Wisconsin where the line runs through Duluth, the new boundary, according to court order, cut directly into and through some of the large ore docks where iron ore from the Mesabi range is loaded onto the big lake steamers. The owners of these docks must now, therefore, pay part of their taxes to Minnesota and part to Wisconsin.

A boundary between two states of the United States may be changed by agreement of the state legislatures, but this agreement must be approved by Congress. Congress cannot change a state boundary without the consent of the state, nor can two states by mutual agreement change their common boundary without the consent of Congress. Disputes between states regarding boundaries must be settled by the Supreme Court, whose decisions are final.

Great boundaries from small points grow. The triangulation station on Mt. Whitney, California, 14,496 feet high

The question has often been asked whether a boundary defined by statute or treaty, as on a specified parallel of latitude or meridan of longitude, should be located by direct astronomic observations or from geodetic computations giving a mean position derived from a great number of observations. It has been generally agreed that an astronomic location is the proper one, but astronomic and geodetic positions may differ materially. For example, the astronomic stations on the 49th parallel boundary east of the Rocky Mountains vary from six seconds north to eight seconds south of the mean parallel of latitude, or a range of more than a quarter of a mile. It seems likely that for future surveys geodetic positions will be used wherever available.

America was settled by the Anglo-Saxons through Massachusetts and Virginia. From these small beginnings radiated claims for most of what is now the United States.

Massachusetts in 1629 included Maine and laid claims to large portions of New York, New Hampshire, and Vermont. However, the independence of Vermont was agreed to in 1781, and New Hampshire and Massachusetts adjusted their differences in the former's favor in 1782. Claims of the Bay State to western lands within the territory of New York state were finally settled in 1786 when Massachusetts relinquished her claims.

RELATIVELY few people today realize that Virginia was once the "giant state" of the Union. Within her boundaries were once included wholly or in part the present states of Pennsylvania, New Jersey, Delaware, and North and South Carolina, as well as a vast region stretching west and northwest to the Pacific Ocean which included major sections of what are now the states of Illinois, Indiana, Ohio, Kentucky, and West Virginia—even the Bermuda Islands were once a part of Virginia. All this was under the terms of the famous third charter of 1611-12.

In 1625 the colony was changed to a royal province, the three charters having been cancelled by the judgment of

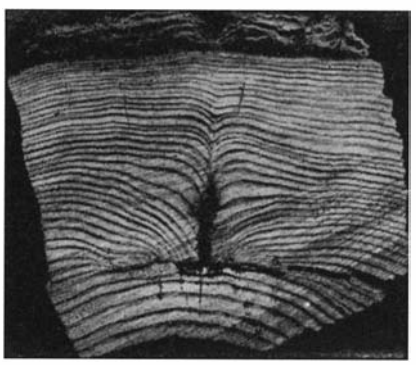
the court of King's Bench in the preceding year, but Virginia still claimed the boundaries fixed by the charters.

Charters to Maryland in 1632 and to Pennsylvania in 1681 substantially reduced the territory of Virginia. The Connecticut charter of 1632 practically made the southern boundary of Connecticut join Virginia, whereas the charters of 1663 and 1665 changed the northern boundary of Virginia to its present statute position, removing from Virginia what virtually are now the entire states of Delaware and New Jersey and part of Pennsylvania.

By the constitution of 1776 Virginia formally gave up all claims to the territory which is now a part of the neighboring states of Maryland, North Carolina, and South Carolina.

VIRGINIA'S area was further reduced by the French treaty of 1763 which made the Mississippi River the west boundary; by the cession to the United States of the territory northwest of the Ohio River in 1784; by taking away Kentucky from Virginia and admitting it as an independent state in 1792; by the division in 1863 when the new state of West Virginia was created and admitted to the Union; and finally by the transfer of two counties to West Virginia in 1866.

Nor was New York State originally a pigmy territory. In 1664 King Charles II of England granted to his brother, the Duke of York, a large territory in America, which included all that tract lying between the west side of the Connecticut River and the east side of the Delaware. The Duke of York had previously purchased, in 1663, the territory on the New England coast which had been awarded to the Earl of Stirling. In 1664, with an armed fleet, York took possession of New Amsterdam from the Dutch and re-named it New York, after himself.



Government worker freshening up an old blaze. *Right:* Section of a tree that was used as a boundary blaze in 1873, cut in 1909, used as evidence in a boundary dispute

In July, 1673, the Dutch recaptured New York and held it until the territory was restored to the English by the treaty of Westminster, in February, 1674. So the Duke of York, to protect his title, obtained a new grant in substantially the same terms as of 1664.

New York's "reducing program" began in 1664 when the present state of New Jersey was sold by the Duke of York to Lord John Berkeley and Sir William Carteret.

IN 1682 the Duke of York sold to William Penn his title to Delaware and the country on the west bank of the Delaware, which had been originally settled by the Swedes but had been conquered by the Dutch and by them surrendered to the Duke of York.

In 1691 all claim by New York to any part of Maine was relinquished, and the islands of Nantucket, Martha's Vineyard, and others adjacent were annexed to "Massachusetts Bay." Also the territory west of the Connecticut River to a line within about 20 miles of the Hudson River, now forming portions of Massachusetts and Connecticut, was by agreements and concessions surrendered by New York to those colonies.

The whittling of New York continued apace. By the cession of 1781 the state relinquished, to the United States, all its claims to land west of the meridian through the western extremity of Lake Ontario between the north boundary of Pennsylvania and the present north boundary; and the Peace Treaty of 1783 cut off the rest of the area claimed by New York west of its present limits.

Massachusetts, prior to 1786, claimed under its charters title to the soil, but not to the sovereignty, of a large area west of the Hudson River that also was claimed by New York. But by agreement Massachusetts leased to New York all land east of a meridian commencing on the Pennsylvania line 82 miles west of the Delaware River and extending northward to Lake Ontario, except an area of 3600 square miles east of that line to be selected by Massachusetts between the rivers "Owega and Chenango."

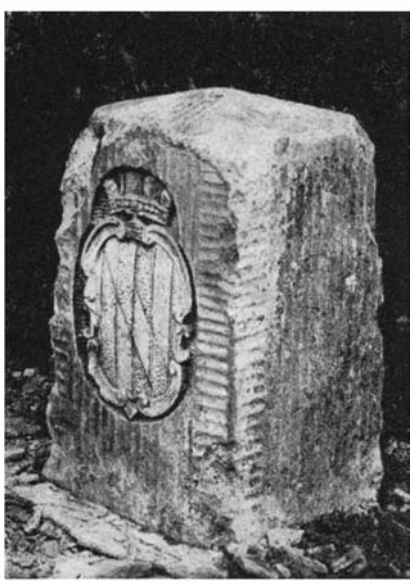
The next reduction job on New York's area took place in 1791, when the consent of New York to the independence of Vermont was made effective by Congress. This left New York with substantially its present boundaries. Thus, according to New York tradition, Vermont was not originally a New England

Photograph by E. A. Shuster, Jr.

An ancient District of Columbia boundary post set in 1792 by a survey party

state, but it will be remembered that Massachusetts had likewise laid claim to Vermont, relinquishing this claim along with New York's similar decision, in 1791.

Westmoreland County, Pennsylvania, which occupied a major section of the northwestern part of the state—almost a fourth of the entire state—has had a shifting history. In 1681 Charles II of England granted a huge tract of land to William Penn called the Province of Pennsylvania. This tract included a section of land in Pennsylvania now known as Wyoming Valley, which was claimed by Connecticut under its charter of 1662. The Indian title to this land was transferred to settlers from Connecticut by deed dated July 1, 1754. This area was organized by Connecticut in



Stone monument Number 20, located on the Mason-Dixon line

1776 as the county of Westmoreland. The conflicting claims of Connecticut and Pennsylvania were a cause of dispute for many years and several legal battles were fought for its possession. However, a court of arbitration appointed by the Continental Congress awarded the disputed territory to Pennsylvania.

One of the favorite sports of the early settlers was that of chipping Indiana to bits. The story starts properly on our great Independence Day in the year 1800 when the "territory west of the Ohio River" was divided into two parts, the eastern section to retain the old name, Ohio; the western part to become the territory of Indiana.

Only five years later, the real chiseling of Indiana began. The northeastern part of the territory was cut off and organized as Michigan Territory. Once more the axe fell, this time on March 1, 1809, when the western section of Indiana was organized as Illinois Territory. This was all of the Indiana territory lying west of the Wabash River

A trail cut through heavy timber in the Idaho-Washington survey

from Post Vincennes due north to the territorial line between the United States and Canada. This was indeed a far cry from Indiana's original allegiance to old Virginia. On December 11, 1816, Indiana was admitted as a state with its present boundaries.

All of this is a commentary on our American type of civilization. Bitterly contested controversies, which in Europe would unquestionably have plunged nations or states into war after war, were always settled in the United States without recourse to arms.

UTAH, once a huge slice of Mexico, was also slashed almost beyond recognition. The story properly starts in 1847 when the Mormons settled in Utah. In 1849 they organized a territorial government which they called Deseret; a delegate sent to Congress was not recognized by that body. Utah was established as a Territory by act of September 9, 1850, and included part of the area acquired from Mexico by the treaty of Guadalupe-Hidalgo. The Territory's limits consisted of: "All that part of the territory of the United States included within the following limits, to wit: bounded on the west by the state of California, on the north by the territory of Oregon, and on the east by the summit of the Rocky Mountains, and on the south by the thirty-seventh parallel of north latitude"—its present southern boundary.

This tremendous area was reduced by the formation, in 1861, of the Territories of Nevada and Colorado, and in 1864 and 1866 by the extensions eastward of the limits of the state of Nevada. Nevada became a state by presidential proclamation in October, 1864. An act of May 5, 1866 further enlarged the state of Nevada by the addition of contiguous territory taken from Utah and Arizona.

Any school boy can tell you there are two major types of boundaries—natural, consisting of rivers, mountains, and coast lines, and artificial, or man-made. Of the natural lines, rivers undoubtedly are the greatest source of dispute and trouble, chiefly because the line may be a rapidly changing one, sometimes involving thousands of acres of land, losing on the one side and building up on the other.

TODAY artificial boundaries are laid out very painstakingly, though this was far less the case only a few years ago. Such lines must be run accurately along parallels of latitude and meridians of longitude, whereupon heavy concrete monuments should be erected at regular intervals of a mile or two. Possibly these monuments will disappear over long periods of time, but the record they leave can easily be retraced.

Only three of our states—Colorado, Wyoming, and Utah—are entirely enclosed by artificial boundaries. New Mexico is almost completely enclosed by surveyed boundary lines, except for about 20 miles.

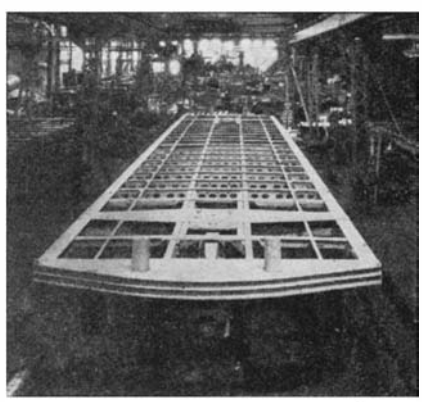
No state is entirely enclosed by natural boundaries. Texas has the greatest mileage of natural boundary lines, though it also has about 900 miles of artificial boundaries. New Jersey, on the other hand, has only a small stretch of about 50 miles of artificial boundaries.

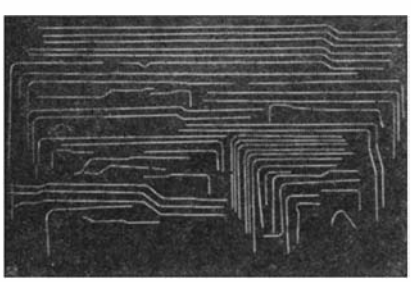
A government survey worker running the Idaho-Montana boundary

One of the new Eighth Avenue subway cars being tested in actual service

NEW YORK'S NEWEST SUBWAY CARS

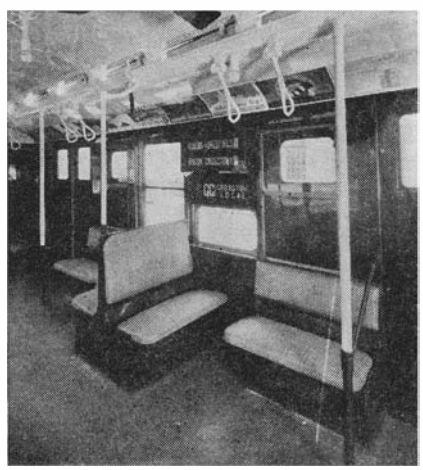
NEW YORK has the last word in subways. The Eighth Avenue subway has been built and may open in January. The cars, which cost 38,000 dollars each, are of particular interest owing to their construction. The contract specified that the delivery must begin within six months of the contract award and continue at the rate of 40 a month. This involved extensive plans on the part of the American Car and Foundry Company, of Berwick, Pennsylvania, where the cars were fabricated. More than 600 drawings were required, in addition to 300 furnished by makers of accessories. One of them, showing everything underneath the floor, was 12 feet long and cost as much as a good automobile.





There are 451 pieces of air pipe and 28 photos like this one are necessary to show them in detail

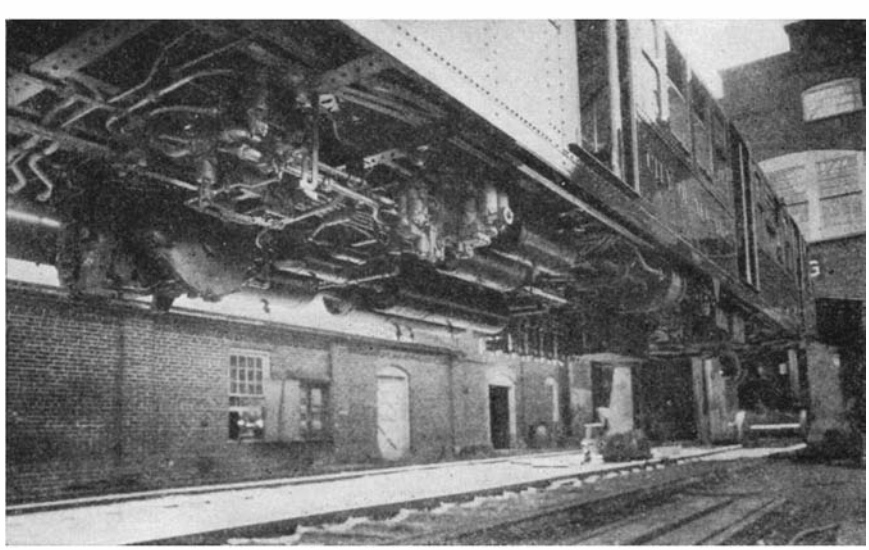
These cars have a number of devices and arrangements which have never been used before. The underframe stress members are made of carbon manganese steel which means increased strength with less weight. Specifications called for cars weighing not more than 85,000 pounds each; after the sample car was weighed it was found to be 600 pounds under the allowable limit. The cars are 60 feet 6 inches long and will seat 60 passengers; they will accommodate 280 and 286 have been crowded into one of them. There are four doors on each side of each car, all controlled by one man on the train. This will make possible fast loading and unloading.



***Above:* Interior of one of the new cars. The illuminated signs change when direction is altered. *Left:* The underframe construction is strong**

More than a freight car load of material came into the plant for each car built. There are more than 1600 different designs of pressings, forgings, and flat items, or 6000 individual items. Some of the other items are impressive. There were required 12,300 screws, 22,558 rivets, 1200 bolts, 5000 nuts, 737 pieces of conduit, 451 pieces of air pipe. There are 43 miles of wire in each car. Some of the operations while not complicated are prodigious; for example, over 100,000 holes have to be punched or drilled for each car.

The bumping of the cars together not only couples them but also couples the air brakes and the 30 electric circuits between the cars, and the turn of a handle breaks all connections instantaneously. The cars were brought from Berwick on their own wheels and the motors were installed in New York.



The car without the trucks has been raised to show the maze of pipes, conduits, and machinery attached to the sturdy underframe. There are 22,558 rivets

WHAT SCIENCE REALLY IS*

By ARTHUR H. COMPTON
Ryerson Physical Laboratory, the University of Chicago

WHY do men who might be doing exciting things in business spend long hours in laboratories over problems in physics or working with X-ray tubes?

I was thinking about that question some time ago while reading a book written by Marco Polo, that adventuresome Italian of the 13th Century who traveled as far east as China and there entered the service of Emperor Kublai Khan. When he came back to his native Italy what surprised his countrymen most was his story about the Chinese and their baths. Most Chinese, he reported, took a bath a day, and many took two baths a day.

Marco's fellow Italians could hardly believe this, especially when he said that these baths were taken in warm water. "How," he was asked, "could so much water be heated? Why, it would take all of the forests in China to provide fuel to heat bath water for so many people!" And then the canny questioners would laugh.

BUT Marco was equal to the occasion. He admitted that fuel *was* a problem but said that the ingenious Chinese had solved it by discovering stones that would burn. These stones, he further declared, were most marvellous because when ignited they could be heaped together and would burn all night, thus keeping the water warm for several hours at a time. Marco's account of these remarkable stones even included more information. They were quarried in the mountains, he said, where they occurred in black veins. This, of course, was really too much to believe. But Italians have always loved a good story, and contemporaries came to regard this as among the best of the bizarre anecdotes related by the loquacious globe-trotter.

Now, however, we realize that Marco's imagination was not simply running riot. He had actually seen black stones that would burn. He had glimpsed the possibilities of coal as fuel. His situation was simply that of a visitor returning from a highly civilized country to a semi-civilized land, for China in the 13th Century was far ahead of Italy, though in Italy burned brightest the flame of western culture.

A few months after reading about Marco Polo's adventures, I found myself in China. But I was *not* astounded as was Marco by finding a more advanced civilization than the one I had left. Instead, industry and arts here seemed to me primitive.

"Why," I asked myself, "in seven short centuries has leadership in human progress passed from the East to the West? Why has China, for the most part, not advanced from the days of Kublai Khan?"

THAT is a popular question in the West, and the first and rather flattering answer we have given is that the white race is intrinsically a superior race. But if we stop to think, that is not a satisfactory explanation. Near Peiping I saw the famous great wall of China. Up and down hill and across rivers it extends for 1500 miles. It is so wide that four horse teams can travel abreast on its top. As an engineering feat it makes the building of the transcontinental railroad a comparatively small matter. We have to go to the Panama Canal to find a project relatively as gigantic in execution. All of which leads to the conclusion that the Chinese certainly are not inferior in abilities.

And then, too, we have said that our progress is due to our superior governmental ability. We know, we have told ourselves, how to organize states so as to bring forth the latent talents and abilities of man, but we forget that Kublai Khan's grandfather was Jenghiz Khan who threw together the greatest empire of all time, both for size and for number of people concerned. Alexander the Great's empire endured but a few years, but the one created by Jenghiz Khan lasted for generations and its power extended even for centuries.

It has been suggested that our brains are more alert, have greater powers of retention, finer sensibilities, and more constructive propensities. And yet those of us who are connected with universities know that some of our finest students are those that come from China, Japan, India, and other lands of the Near and Far East.

And so we are compelled to accept the conclusion that the shift of the leadership of civilization from the East to the West is not due to racial superiority nor to any innate advantage that the white people may have over others.

The West, I believe, owes its favorable position to an idea: *The idea of science.*

Now, the idea of science is simply an attitude that men may have toward the world. It is a desire to find out how this outside environment, in which they live, works, coupled with the desire to increase their power to control it. It is an attitude that looks at life, determines its methods of operation, and adjusts them, so far as is possible, to human needs.

Leonardo da Vinci was one of the first consciously to develop this point of view. And Galileo, Kepler, Newton, and a host of others should be permanently great names in our history, for they made significant contributions to the extension of this way of looking at life and things.

Science was largely responsible for the industrial revolution which has altered the lives of people. If you do not believe this, go to the Orient where in many places you will find spinning wheels, potter's wheels, and other tools in use today such as the Occident had centuries ago. Industry, by itself, is stagnant and static. It needs science to make it progressive and dynamic.

VIRTUALLY everything we touch is, in part, due to scientific investigation. Science was called upon at almost every stage of the development of the automobile and the steam or electric train that bring the modern business man to work. It made possible the development of skyscrapers and typewriters and printing presses and the radio.

At home we sit down to a table on chairs produced by scientifically conceived machinery. The tablecloth was woven on scientifically constructed machinery. The very dishes from which we eat were made possible by an experimentation with high temperatures, so that the ancient art of the potter might keep step with our age. Indeed, our whole day's life is inextricably bound up with scientific research.

So it seems reasonable to take the point of view that the advance of civilization and the hope for its future are in science.

Science is founded upon a belief that the world is reliable in its operation.

*As told to Leland D. Case, and published in *The Rotarian.*

And, strange as it may sound to some readers, this view was not widely current 200 years ago, and hardly conceivable 2000 years past. To believe that the world is reliable takes us away from the old conception that "things just happen" or that very persistent belief that capricious and whimsical gods dispose of man and events according to fancy.

The characteristic attitude of the past is summed up in the case of the farmer who, when his barn was struck by lightning, offered sacrifices to Zeus, Thor, or an appropriate god so that such a thing might not again happen. Now we know the thing to do is to put up lightning rods.

AND we don't stop there. Not only do we protect ourselves from outlaw electricity, but we have domesticated the force, as we did cows and horses, and have compelled it to draw our loads and carry our burdens. We can do this because we think of the world as a reliable, orderly thing, a cosmos and not a chaos.

Many very sincere scientists, in their endeavor to simplify the universe, overlook the subtle but rich implications of the idea of science for the matter of living. Science, viewed broadly, is more than a matter of test tubes and electrons. Fundamentally it is a discerning approach to the problem of living satisfyingly in an environment of materials, men, and events that do not of themselves conform readily to our desires. It is a search for truth.

Historians know that this manner of looking upon the world, while it may have received a lasting acceleration through the pioneer efforts of Leonardo da Vinci, Galileo, and others, was not unknown to wise men of Greece, 500 years before Christ. For example, Thales of Miletus knew of electricity. Indeed the word electricity is from the Greek word for amber because when amber is chafed it is electrified.

The great problems, how and of what is the world made, were the dominating inspiration of several philosophers who dwelled in Greece some 2000 years ago. Pythagoras who lived 500 years before Christ, remembered by every high school geometry student because of his theorem on the square of the hypotenuse, determined the rate of the vibrations of the notes of the musical scale with fair precision.

Eratosthenes went many miles up the Nile in winter to take stellar bearings, and, by facts so acquired, measured the size of the earth within an error of only 3 percent. We speak of molecules and atoms but probably not many of us know that back in 400 B.C. Democritus developed the idea of atoms.

Galileo, the true father of the modern scientific era, contemplating the beats of a pendulum (lamp) at Pisa

The question forces itself upon us: Why did not the idea of science develop in old Greece? Why did not the industrial revolution take place in 200 B.C. instead of in the 18th and 19th Centuries A.D.?

The first reason is, probably, Socrates. The modern skeptic punches holes in old ideas, but this famous skeptic put holes in the then new idea of science. The current school of scientists had advanced the theory that ideas and purposes, as well as stones and water, are composed of atoms. Socrates pointed out that the fact that you can and do think is in itself proof that something was started for you with which you commence. And Socrates won the day.

It is hardly fair to say that Socrates killed this early scientific school, but he helped do so. And so did Plato. And so did Alexander the Great who brought back from his travels in the Orient those Chaldean magicians and astrologers who introduced the idea of magic into the West.

Thus Greek science died in early infancy. The Greeks couldn't develop the idea of science because they could not reconcile a reliable world—a world controlled by atoms—with the world of thought. The problem that Socrates saw, the gulf between mind and matter, the enigma of purpose and thought, still remains with us. Yet, it is one of the deepest satisfactions of men who devote their lives to science that in the search for truth in the material world occasional flashes come which aid in the untangling of such philosophical problems as these.

Not so many years ago I was studying philosophy with my father and I recall that one of the most baffling questions to which we gave thought was that of free will. Some scientists used to say that man is the choiceless tool in the hands of his past experience and his heredity and his environment. But, as we delve deeper into science we are surprised to find that some "pat" airtight explanations of other days are not sufficiently flexible.

WE have, for example, long been told that the law of causality is inexorable, and in physics we were taught that a definite set of conditions produces a definite set of results. But, in an experiment involving the scattering of X rays by electrons we have discovered that the law of causality seems to break down. These electrons would not behave as we thought they should. We have in fact had to conclude that the law of causality is largely one of high probability, in short, a statistical law.

These experiments, and others, interpreted in terms of a philosopher, mean that a person's thoughts are not definitely controlled by what has happened. It takes away the old mechanism with which thinkers manacled the human spirit. Indeed if old Democritus had only known the results of our experiments he could have vanquished Socrates, and the history of the world might have been changed, the Age of Science coming two millenia sooner.

Why do men who could devote themselves with reasonable certainty of success to business and to the professions prefer to toil in laboratories and to spend unbelievably long periods unraveling problems? My answer has been given. It is the enduring satisfaction of new interpretations of discoveries, new approaches to this high adventure of living. And in this study of science, the practical is really secondary to the enriched attitude the scientist acquires towards life.

EROSION DARES THE WEST*

By W. R. CHAPLINE

WHEN the white man came to the West he found a country far different from that which we now know. The Indians had made but little use of the agricultural possibilities, the forests were virgin, abundant herbaceous and shrubby vegetation was available for the wild life which abounded everywhere. Mountain streams ran cool and clear and were filled with trout. Even the desert supported perennial grasses sufficient for freighters into early southwestern mining camps to hobble their sixteen-horse teams for night grazing where they stopped along the road. In his conquest, the white man has harnessed the streams for irrigation and power, the desert has been brought under cultivation through irrigation, mines have given up their minerals, the forest has yielded its timber and other wood products, and the ranges support an extensive livestock industry.

THUS a new civilization has been built up within the space of 50 to 70 years. Prosperous farm homes have been established; schools, churches, and villages dot the irrigated valleys; and large urban centers have gained added impetus in their growth, if not their main development, from dependent irrigated farming lands. One fifth of the population of Arizona, for example, is located in the irrigated portion of the Salt River Valley. Idaho has a heavy concentration of its population in the irrigated Snake River Valley and its tributaries. The rapid development of southern California would not have been possible without water, and its future development depends in large measure on the successful and adequate development of the Colorado River, of which the Hoover Dam is the first outstanding construction. This stupendous project with its 700-foot dam will impound 30,500,000 acre-feet of water, irrigate over 2,000,000 acres, develop over six and one half million dollars worth of power annually, and furnish the needed domestic water supply for Los Angeles, San Diego, and other important cities located in southern California.

Into this new Western civilization, taking shape on such a grand scale, the menace of soil erosion has flung its dare with a gigantic grimace. Erosion depletes the soil by removal of the productive top layer. It increases the destructiveness of floods and through the deposition of silt and other erosion débris destroys valuable properties. The silting of reservoirs and other irrigation works in the West is already seriously endangering established projects and at the rate erosion is increasing, it is making prospective ones uncertain.

The Zuni Reservoir in New Mexico, for example, has in 22 years filled with erosion débris to over 70 percent of its capacity, practically destroying its usefulness. By 1925, but nine years after the completion of the Elephant Butte Dam in New Mexico, almost 9 percent of the reservoir capacity had been taken by erosion débris. Indications are that erosion is increasing on crucial parts of the watershed.

A survey of a portion of the Boise River watershed in Idaho disclosed that only 27 percent of the area had escaped erosion. Much of the upper soil layer on 56 percent of the area had been lost by widespread sheet and light gully erosion. Serious gully erosion is occurring on the remaining 17 percent. The reservoir and other irrigation works are being severely silted, despite costly efforts to keep down these accumulations.

Silt presents the most serious problem of the lower Colorado River. Silt formed the Imperial Valley by damming it off from the Gulf of California and thus created much of the agricultural wealth of the valley, yet it threatens to destroy this wealth. The floods of the Colorado River become especially serious and costly because of the vast amount of silt which the water carries and deposits in the river bed and on flooded land, necessitating higher and higher levees, clogging the irrigation canals, and sealing up the soil with fine suspended particles. Fortier and Blaney have estimated that silt requires from the farmers of the Imperial Valley an average annual expense of two dollars an acre. These investigators also estimate that an average of 253,628,000 tons or 137,000 acre-feet of silt are carried past the site of the Hoover Dam annually. At this rate the reservoir would be filled with erosion débris in about 220 years, but its effective usefulness as a flood control and irrigation water reservoir will be materially reduced if not destroyed long before that.

THE water flow of the Colorado River varies greatly during the year. A great flood occurs usually in the spring following the melting of snows on the watershed; at other times the flow may become very low. Furthermore the amount of water varies greatly from year to year and may for several years at a time be inadequate for the proposed development in the lower basin, especially when large additional areas are brought under irrigation in the upper basin and the necessary reservoirs become shallow through silt accumulations, thus increasing the proportion of water evaporation from them.

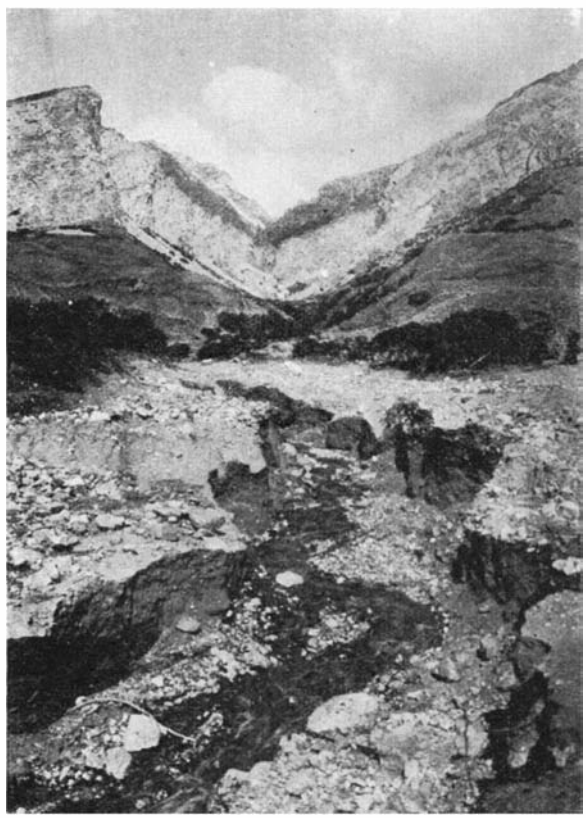
Irrigation developments, even though they may pay for their original cost before the reservoirs are destroyed by silting, become useless in 50 or 100 years or more. In places this period may be extended by rebuilding the dams and increasing their height. But, with evaporation averaging eight feet or more a year, as it does at the Elephant Butte Reservoir, and with each increase in dam height exposing a greater expanse of water to evaporation, there is a practical limit to this expedient. Dredging has been suggested as a silt-removal measure but costs so far have proved exorbitant. Even if the effective

The waters of the Salt River cutting out silt in the upper part of the Roosevelt Reservoir basin, and carrying it nearer to the dam

*Courtesy *American Forests*, Washington, D. C.

life of a reservoir can be doubled, through such expedients, what is to become of the civilization which it was instrumental in creating when the usefulness of the reservoirs is destroyed by silting? Engineering works may be written off the books but human life and community development cannot be so treated. We must look forward 200 to 500 years or even more for permanency of such social developments and determine erosion-control measures that will make this possible.

Numerous factors, of which climate, soil, topography, and geologic formation are doubtless the most important, influence erosion, but the vegetative cover is the main single controllable factor. The natural balance on the western arid and semi-arid lands, between the forces that tear down and those that build up the soil, is a delicate one, but if the vegetative cover is not disturbed erosion is usually slight. Drought, cloudbursts, snowslides, and other natural phenomena may unbalance the delicate equilibrium which nature has so carefully developed and may lead to excessive erosion. But nature, if unimpeded by man, quickly sets to work to re-establish the balance; the vegetation gradually spreads over the scars, the slopes assume an angle of repose, and eventually the normal conditions return.



The depletion of vegetation resulted in this arroyo, carved by the floods which followed heavy rains

MAN'S activities, however, by reducing the vegetative cover or altering the topography or soil, can and do upset the balance completely. Where this occurs these activities are seldom abated and severe erosion follows. Once started, this may develop to disastrous proportions.

There is ample evidence that erosion has become much more widespread and more serious since the white man's occupancy of the West. Numerous small valleys which in pioneer days were covered with grasses and trees and through which small streams meandered, have been destroyed by wide, deep arroyos, following destruction of the protective cover on the watersheds, attempts at hillside cultivation, the clearing of timber and brush along stream courses, the construction of roads and trails without proper drainage and other unwise developments.

Forest and brush fires devastated vast areas in the early days of settlement and even now, with great effort being made to control them, fires destroy the vegetation on hundreds of thousands of acres in the West every year. Lumbering is thinning the timber stand, hydraulic mining has cut out the sides of gulches and rich valleys, and smelters have seriously depleted several hundred thousand acres.

Overgrazing has doubtless been the most important factor in the reduction of the protective cover on watersheds. Before 1890 more livestock were on the ranges than they could support and this condition prevailed on practically all ranges for 20 years or more. The most palatable forage plants were killed, leaving only a scant stand of low-value vegetation. Excessive trampling destroyed plant roots and packed the soil. Under such conditions there was little to check the rain as it fell; the more compact soil could not absorb the water, which ran off and was quickly converted to a slimy mass of flowing mud. Shoestring gulleys started and speedily gained depth, further accelerating the run-off, while the main drainage channels became raging torrents.

Although the regulation of grazing within the National Forests and better appreciation on the part of the stockmen of the value of abundant feed has aided in checking the erosion, at least locally, several hundred million acres are still overgrazed and erosion on these areas is becoming more severe yearly. This condition prevails particularly on the greater part of the 196,000,000 acres of Public Domain and the vast area of state and private lands intermingled with this Public Domain on which at present stock grazing cannot be controlled by ordinary legal methods.

Probably the greatest loss from this range deterioration and soil depletion through erosion has been the reduced productivity of the range lands for livestock grazing. In their original condition the slopes and valleys, except in those arid parts where rainfall was very light, were well carpeted with valuable grasses and a small percentage of other herbaceous and shrubby plants. The decaying vegetable matter had built up the surface soil into a friable condition and added to it a large quantity of rich organic matter. The mulch of decaying vegetable matter acted as a sponge, and the friable humic character of the soil allowed a maximum moisture penetration. The result was that the more succulent forage plants made the most of the rainfall and the fertile soil and produced abundantly.

WHEN erosion removes six inches or more of the fertile topsoil, as it has done on large areas of such important watersheds as the foothills of the upper San Joaquin Valley, the mountains of central Utah, and the Boise River watershed of Idaho, the sterile subsoil remaining is incapable of producing the forage the land once supported. Years of careful management will be required to restore the soil and vegetation, yet this must be done if the abnormal erosion which is occurring is to be controlled. The importance of restoring a satisfactory cover may be appreciated when it is realized that for every acre of the 1,700,000-acre Boise River watershed there is a dependent value of farmland alone in the irrigated valley of this project amounting to 32 dollars.

Not only is there reduced productivity of range lands and excessive silting reservoirs, but the more rapid run-off from the depleted slopes, the greater quantities of silt carried, and the quicker concentration of high water from small drainages into flood crests present a watershed problem that may assume disastrous proportions. During the summer of 1930, Utah, for example, suffered from very severe floods. Whole slopes were excessively eroded. Great gullies were cut in the hillsides. Soil, rocks, and other forms of erosion débris from slopes and canyons were carried out into the valley to cover with a layer one to several feet deep orchard lands valued at 600 to 800 dollars an acre. Homes were swept away or filled with earth and rocks. It cost 100,000 dollars to open and repair the highways alone.

There is little question but that the depletion of the vegetation was one of the main factors in the severity of these floods. The report of the Governor's Special Flood Commission concludes that "there is ample evidence on the watersheds of Davis County to show that had the plant cover been approximately equal to its original natural condition, the flooding in that section from the rains of 1930 would have been far less serious, if not prevented."

The report brings out further that a study of the deposits at the mouths of canyons shows that "floods like those of 1923 and of 1930 have not been normal occurrences . . . in the past. . . . Their occurrence in recent years is to be looked for in changes from some previous condition. These changes are found in the plant cover."

Engineering works have been suggested for erosion control. These are important and will aid materially, especially large dams and channel control works in rivers, and small dams, settling basins, and other works in the tributaries. These works, however, will prove ineffective and of but temporary value unless the erosion and rapid run-off can be controlled by vegetation.

PLANTS not only lessen the force of rainfall but intercept part of it. Vegetation improves soil structure, allowing greater moisture penetration; it increases the water-holding capacity of the soil by increasing organic matter; it breaks the effect of wind; it binds the soil and lessens sheet erosion; it obstructs run-off and reduces the velocity of flow and thus the carrying power of the water; and by catching soil particles it tends to form miniature terraces on slopes and dams, and fills in small gullies. The more complete the plant cover, the more adequate is the protection against erosion.

Erosion-streamflow experiments on forest and range lands have indicated the value of this vegetation in controlling erosion.

In the Wagon Wheel Gap experiment in the mountains of Colorado, Bates and Henry report that the rapid clothing of the watershed, from which the aspen and other timber had been cut, with a dense stand of aspen sprouts and other shrubby and herbaceous vegetation, prevented any material erosion.

Studies by the Intermountain Forest and Range Experiment Station show that the serious erosion on the Boise River watershed in Idaho has been caused by depletion of the natural plant cover by overgrazing and drought, trampling by livestock, rodents and fire. Ungrazed, well-vegetated areas even on slopes with a gradient as high as 90 percent almost uniformly have a smooth, undisturbed, uneroded surface. Only 4 percent of the area densely covered with vegetation is eroding badly even when grazed. Most of the area scantily covered with vegetation shows severe sheet erosion and 20 percent is badly gullied.

A stump in the Roosevelt Reservoir at low stage, showing the deposit of silt left after the floods receded. Such silting endangers the efficacy of great irrigation projects

On an experimental watershed on the Wasatch Plateau in Utah where past overgrazing had depleted the vegetative cover until it occupied only about 16 percent of the surface, an average of eight to nine tons of soil was eroded annually from each acre between 1915 and 1920. Starting with the latter date effort was made to increase the plant cover as rapidly as possible by artificial and natural reseeding and since 1923 the watershed has supported an average cover of 40 percent. By comparing results with a check watershed, it was found that the increase in vegetation from a 16 percent cover to one of 40 percent brought about a 64 percent reduction in surface run-off from summer rains and a 54 percent reduction in sediment removed by these rain storms.

The 40 percent plant cover had no material influence on surface run-off from melted snow in the spring as compared to a 16 percent cover. On the average 56 percent of the available snow water supply ran off of the watershed in the years 1916, 1918, and 1919, and 60 percent of the snow water supply in the four years, 1926 to 1929, inclusive. The greater cover prevailing in the period since 1926, however, reduced sediment per acre washed off the watershed by 67 percent.

THESE Utah studies by the Intermountain Station show further that under extreme depletion of soil and plant cover it requires many years of careful management to restore the watershed values. They show that total exclusion of livestock from ranges is not necessary except where the plant cover has been almost eliminated and the fertile part of the soil carried away. They emphasize the essential need of effective regulation of grazing.

The erosion-streamflow problem is so important and yet so complicated throughout the West—and the entire country—that intensive studies of the problem in all its aspects should be undertaken on every major watershed. In view of the important part that vegetation plays in controlling erosion of our soils it is essential that research determine the best type of plant growth for the widely varying soil types and climatic conditions of the West, the influence of this vegetation on water supply, and how it may be restored and maintained most effectively. It is equally important to know more concretely the extent to which timber cutting and grazing can be allowed under each of the main timber, range, and watershed conditions in keeping with maximum protection to the soil.

An example of the effects of improper grazing in the West. After the hills were stripped of vegetation, destructive gullying and sheet erosion resulted

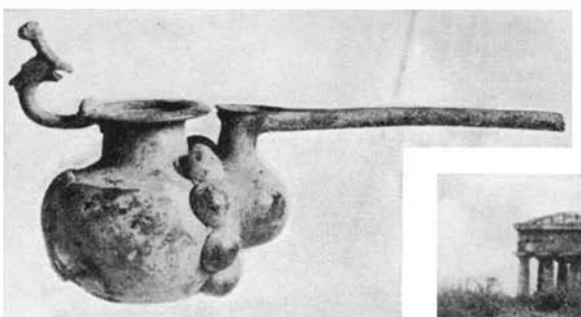
FROM THE ARCHEOLOGIST'S NOTE BOOK

Curious Lead Tablet

A SMALL lead relief in The Metropolitan Museum of Art is a document full of interest, for it apparently gives a picture of the liturgy used in a mystery religion which flourished among soldiers and civilians in the Danube Valley under the Roman Empire. In the second century of our era,

Lead relief, 2nd Century A.D., from Danube Valley, 3 by 4 inches

when this relief was produced, the Danube was an important frontier and loomed large in Imperial politics. These small votive tables have been found in the present Hungary, Servia, and Roumania. The creed evidently had as its central figure a Great Mother goddess. It combined Mithras—the Persian war god of the sun—with the Thracian Horseman Hero known to us by innumerable monuments of Imperial times.



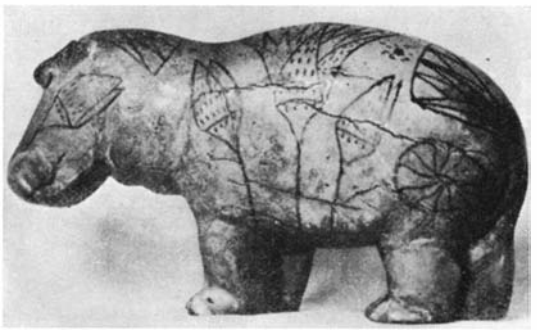
Bronze lamp from a grove in Luristan, west Persia, about 200 B.C.

Luristan Bronzes

MANY remarkable Luristan bronzes recently brought to light in the mountainous region of western Persia, near Bagdad, were loaned by the Boston Museum of Fine Arts to the Persian exhibition in London. They bear mute testimony of an early chapter in Persian history. Parallels to Sumerian, Assyrian, Hittite, and especially to Scythian and Siberian art appear and give rise to wide speculation as to the people and culture which produced them. Further investigation of them may throw valuable light on the origin, nature, and movement of early civilizations in western Asia.

The Luristan finds to date consist largely of grave furnishings—objects of personal adornment, tools, household utensils, weapons, chariot fittings, and horse trappings. They have come to light with "dramatic suddenness," not as the result of any organized archeological expedition but as accidental discoveries by local tribesmen. The province of Luristan is peopled by the Lurs, the most unruly of all the mountaineers of Persia. The bronzes exhibit a combination of naturalism and conventionalism, a vivid and sensitive realism embodied in a rigorous and ingenious idiom. But their historical importance outruns their beauty, for they constitute a long-sought linkage between the various early arts of western Asia.

Bridle bit from Luristan, 200 B.C.



A charming little hippopotamus in vari-colored faience from Egypt dated 1950 B.C.

A Benevolent Hippopotamus

THE Metropolitan Museum of Art has a charming faience figure known officially as "Hippopotamus with lotus flowers, birds and leaves, XII Dynasty, 1950 B.C.," but the color print of the original made such a hit with an English army officer that he dubbed him "William" and wrote a most amusing account of "William" as a counselor and friend in the London "Punch," which was so entertaining that the Bulletin of the Metropolitan Museum reproduced it in full. In color the Egyptian faience figure is a delicate blend of greens, blues, and yellows.

A Street of the Ages

PAESTUM with its three beautiful ruined temples is within a day's trip of Naples. The temples are the most imposing relics of Greek architecture on the Italian mainland and date from about 600 B.C. Excavations are now being carried on at Paestum and important results may be looked for. This is a part of Premier Mussolini's plan for archeological research.

Pavement of a street in Paestum, Italy, showing the temple of Neptune

ANALYZING "ARCHIE'S" SHOTS

By CAPT. ALBERT M. JACKSON and LIEUT. ROSWELL H. WARD
Coast Artillery Corps, U. S. Army — U. S. Army, Reserve

"ARCHIE," as the anti-aircraft gun was known during the war, has come into his own. Anti-aircraft defense forces are now a recognized and highly developed element in the armies of all nations. As outlined in previous articles in the SCIENTIFIC AMERICAN, the United States Army has been among the leaders in the development of guns and gun-control equipment, searchlights, and sound locators for defense against air raids. However, with the improvement in anti-aircraft guns, another difficult problem has arisen. How can we measure the effectiveness of anti-aircraft fire?

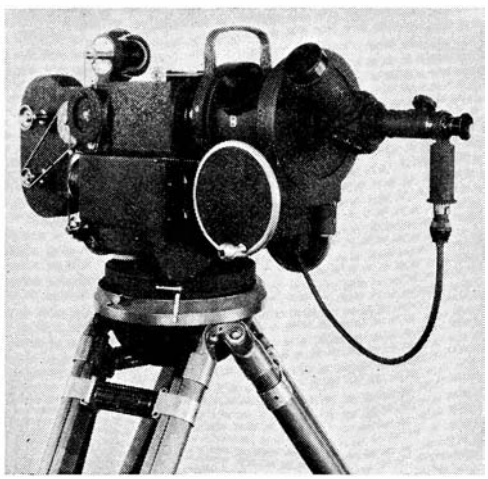
Consider for a moment the circumstances under which an anti-aircraft battery operates when conducting firing exercises in the field. A battery of four three-inch anti-aircraft guns can deliver a combined total of somewhat over 100 shots per minute. They are firing on a target towed behind an airplane at an altitude of from 2000 to 15,000 feet and a horizontal range of 12,000 feet. The target is traveling at the rate of 120 miles per hour.

AN observer watching such a battery in action has no more had time to get his glasses focused on the distant target than the firing begins and shell-bursts—minute and far distant puffs of smoke—begin to appear around the towed target. Almost before he realizes it the target has passed and the guns are silent. In an interval of one to four minutes, several hundred high explosive shells may have been thrown at the high-flying speck of white that is the "bull's eye" for the anti-aircraft gunner.

This split-second element in anti-aircraft practice is but a simulation of the conditions which might be anticipated in case of a military emergency. Enemy bombers, bent on raiding important military positions or supply centers, will fly high and fast, and every resource of the ordnance engineer is directed towards delivering the maximum volume of fire in the extremely short time available.

It has been estimated that from one to six minutes will be the average amount of time which a ground battery will have to fire on an airplane target. At night, firing by the aid of sound locators which direct searchlights on the target, the time available is even shorter.

With this imperative time element underlying every technical development made by the artillerist in his answer to the air raid challenge, the fire of the guns must not only be made as rapid and as accurate as possible, but special means must be employed to ascertain the effectiveness of the guns.

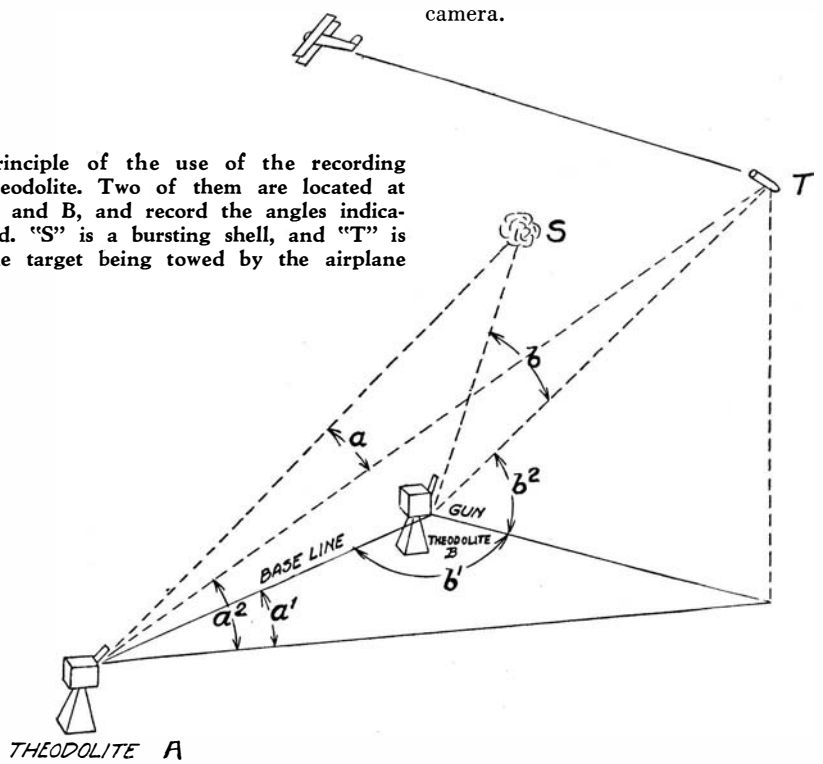


A close-up of the recording theodolite, showing eye-piece, controls, and camera

The sea-coast gunner or the field artilleryman can "spot" his shots direct or by airplane observation, but, in comparison with the anti-aircraft gunner, no other gunner, on land or at sea, has such a drastic time requirement to face. The anti-aircraft gunner is dealing with a target moving at high speed, and, above all, a target that moves in *three dimensions.* Studying the accuracy of fire on a ship at sea, or on a fixed target on the ground is comparatively simple in contrast to the problem presented when one must ascertain the effectiveness of gun fire at a high rate of fire, on a moving target capable of moving in three dimensions!

The Jackson-Sperry Recording Theodolite is the United States Army's answer to this problem. It utilizes the speed of the moving picture film to meet the rigid time requirements, and employs a method of "dual observation" to fix the position of the shell-burst in relation to the target in three dimensions.

A theodolite is basically an instrument for measuring angles. The familiar surveyor's transit is one form of theodolite. The recording theodolite is really an angle-measuring instrument combined with a moving picture camera.

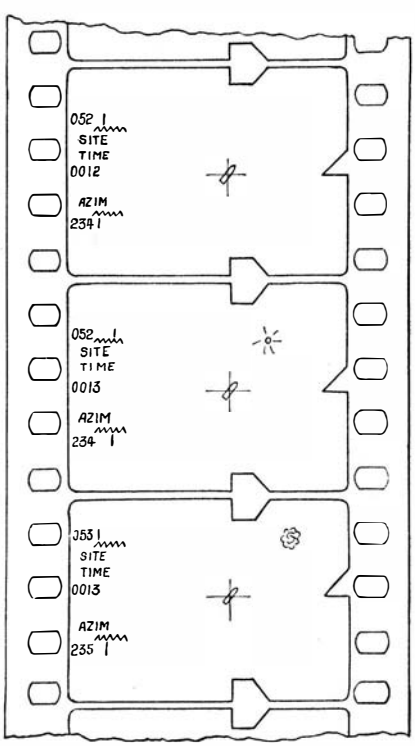


Principle of the use of the recording theodolite. Two of them are located at A and B, and record the angles indicated. "S" is a bursting shell, and "T" is the target being towed by the airplane

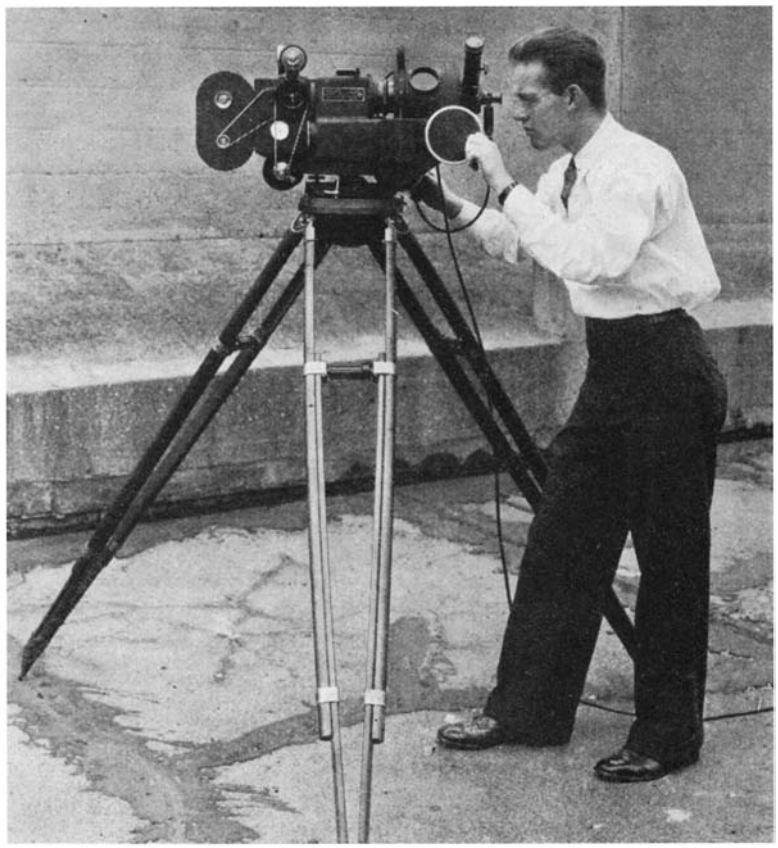
As shown in the accompanying illustrations, the theodolite is equipped with a view finder and training mechanism which an observer uses to keep the instrument trained on the target. This is the only use of the "human element" in the operation of the entire system.

As a "photographic-angle-measuring" instrument the theodolite must not only be constantly trained on the target, but it must also measure the angle of elevation and the angle of azimuth (direction in the horizontal plane) of the target. This measurement of angles is achieved by having two indicators built into the camera mechanism which photograph these angles on the margin of the film. The theodolite is trained so that the target is always in the center of the picture. In order to indicate the location of the target when it is not clearly shown on the film, two reference marks are provided, at the edge and at the top of each frame to indicate the center of the exposure.

AT the left of each frame the angle of site or of elevation, and the angle of azimuth are photographically recorded. It is also necessary to know the time when each exposure was made. An indicator connected with a time interval device photographs its time indication on the margin of each exposure. Thus every exposure gives the position of the target whether it is visible on the film or not; it gives the location of the shell-burst in relation to the target, and it gives the elevation and azimuth of the target, and the time of exposure.



Three frames of the record film. At the left is recorded elevation, azimuth, and time. Reference marks locate the position of the target



The recording theodolite in action. The operator is training it on the target by looking through the eye-piece and manipulating handwheels. The cable goes to the time interval device and the other theodolite

Two of these theodolites are used. One is located behind the gun position and the other at one flank of the battery. They are connected to a common time interval device which operates the time recorders in each instrument.

Both theodolites are put into operation as the shooting begins. The observers at each instrument concentrate their entire attention on keeping the target in the center of their field of vision. It is apparent that two records of every "shoot" will be available, one taken from the gun position and one from the flank position.

When these films are developed they are projected on a specially graduated screen. By the use of the graduations the angular displacement of the shell-burst from the target can be read off in two dimensions. Then when the film taken from the flank position is projected, the angular displacement can be read from the exposure which was taken at exactly the same time. (The time record permits these battery views and flank views to be matched in order to record the simultaneous observations from the two positions.)

When all of these angles have been obtained for the various "matched" exposures; the azimuth and elevation of each theodolite; the angular displacement of the shell-burst from the target; and with a known distance between the theodolites as a "base line," it is merely a routine geometrical problem for the gunnery officer to compute the accuracy of his fire. Space does not permit a complete explanation of this calculation. Suffice it to say, however, that the mathematical routine used is elementary in comparison with some of the mathematical problems encountered in other anti-aircraft development work!

BY the use of this system a permanent record of each firing is obtained; the record is not dependent for its accuracy on the human element; and it represents the only possible solution to the very difficult "scoring" problem which the intensive development of anti-aircraft equipment has presented.

Recording theodolites are used to determine the accuracy of guns firing on a towed target; to determine the "expectancy" of hitting a selected "point in space" (when guns and theodolite are trained on some predetermined point and a series of test shots are fired); to measure the trajectory of machine-gun tracer bullets; and for various other special uses.

It is thus apparent that it is not only necessary for our anti-aircraft defense forces to study the greatest possible refinement of the guns and gun control equipment alone, but it is also necessary, in working in these hitherto untrodden fields, to devise entirely new methods for assessing the value of the improvements which are constantly being made.

NEW AND EXOTIC DELIGHTS FOR OUR TABLE

By M. H. TALBOTT

A "cantaloup tree of the tropics," the papaya, with a fine cluster of delicious fruit

THANKS to the experiments of patient investigators, the people of this country are not going to eat the same things year in and year out. The Bureau of Plant Industry of the Department of Agriculture has supplied our agriculturists with many exotic varieties of fruits and vegetables, having gathered them from all parts of the world. These new foods which they have brought to us are a reality in many places and will soon be eaten not only in the large cities but throughout the country, and will replace certain others.

Visitors in the far South and in California are amazed to see their breakfast "cantaloup" picked from a tree. This is the papaya, resembling our popular cantaloup in appearance and taste, but somewhat richer and sweeter. Unlike the cantaloup, the papaya may be stewed, fried, baked, or creamed, if picked underripe, and fritters made of it are especially good. This strikingly picturesque tree, called "the cantaloup tree of the tropics" is straight and branchless with huge leaves clustered at the top, the fruit growing closely along the upper part of the trunk. The size of the fruit ranges from that of a large pear to 30 pounds in weight. The skin is thin, tender and smooth, and of delicious looking yellow. The flesh, too, is yellow and is from one to three inches thick.

The chayote, or vegetable pear, grows profusely on vines. Its texture is like that of the squash

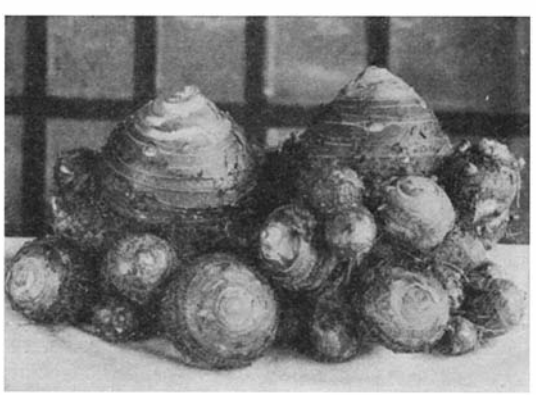
"THERE may be a better fruit than the mango, but if so the gods still guard it jealously and mortals do not miss it so long as they have a supply of mangoes, which far outshine the famed apples of the garden of the Hesperides" says a friend of mine of this delicious fruit which grows in the South. It has a texture between that of an apple and a peach, the flesh is a rich golden yellow, and the flavor a combination of apricot and pineapple. Most people acquire a fondness for this new fruit immediately whether they eat it fresh or stewed, or in dumplings, pies, jelly, preserves, or chutney. Unlike the orange and grapefruit, the mango is distinctly a summer fruit, and ripens from June to September. Experts say it will not be long until those seeking variety for jaded appetites will make many varieties of mango popular.

Don't pucker your mouth at the mention of a persimmon for the Japanese and Chinese varieties have no pucker. These are large, greenish-brown in color and have several seeds. They may be eaten when as hard as an apple; when they soften they are delectable as a breakfast fruit, and they are used in salads and, with sugar and cream, as a dessert. They may be purchased, wherever fine fruits are sold, from late summer until December. They range in size from a few ounces to a pound in weight.

The Orient has given us another attractive fruit in the loquat. This juicy fruit, about the size of a plum, with a taste resembling a cherry, varies in color from a banana-yellow to deep orange. The fruit, which ripens in spring and early summer, grows in large clusters upon an evergreen tree which is quite hardy and stands the cold of ordinary winters in the southern states and California.

As long ago as Biblical days the pomegranate has flourished around Jerusalem and has been a standard fruit down through the ages. However, it is now widely grown in the South, where it ripens in the late summer. It grows to the size of a large orange, though somewhat flat on top and bottom with an odd tubelike calyx crowning its leathery skin. It ranges in color from yellow to purple, with an attractive sub-acid, separate-celled pulp which is eaten raw or which can be made into a refreshing drink.

It is hoped soon to introduce to American housewives the mangosteen, a famous fruit in the Asiatic tropics, for it is gaining a foothold in this continent. It is the size of a mandarin orange, deep purple externally, with a thick woody rind within which are several segments of snow-white pulp of extremely delicate flavor. Because of its great delicacy and the difficulty in transporting the fruit long distances, Queen Victoria once offered a handsome reward to the first man who succeeded in placing mangosteens on her table at Buckingham Palace, but the reward was



Photographs courtesy Department of Agriculture, Bureau of Plant Industry

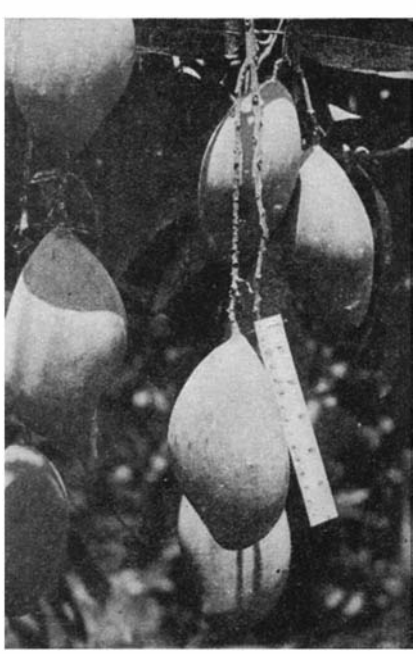
The dasheen, with a rich nutty flavor, has a higher food value than ordinary potatoes

never won. However, with the advent of refrigeration it has become possible to ship the fruit without great difficulty.

Uncle Sam not only brings us fruits from the distant corners of the earth but he is very busy creating them. Don't fail to try his new tangelos. This citrus fruit is a cross between the tangerine and grapefruit, and it is between these two fruits in size, with the tangerine's loose, easily detachable skin, and the grapefruit's bracing flavor. You can now eat a grapefruit as easily as a tangerine with the added virtue that it doesn't squirt. Another new variety of orange—a cross between an orange and a tangerine—has a thin, smooth, orange-colored, easily peeled skin, with a texture of pulp like that of an orange and the taste of a tangerine.

Have you eaten any chayotes, dasheens, udo, or bamboo shoots? In the garden of tomorrow they may be as common as our everyday vegetables.

ONE of these new vegetables, the chayote, sometimes called vegetable pear or mango squash, for centuries has been a staple food in Central American countries. In the last few years there has been increasing interest in growing it for home use and local markets in the lower South, but this year they will be shipped in carload lots to northern markets as well. It may be eaten boiled, mashed, fried, stuffed, or baked, used cold in many salads, in fritters, or made into sweet pickles. Unlike most squash this vegetable holds its form perfectly after being cooked. Its flavor is delicate, with both a cucumber and squash resemblance, although some aver its taste is similar to stewed oysters. It fruits in the fall, but has such remarkable keeping qualities that it is available as late as March.

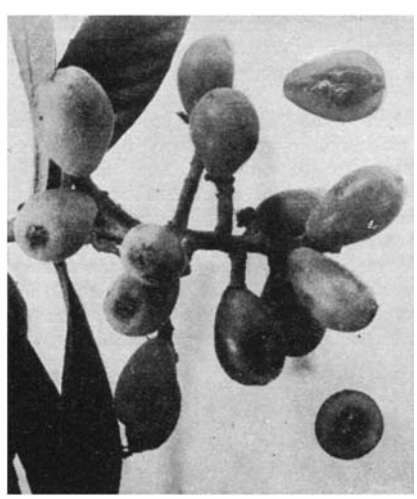


A six-inch rule shows the size of the mango, an excellent new fruit

A rival of the white potato is the dasheen, which looks like a cross between a large white potato and a sugar beet. It has a higher food value than the former, containing 50 percent more protein and a like higher percentage of starch. It has a more tempting flavor than white potatoes. The flesh of the

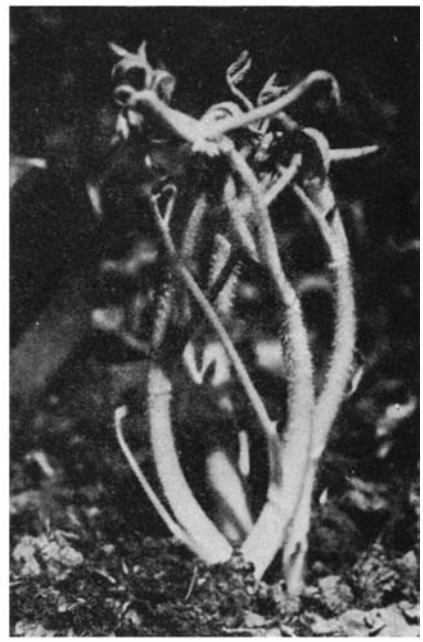
The chayote is so firm that it holds its form perfectly after cooking

large tubers when cooked is violet in color—which is pleasing to the hostess interested in color schemes—with a taste suggestive of boiled chestnuts. It can be served in any of the ways the ordinary potato is used and its nutty flavor makes it desirable as a stuffing for fowl and meat, for which purpose it is much used by southern cooks. It has proved no more difficult to keep in storage than the sweet potato. This vegetable is no longer an experiment; the industry has become established and the demand for it is rapidly increasing.



The loquat, from Japan. Two loquats are cut to show size of pits

Over in a corner of the garden of tomorrow it is more than likely that one will find some edible bamboo, for it is now being grown in parts of the South with considerable success. It comes to us from Japan. There are several varieties of these asparagus-like shoots; so fresh and tender are they that they can be snapped off with the hand, and when cooked they form one of the greatest vegetable delicacies in the world. If you cannot wait until you find them in your garden, they can now be bought canned in almost any



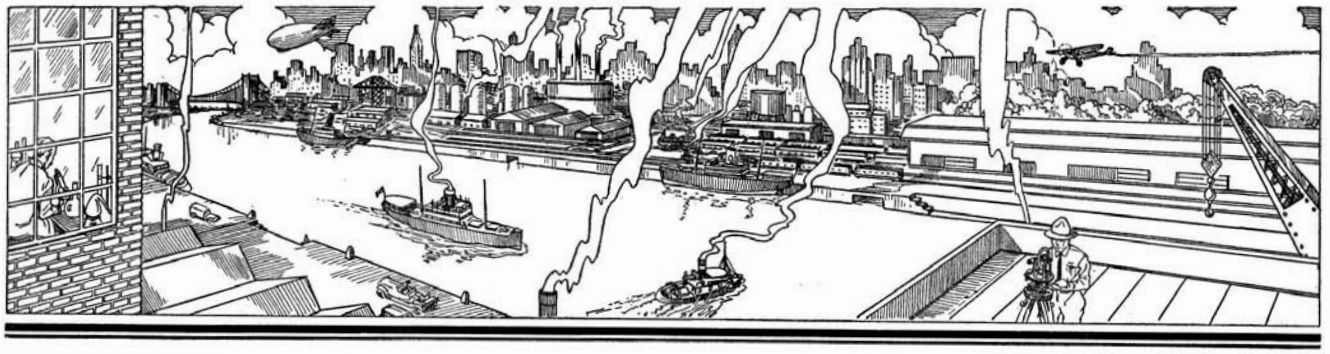
Udo, a Japanese vegetable which is delicious cooked or in salad form

Chinese or Japanese store, as they are shipped here for the thousands of Chinese and Japanese residents of this country. Bamboo shoots can be cooked and served in many ways, but cooked in salted water and served on toast with a cream dressing they are delicious.

Some one has called cabbage the "great American dish," but there are many who, though liking its taste, will not use it owing to its unpleasant odor when cooking. Relief has been found for these by the Government experts who imported and started the cultivation of petsai, a cabbage which is entirely odorless and with a flavor far more delicate than that of our native vegetable.

THE traveler in Japan is familiar with an attractive blanched vegetable called udo, for it is very popular in that country. It has been found possible to grow it in a wide area in the United States. It is used in many ways in Japan, but whether cooked the same as asparagus or used as a salad, it deserves high rank among vegetables.

There are opportunities ahead for growers who have vision. Thirty-odd years ago when people tried that mysterious delicacy the grapefruit, it was as a rule with disappointing results, as they tried to eat it like an orange; now-a-days even in remote hamlets it is eaten in quantities. The potato, long established in favor with the people of many nationalities, traveled a thorny path to its present position of favor. Those who saw the possibilities of "love-apples," as tomatoes were first called, deserve a monument for persevering in raising this vitamin-filled vegetable; it is only a scant century since it was grown as an ornament and was thought to be poisonous.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

New Commercial Synthetic Rubber

THE development by E. I. du Pont de Nemours & Company of a new synthetic rubber was announced recently at a meeting of the Rubber Division of the American Chemical Society.

Stripped of the technical terms in which the chemists who participated in the development announced this long step toward the solution of the world's rubber problem, it was disclosed that the primary raw material for the new synthetic rubber is acetylene, which requires for its production only coal and limestone. The only other raw materials are salt and water. All of the materials are available in unlimited quantities.

The announcement of what is regarded as one of the outstanding chemical discoveries of the century was made in papers, highly technical in character, presented by F. B. Downing, W. H. Carothers, and Ira Williams. The papers revealed that the new synthetic rubber is made by the controlled polymerization of chloroprene. Chloroprene is made by the catalytic polymerization of acetylene to mono-vinylacetylene, which is then treated with hydrogen chloride to produce chloroprene. This chemical result has led to the selection of "Duprene" as the trade name for the new rubber.

Simple as the process sounds, it has required the concentrated efforts of more than a score of chemists over a period of several years to find the proper conditions for bringing together these abundant raw materials to produce the synthetic rubber.

The new rubber, according to the announcement, has many commercially valuable qualities which will supplement the present uses of natural rubber, since there are certain important differences in the properties of this new product as compared with the natural product. While it has not yet advanced to a point where it can be substituted for natural rubber in its wider range of everyday use, those who have been active in its development feel that further effort may greatly enlarge its field of usefulness.

Among the valuable properties of the new product set forth in the announcements is the fact that it is much more resistant than natural rubber to the swelling action of gasoline, kerosene, and other solvents that are notoriously harmful to rubber. It is also more resistant to oxygen, ozone, and many chemicals that attack rubber.

One of the most interesting features of the new rubber is that it is vulcanized by the application of heat alone, whereas it is necessary to add sulfur in order to vulcanize natural rubber. Another important disclosure was that an artificial latex can be made from chloroprene. The artificial latex is a milk-like liquid consisting of particles of fully vulcanized synthetic rubber suspended in water. Upon drying, a sheet of fully vulcanized rubber is obtained. The Duprene latex differs radically from natural latex because of its increased penetrating power which makes possible the impregnation of many porous materials that cannot be impregnated with natural rubber latex.

Many other significant properties of the new synthetic rubber were disclosed, including the fact that its X-ray diagram is similar to that of natural rubber, showing that it has the same type of molecular structure. Synthetic rubbers have been produced before by many of the scientists who have devoted their attention to this important branch of chemical research, but so far as is known none of these products has given the same type of X-ray diagram as natural rubber and none of them has equalled it in physical properties.

Iron Soft as Copper

HIGHLY purified iron, possessing many of the qualities of copper, has been prepared in Germany by a new process described recently by Dr. L. Schlecht. Carbon monoxide of a high degree of purity is passed over hot iron previously purified by ordinary methods, forming liquid iron carbonyl. On heating this liquid, carbon and oxygen are driven off, leaving iron in an exceedingly finely powdered form with hardly a trace of impurities. The individual spherical particles are 20-millionths of an inch in diameter. When this powder is heated still further to a temperature of 1200 degrees Centigrade, it changes into solid iron that resembles copper in its softness, resistance to corrosion, and other properties. The process is declared to be applicable on a large scale.—*A. E. B.*

Mystery of Lath Marks Due to "Volley Ball Game"

UNSIGHTLY lath-marks, commonly seen on walls and ceilings and, until recently, as puzzling as mysterious finger-prints in a criminal case, have been explained at last. Dr. W. J. Hooper of

Pitch-black darkness, so far as the eye could see, enveloped this room while this photograph of 61 business men and bankers was taken in the new Kodak Research Laboratories. Actually, the room was flooded with invisible infra-red rays from 16 1000-watt lamps, the light from which was filtered so that none but the infra-red rays passed into the room. The exposure was one second

Battle Creek College, in co-operation with the Wood Conversion Company, has just completed a series of interesting tests which not only show the cause of the marks but also point to a way of preventing them. Oddly enough, the remedy remains hidden in the walls but it affects the visible areas of lath and plaster rooms.

The experiments, conducted on sample walls, showed that the marks were due, not to porosity of the plaster, to electrical phenomena, gravitational, or other commonly mentioned causes but to a difference in temperature of the surfaces involved and to a sort of "volley ball game" that goes on among the air molecules, played with the tiny dust particles that cause the marks.

Here is what happens, Dr. Hooper's tests revealed, to produce the unsightly marks that sometimes expose the anatomy of a wall or ceiling almost as clearly as would an X-ray photograph.

As air, carrying the dust particles, passes over the surfaces, it comes in contact with areas of different temperature. These differences are present because plaster and wood have different values as heat conductors, plaster being a better conductor than wood. Years ago, it was discovered that a hot body seemingly repels dust, whereas dust will deposit itself freely on a cold body.

That is what occurs on a wall or ceiling of plaster and lath and Dr. Hooper's explanation is this: "The air molecules," he says, "are the players and are constantly striking the suspended dust particles which are driven about the atmosphere as a result of this bombardment in a sort of volley ball game. Next to a relatively warm wall surface, the players are very active and they play more energetically than the slow, sluggish players next to the cooler surfaces. One would naturally expect the more alert players to be the more efficient in keeping the ball off their court—and so they are!

"In this game of molecules, the volley ball dust particles most frequently lodge where the cooler and more inactive team is less effective in driving them back."

In conducting the tests, a portable section of a wood and plaster wall was constructed, the upper surface covered with wall paper. A smudge was produced by a smoking kerosene lamp. At first no lath marks appeared. Then the windows in the laboratory were opened so that a draft of cold air could circulate underneath the sample wall. The lath marks quickly formed. A result had been produced but its cause was still a mystery!

A draft of heated air was introduced instead of cold air. A remarkable change took place. The marks appeared but in a totally different position. The streaks of soot were deposited directly over the lath instead of between them as is the usual case in a dwelling. This pointed to the real cause of the mystery. Half the section was exposed to hot air and half to cold. The section exposed to the hot air was marked with streaks directly over the lath but in the other half, the marks appeared between the lath.

The mystery was solved. Due to the principle that a warm body seemingly repels dust marks whereas a cool one attracts the deposit of dust, the soot was deposited over the lath in the hot air section because the lath areas, being poor conductors of heat, remained cooler than the other areas. In the other case, the plaster between the lath was cooler and hence, was marked, because the lath areas, due to their relatively poor conductive quality, remained warmer.

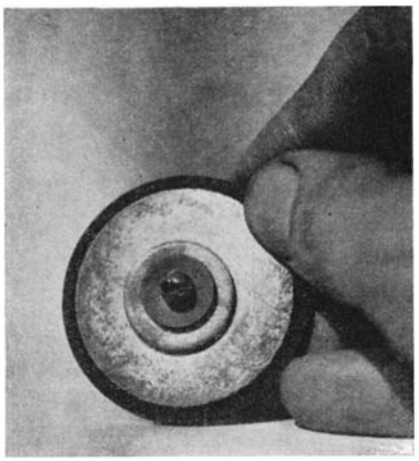
Having thus solved the problem of the appearance of the marks, Dr. Hooper then sought a way to prevent them from forming. A sample wall, similar to that of a dwelling, was built but with its inner space divided into two equal compartments. Into one of the divisions, a one-inch layer of Balsam-Wool, wood fiber between asphalt-coated paper covers, was installed to form an insulating blanket. The other space was left empty. During the ensuing experiments, the air next to the clapboards on the outside of the wall was kept at a constant temperature of approximately zero degrees, Fahrenheit, while the soot-laden air within the smoke chamber next to the wall paper was kept at about 80 degrees, Fahrenheit.

It was interesting to observe that the section which was insulated with the Balsam-Wool was practically free from the lath marks, while the other untreated compartment was prominently figured with them. Lath marks, it was thus clearly demonstrated, indicate "thermal leaks." The heat passes out through those places most heavily covered with dust; in other words, they are the cold places, indicating a loss of heat from within.

"A dwelling in which lath marks make their appearance readily is one most likely to be poorly insulated," said Dr. Hooper. "This information should be of considerable value to anyone considering the building of a home with wood-lath and plaster walls."

Free Electricity From the Sun

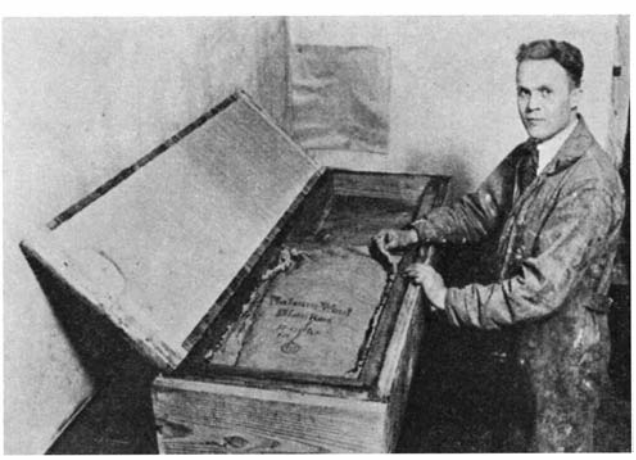
WITH a small disk developed in the laboratories of the Westinghouse Electric and Manufacturing Company, an electrical current is generated simply by exposure to light. The disk is of copper oxide and is about the size of a silver dollar. Possibility is seen that it may take the place of the photo-electric cell in some applications; but, unlike the latter device which requires an outside source of electrical current, the photo-voltaic cell generates its own current.



The small disk which generates electricity when exposed to the sun

Built into a meter as a self-contained unit, the device would serve admirably as a direct indicator of light intensity. Such a meter has been produced by Dr. E. D. Wilson of the Westinghouse Research Laboratories, Forest Hills, near Pittsburgh, Pennsylvania, but it is not yet commercial. In the movie studio or portrait studio the instrument would be an infallible monitor of illumination levels. In schools and other public buildings or in factories rapid check could be made of the adequacy of lighting conditions.

Dr. Bruno Lange, of Berlin, has conducted extensive experiments with copper oxide discs and has obtained somewhat similar results. It has been reported that



How insulation helps preserve cleanliness of wall surfaces. On the wall section at left, insulated by one-inch layer of Balsam-Wool, the dirt accumulations are almost negligible

Reducing the intensity of "lath marks" by installing Balsam-Wool insulation in the inner wall space. The wall section at left was insulated; that at right uninsulated

Probably the nearest the new Navy airship *Akron* will ever come to mooring at the mast of the Empire State Building in New York: a snapshot taken from the windows of our editorial offices when the *Akron* made her first flight over the city. The airship is 785 feet long; the building 1248 feet high

by using silver selenide he has been able to increase the output of the cell as much as 100 times.

Tests so far conducted indicate that the power developed in this manner by the Westinghouse disk would be approximately one watt per square yard of oxidized copper exposed to the sunlight.

Interest in the device has been keen, not only because of the manner in which the instrument measures light intensity but also because of the manner in which it has stimulated the attention of engineers in their search for a method to develop current from the rays of the sun.

The "Akron's" Passenger Record

EARLY in November, the new naval airship *Akron*, having successfully passed its acceptance trials and having been accepted by the Navy, made its first flight over New York in company with the *Los Angeles*. The air was somewhat gusty but she sailed smoothly over the city under perfect control.

On the following day, the new monster of the skies went aloft from Lakehurst and made a 500-mile flight with a larger number of passengers aboard than has ever before been carried by any aircraft. A total of 207 persons, including a crew of 66, carried on this flight, overtopped for the first time the record of 169 persons carried by the German flying boat *DO-X* at Lake Constance two years ago.

Phosphorus Smoke Screens

DESPITE the number of materials used during the World War to produce smoke screens and the many others that have been tested since then, the most efficient discovered so far, from the standpoint of its screening power, is phosphorus, B. G. Macintire of Edgewood Arsenal, Maryland, declared in a recent issue of *Chemical and Metallurgical Engineering*. Burned in an excess of air, it produces P_2O_5 which quickly combines with moisture in the atmosphere under conditions of high relative humidity, to produce solutions of phosphoric acid.

A method for producing a smoke screen quickly and efficiently over a wide front is shown in the illustration. It consists in distributing liquid phosphorus on the ground at a uniform rate from a container attached to some type of motor vehicle in rapid motion. The closed container, in which the white phosphorus is placed, is provided with an outer jacket around the sides and bottom, an air vent on top, and a discharge pipe in the bottom. After placing the white phosphorus in the container, it is brought to the molten condition by passing the exhaust from the motor vehicle into the jacket. When molten, it is released from the tank and allowed to flow onto the ground while the motor vehicle is in motion. As the molten phosphorus comes in contact with air, it fires instantaneously.

—*A. E. B.*

New Test for Pregnancy

THE fact that the pituitary gland empties an excessive amount of its hormone into the blood within a few days after conception is the basis for a test for pregnancy which has recently been proved accurate by the following investigators: Dr. M. H. Friedman of the University of Pennsylvania; Dr. H. L. Reinhart and Dr. Ernest Scott of Ohio State University; Dr. P. F. Schneider of Northwestern University; and Dr. T. B. Magath and Dr. L. M. Randall of The Mayo Clinic.

The test, known as the Aschheim-Zondek test because it was devised by Dr. S. Aschheim and Dr. B. Zondek, of Germany, is of extreme medical importance and may be a life-saving measure for the patient.

With the over-production that is characteristic of natural processes having to do with reproduction, more of the pituitary gland's hormone is made at this time than the body needs. All of it is carried about the body in the blood stream and as the blood passes through the kidneys the excess amount of the hormone is filtered out and passes from the body in the secretion of the kidneys. If some of this secretion is injected into non-pregnant female experimental animals, a detectable change in the ovaries of the animals takes place.

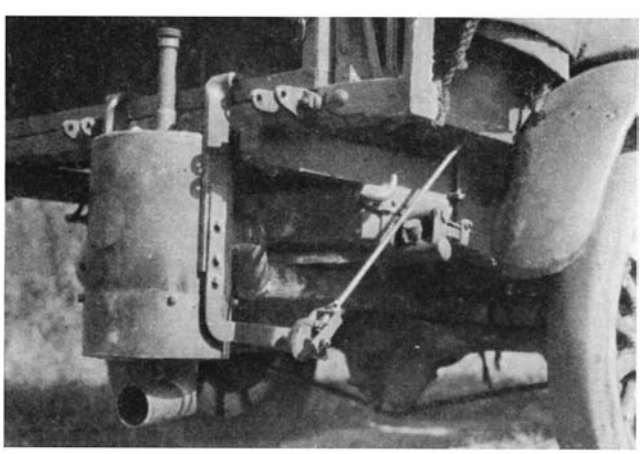
There are some diseases which may make women incapable of standing the added strain of pregnancy. If in such a case there is a possibility that conception has taken place, it is of first importance that the fact be known as soon as possible. The Aschheim-Zondek test gives this information earlier than any other method. The test is also valuable for distinguishing at an early stage between pregnancy and tumors or growths which may be dangerous and require immediate removal. There are a number of other uses of the test which, conscientiously applied, rob the function of reproduction of some of its dangers.

The search for a test of pregnancy has continued for 4000 years. Drs. Aschheim and Zondek discovered a curious record of a pregnancy test in an Egyptian papyrus. —*Science Service.*

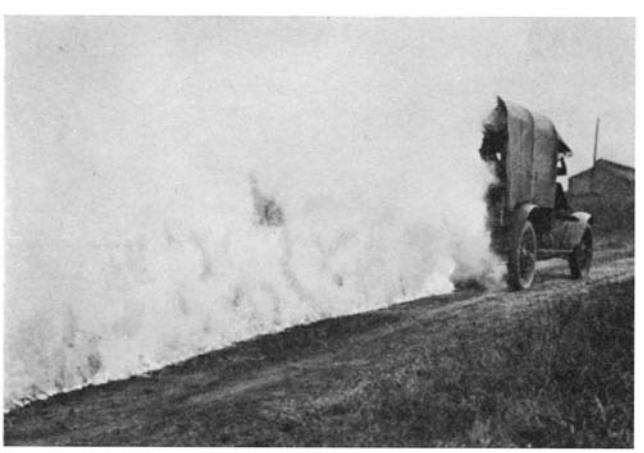
Raw Coal a Wasteful Fuel

ACCORDING to Dr. E. F. Armstrong, a British authority on fuels, 72 percent of the sulfur in coal goes up the chimney as sulfuric acid. He estimates that the alarming figure of three to four million tons of acid is discharged annually from domestic fires alone together with a half-million tons of coal-tar, the two products having a round value of 400,000,000 dollars per annum.

Dr. Armstrong, visualizes for the future "Gas, electricity, carbonizing plant, coke oven—all located together, working in harmony with the object of producing electric-



The phosphorus container on the rear of an army truck. The phosphorus is liquefied by the heat of the exhaust



Laying a flaming phosphorus smoke screen from a specially equipped truck at Edgewood Arsenal, Maryland

ity for power, gas for heating, and either for lighting. No raw coal to be burned in the towns; coke or char to be supplied for industrial heating. The factory making motor spirit, tar and its derivatives, ammonia, and the simpler organic compounds. The sulfur retained at the factory and converted into sulfuric acid. Our cities will be cleaner, healthier, happier; our utilities cheaper, more helpful, more popular; coal will be used to its greatest advantage."
—*A. E. B.*

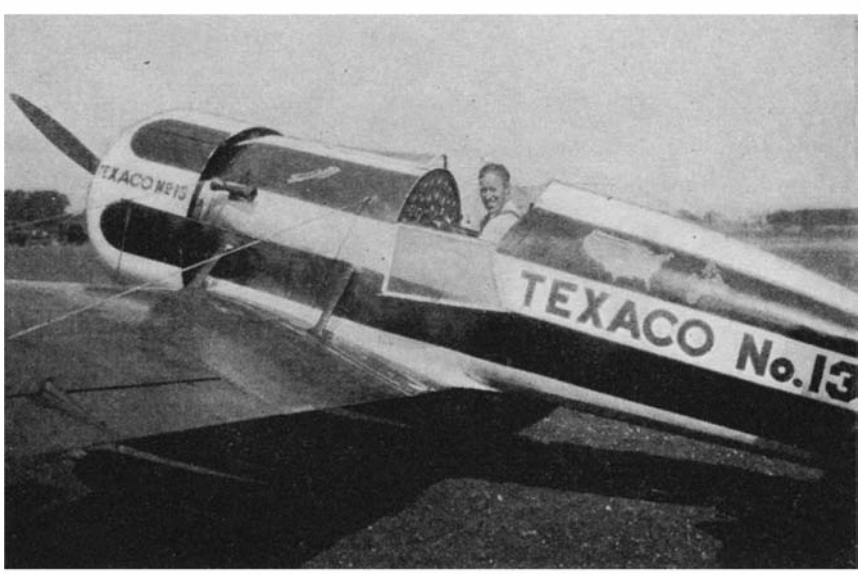
Microscope Reveals Skill of Ancient Egyptian Brewers

THAT the ancient Egyptians knew the art of brewing beer is proved by the expert use of a microscope by a German chemist who has examined the ancient beer jugs taken from Egyptian tombs. Strength of the long-ago beer was shown by remaining starch grains, revealed by the powerful microscope. The water used could be identified because it had left fragments of water weeds from the Nile. The microscope proved that the Egyptian brewers were careful to use the same kind of yeast. And one bottle of beer had gone sour, as was proved by skins of vinegar eels under the microscope.—*A. E. B.*

Air Records

THE accompanying photograph shows Captain Frank M. Hawks, Aeronautical Advisor of the Texaco Company, while on a recent visit to the Aeronautical Department of the General Electric Company. Hawks continually flies his Texaco 13, a Travelair Mystery ship equipped with a Wright Whirlwind 400-horsepower engine, and distance has ceased to have significance for him.

He has broken many cross-country records both in America and Europe. We can cite but a few: New York to Los Angeles, 2510 miles in 14 hours 30 minutes; New York to Havana, 1403 miles in 8 hours 8 minutes; and London to Berlin, 620 miles in 2 hours 57 minutes. Some of Hawks's records have already been broken by others. It may be argued that these records have little value. On the contrary they point the way for increase in speed of the regular airlines. The speed of the Mystery ship is due to high power, the complete venturi cowl around the engine, spats on the wheels, and but a few streamlined wires for all the wing bracing.—*A. K.*



Captain Frank M. Hawks who has broken many cross-country records both here and in Europe in his Travelair Mystery ship powered by a 400-horsepower engine

Modern Aviation Fuels

MAJOR James H. Doolittle, winner of the Harmon Trophy for his blind-flying achievements, another who holds today many records in the aviation field, spends much of his time in the laboratory when not flying and has a deep knowledge of the remarkable fuels which have to be used in the modern aviation engine. The aircraft engine has increased tremendously in power for a given weight by better mechanical design, by increased compression ratios, and by more powerful supercharging.

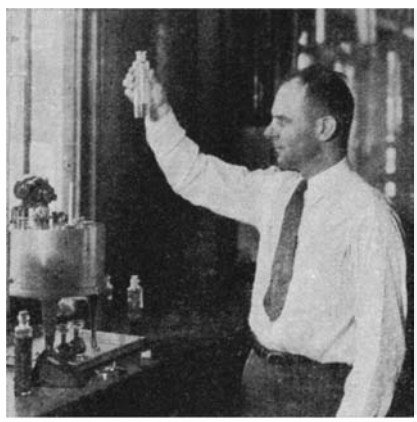
This increase in power-plant efficiency has involved no reduction in reliability, provided the proper fuel is used. Only in recent years has an attempt been made to measure accurately the anti-knock properties of a fuel and to incorporate this anti-knock quality in recognized fuel specifications. It is this increased knowledge and the elimination of fuels with unsatisfactory knock ratings that enables modern engines to stand up in their grueling service.

It is a fact that in spite of the large supplies of crude petroleum available, there is a scarcity of the particular crudes required in making a special aviation gasoline. If all the desirable crudes, from every state in the country, were turned over to the aviation industry there would still not be enough of such crudes to supply the 20,000,000 or more gallons of special gas used in airplanes in the United States per annum.

The use of tetra-ethyl lead appears to be a necessary evil. A little of this chemical added to a good gasoline will greatly improve its knock rating. A great deal added to a fuel with poor knock rating will not help very much.

Apparently, it is hopeless to use straight gasoline. The maker must take a good gasoline, and then build it up by various cunning artifices of chemistry until it meets the following flight requirements:

1, Fuel must have a high knock rating—must run a high-compression supercharged engine without detonation. 2, It must give good distribution, accelerate rapidly, run economically, and not overheat the engine. 3, It must give easy starting characteristics, especially in cold weather. 4, It must have low vapor pressure—that is, have no tendency to form gas locks in the fuel lines, carburetor, or tanks. 5, It must be stable



Major Doolittle, holder of many flight records, in his fuel laboratory

and retain its characteristics even after long storage. 6, It must be free from sulfur in order to eliminate corrosion and odor. 7, It must be free from gum to avoid sticking valves or deposits in the induction system.

The large oil companies are spending much money, time, and technical effort in providing this ideal aviation gas. After they are through, perhaps they will also condescend to give the ordinary motorist a similar luxury in his fuel!—*A. K.*

"Civil Aeronautics in the United States"

UNDER the above title the Department of Commerce has published a comprehensive and authoritative survey of commercial flying in the United States, which is most interesting and encouraging.

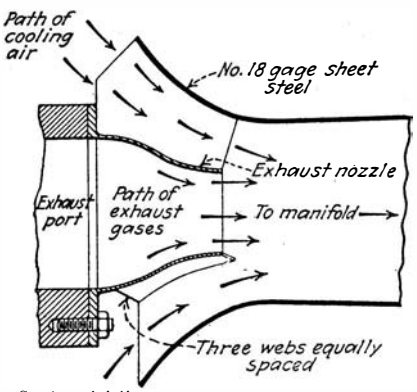
At the present time, the aeronautics industry really means the aviation industry. Balloons and airships were flown successfully long before the airplane appeared, but their development has been mainly on military and naval lines. With the advent of the *Akron*, hopes of a transatlantic airship service have again been revived, but at the present moment there are only a few commercial airships flying in the United States. These are small craft of the non-rigid type, used primarily for demonstration and advertising purposes.

This limited use of the commercial airship is in marked contrast to the extensive use of the airplane for carrying mail, passengers, and express, and in such miscellaneous operations as aerial photography, crop dusting, flying instruction, and so on.

In its adolescence, prior to the war, flying was largely a matter of exhibition or stunt work. A sign of maturity was the inauguration of the first airmail line on May 15, 1918. Through modest beginnings and surviving many vicissitudes, the airmail system has now grown to vast proportions. The scope of the airmail system as now constituted may be gleaned from the fact that on July 1, 1931, there were 42,986 miles of mail airways. The daily average of flying

miles scheduled for United States contract mail was 94,049 and this was carried on 58 domestic routes and 15 routes to Canada and Central and South America. American commerce and industry recognize fully the saving to be effected by flying their mail. From the standpoint of interest alone, these savings represent a very substantial figure. The estimate has been made that 24,000,000 dollars in the form of bank clearings, remittances, and negotiable securities arrive daily in New York City by airmail.

In the matter of passenger air transport we lagged behind Europe for many years. The first regular passenger service in the United States was not available until 1926.



Courtesy *Aviation*

The N.A.C.A. ejector type manifold

In that year 5782 passengers were carried, mostly on the west coast and in Florida. This was a very small number, about one twentieth of the figure for air passenger travel in Europe at that time. Since that year growth has been both steady and rapid. In the six months from January to June, 1930, 208,357 passengers were carried over regular routes, and there are now 98 passenger routes in operation.

The average fare in 1926 was 12 cents a mile. It subsequently dropped to 10.6 cents a mile, then went back to 12 cents. In 1930 it dropped to 8.3 cents a mile, approximately the same figure as for the best rail and Pullman accommodations. The low fares accomplished their purpose of introducing flying to the public, and they have now been raised until they are again a trifle higher than the tariffs charged for rail plus Pullman. Considering the time element, so important for the business man, there is no doubt that air travel is by far the cheapest form of transportation.

At the same time schedules have been greatly improved, and in some cases departures at 15-minute and hourly intervals are available.

Planes have become more and more comfortable, even luxurious.

Arrangements have also been made by several air-transport operators for handling air express upon a basis similar to that in effect for railroad express. The ground organization for this system is supplemented by a railroad express agency, which collects packages from the senders, dispatches them over the airlines, and delivers them to the address of their destination. While the development of air express has been less rapid than that of other services, 2,869,255 pounds of express matter were carried in 1930.

The Department of Commerce insists on the infinite possibilities of air express, and suggests a large list of articles that may be profitably sent by air. This list includes jewelry, cut flowers, fancy fruits, vegetables, meats, delicacies, newspapers, motion picture films, and so on. Dry ice used for refrigeration is proving increasingly useful, and has been employed for delivering fish from Mexico to New York City!

Perhaps the best visual idea of the extent of the air services may be obtained from the map reproduced on page 24 of this issue. —*A. K.*

Cooling the Exhaust Manifold

MOST fires following crashes originate from the spilling of gasoline or oil on the hot engine manifolds. After a long series of tests, the N.A.C.A. has produced an ejector type of manifold, in which the temperature is lowered below the ignition point of gasoline.

Each exhaust port of the engine discharges into a special nozzle, which narrows considerably at its end. The exhaust gases leave the end of the nozzle at great speed, and therefore suck in quantities of cool air through the annular opening surrounding the exhaust nozzle.

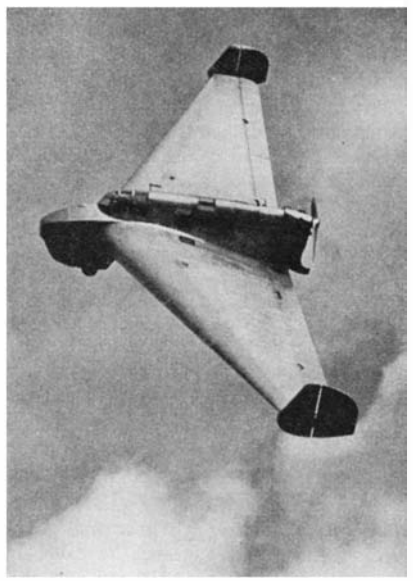
In tests on a Fairchild airplane, the maximum temperature of the manifold was lowered as much as 200 to 400 degrees Fahrenheit by the application of the ejector type manifold, while the performance of the airplane was not materially affected. Our sketch (which we owe to the courtesy of *Aviation*) shows the apparatus diagramatically.

This simple device is likely to be quite useful.—*A. K.*

A Tail-less Airplane

A GERMAN designer of note, Herr Lippisch, has developed a "tail-less" airplane which has shown excellent flying qualities at the Tempelhof Airport in Berlin. While the idea is by no means novel (similar machines were built by Burgess and Dunne in the United States some 15 years ago, and by Captain Hill in England just a few years ago) this newest embodiment of the "tail-less" idea is extremely neat.

The purpose of the tail-less airplane is of course to reduce the plane to its simplest possible form, lessen its cost and thus make flying more generally possible.



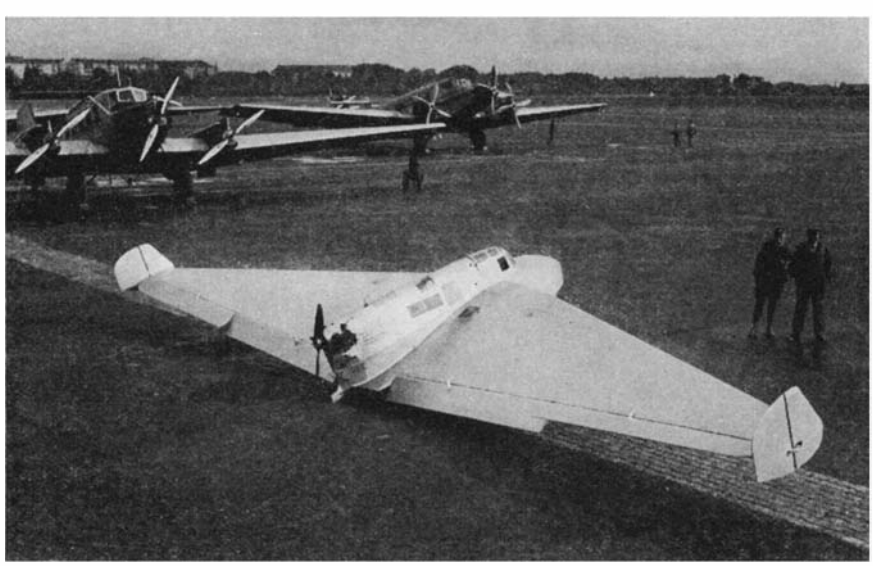
The "Nurflügel" in flight

Instead of the conventional fuselage, there is a well streamlined nacelle, mounted on top of the cantilever or internally braced wing. This nacelle projects out in front, and contains two seats one arranged behind the other, the front seat being provided with controls of the usual type. Plenty of celluloid window space at the front end of the nacelle gives the pilot excellent vision. Hinged cockpit hoods are provided, and some of the side panels are arranged to slide in their frames. A two-cylinder, 30 horsepower Bristol Cherub engine is placed at the rear, so that the machine is a "pusher."

The under-carriage consists of three independently mounted wheels with balloon tires. There are two wheels under the wing, one on each side of the nacelle enclosed in a streamline casing secured to the wing. The small front wheel is also enclosed in a streamlined casing. The cantilever wing and details such as the enclosing of the wheels give the "Nurflügel" (literally, "a wing only") a wonderfully clean and streamlined appearance.

The main interest of the machine lies,

(*Please turn to page* 51)



This newest tail-less airplane is small and striking in appearance

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REG. TRADEMARK
puts *speed* in industry

Masonite Presdwood, the all-wood grainless board, grew up with the machine age—with the crash of presses, the whir of planers, the bite of drills. It thrives on the rushing speed of modern production methods... saves precious minutes on every operation... never slows up the production line. Works equally well with hand tools. Never splits in nailing close to the edge.

Everywhere they're used, these modern industrial boards, rigidly graded at the mill, cut labor and material costs, eliminate waste and rejections. For making good products better, nothing compares to Presdwood—for steel-plate strength, durability, imperviousness to moisture, and easy workability. It comes in lengths up to 12 feet, or cut to your specifications. Smooth in finish; rich brown in color. Apply lacquer, enamel, paint, stain, varnish—any finish you please.

A sample of Presdwood sufficiently large for testing will be sent on request. Also the Presdwood booklet telling the story of its manufacture and listing 80 of its uses.

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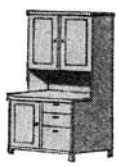
QUARTRBOARD · *Cushioned* FLOORING
"Made in Mississippi"

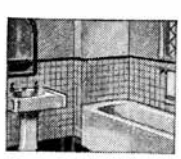
"Made of Presdwood"—brooders, brooder coops and other poultry equipment made by the Klein Manufacturing Co., Burlington, Iowa



McDougall Company, Frankfort, Ind., manufacturers of kitchen cabinets, depend on Presdwood for the cabinet backs

The Grand Rapids Store Equipment Co., Grand Rapids, Mich., are enthusiastic over Presdwood. They use it for case backs

Ends of spools for silk thread, yarn and ribbon are made of Presdwood by the Apex Spool Co., Philadelphia



A pleasing moisture-resistant tile for bathrooms, lavatories, etc., is being manufactured from Presdwood by the Tylac Company of Monticello, Ill.

Incubators made of Presdwood by the Advance Manufacturing Co., Springfield, Mo., have won much favorable comment

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THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

MANY an amateur telescope maker has reluctantly given up the intriguing idea of using the superior Pyrex disks for his telescope mirror, because they cost so much. Here, however, is a hint that came in an informal note from Russell W. Porter, who writes: "Kirth says he's read of a German who made a mirror on the bottom of a Pyrex pie plate and got a good figure, and the rim produced sufficient stiffness." What an idea! We haven't had a chance to try it out but we hope a lot of workers immediately will. A trip was made across the street to a store to look at Pyrex

Sergeant Stephens and his 8-inch

pie plates. They are good for about 7-, 8-, and 9-inch mirrors, and their cost is only a dollar or two. In roughing out, to save loss of thickness, we suggest a stroke with center of mirror above edge of tool, either straight across, around and around, or in epicycles. Who will be the "goat" to give this a trial? It sounds good. What percentage of these plates will hold their figure? Nobody knows. That is what must be found out by a few self-elected martyrs.

THREE more telescopes, and good ones at that, are described this month by their makers. Master-Sergeant T. J. Stephens of the Coast Artillery School Detachment at Fort Monroe, Virginia, writes: "Immediately after receipt of a copy of 'Amateur Telescope Making,' I developed a severe case of telescopeomania. I have completed two telescopes. Contrary to instructions, my first attempt was an 8-inch, which, after about three months of doubt, hesitancy, and many uncomplimentary remarks anent the characteristics of pitch, was finally completed, everything coming out just about as predicted by 'Amateur Telescope Making.'

"At that time I thought I was cured. But about nine months later the fever came on again. I tackled a 12-inch, hoping surely this would effect a permanent cure—but not so. Already the old familiar symptoms

Later the sergeant made a 12-inch

are showing up again and my case appears a hopeless one.

"With reference to the Ford parts mounting, in my opinion it is entirely too light for a telescope of this size. It works smoothly enough and, when there is no wind, is passably rigid, but not much of a breeze is needed to set the stars waltzing. The mounting, evidently, was considerably weakened by turning off the flange and the elimination of the brake parts, to allow for the slow-motion arrangement. Even with these parts retained, it is believed, it would not be sufficiently rigid to warrant recommending its use for a telescope of this size and weight—about 175 pounds supported by the polar axis."

If Sergeant Stephens' mounting is unsteady, its base ought not to be. This appears to be an old gun position at the fort, as shown in the photograph.

PAUL A. CHAMBERLAIN, 264 Falls Boulevard, North Tonawanda, New York, has combined the open tube and closed tube to neat advantage in an 8-inch telescope. Read what he says:

"For a mounting I found 3-inch pipe and fittings do very well. The grinding, polishing, figuring, and silvering went along just as mentioned in the book.

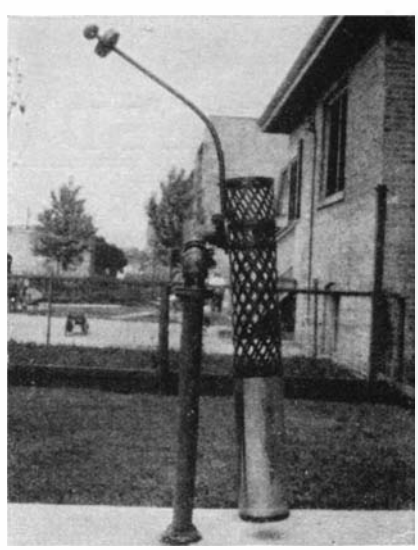
"I finished the telescope so quickly that I was disappointed—three months work at night. The work was very interesting. The optical performance of the telescope is most gratifying; the double-double system of Epsilon Lyrae is clear and discernible with the ¼-inch eyepiece.

"One picture shows the worms and gears for adjusting in right ascension and declination. The bearings on the pipe thread have been machined to a very close fit, for uniform and smooth action. This picture also gives an idea of how the eyepiece and small prism are mounted. The mounting is the Springfield type.

"The telescope is detachable from the stand which is fastened to the walk."

A NEAT 10-inch reflector is described by its maker, N. E. Bucklin, 2700 Catherine Street, Dallas, Texas, who says he is making another. "I was at it three or four years before 'Amateur Telescope Making' was published, but I never did get to first base until I had that book. Information certainly was hard to get.

"The telescope is now used as a Newtonian, with eyepiece at the upper end of



Paul A. Chamberlain's half-and-half reflector with 8-inch mirror

the tube, not shown in the pictures. The eyepiece jacket at the lower end of the tube is for a future Cassegrainian set-up, there being an extra diagonal mirror support just above the main mirror, and the hyperboloidal convex mirror is to be placed in the Newtonian holder at the upper end of the tube, without altering its location.

"The main mirror is of 10-inch aperture, 77 inch focal length, and was parabolized to approximately three-fourths full correction. The definition exceeded hopes, standing the theoretical limit of magnification

CURRENT BULLETIN BRIEFS

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

How the Chemical Product Differs Economically (Reprint from *Chemical and Metallurgical Engineering*, July 1930) by Lawrence W. Bass deals particularly with the ratio of wages to value added by manufacture in various industries. *Mellon Institute, Pittsburgh, Pa.—Gratis.*

Biennial Survey of Education in the United States 1928-1930 (Bulletin No. 20, Office of Education, U. S. Department of the Interior) deals with engineering education and gives condensed information on the whole subject. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Control of Airplanes at Low Speeds by Means of Conventional Ailerons (Aeronautics Bulletin No. 15) describes certain wind-tunnel studies of the standard type of lateral control of airplanes in relation to safety. *Aeronautics Branch, U. S. Department of Commerce, Washington, D. C.—Gratis.*

Textile Research at Mellon Institute (Reprint from *Textile World*) by Lawrence W. Bass shows how small an amount is being invested by this industry in research and indicates some of the outstanding results of research in this field. *Mellon Institute of Industrial Research, Pittsburgh, Pa.—Gratis.*

Reports of Excavations at Jemdet Nasr, Iraq (Anthropology Memoirs, Vol. I. No. 3) by Ernest Mackey describes some of the results of excavations by the Field Museum-Oxford University Joint Expedition, with particular reference to pottery tools and implements. *Field Museum of Natural History, Chicago, Ill.—$2.00.*

Wrought Steel Pipe deals with the process of manufacture of butt weld pipe, lap weld pipe, and electric weld pipe. Full tables are provided as well as advice on the care of pipe, casing, tubing, and drill pipe. *Republic Steel Corporation, Youngstown, Ohio—Gratis.*

Treatment of Water for Ice Manufacture (Bulletin No. 219) by Dana Burks, Jr., gives a report of an investigation conducted by the Engineering Experiment Station and the Utilities Research Commission. The industry is composed of manufacturing units operating independently and locally. We learn one interesting fact that is not concerned with the water. A ton of coal burned in a steam driven ice-plant produces four to six tons of ice while the same fuel consumed in a power station for ice-plant consumption will make from 15 to 18 tons of ice. *Engineering Experiment Station, University of Illinois, Urbana, Illinois—60 cents.*

Christmas Trees as a Cash Crop for the Farm (Farmer's Bulletin No. 1664, U. S. Department of Agriculture) by F. H. Eyre shows that the growing of Christmas trees as a crop affords a profitable side line for the farmer in some sections of the United States. The market for Christmas trees is well-nigh universal. The pamphlet gives full directions for growing. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

List of Publications Jan. 1 to June 30, 1931 describes the Laboratory publications available. *U. S. Forest Products Laboratory, Madison, Wis.—Gratis.*

Nail-Holding Power of American Woods (Technical Note Number 236) is a four page leaflet on the nail holding power of various species of wood. *Forest Products Laboratory, Madison, Wis.—Gratis.*

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CURRENT BULLETIN BRIEFS

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

How the Chemical Product Differs Economically (Reprint from *Chemical and Metallurgical Engineering*, July 1930) by Lawrence W. Bass deals particularly with the ratio of wages to value added by manufacture in various industries. *Mellon Institute, Pittsburgh, Pa.—Gratis.*

Biennial Survey of Education in the United States 1928-1930 (Bulletin No. 20, Office of Education, U. S. Department of the Interior) deals with engineering education and gives condensed information on the whole subject. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Control of Airplanes at Low Speeds by Means of Conventional Ailerons (Aeronautics Bulletin No. 15) describes certain wind-tunnel studies of the standard type of lateral control of airplanes in relation to safety. *Aeronautics Branch, U. S. Department of Commerce, Washington, D. C.—Gratis.*

Textile Research at Mellon Institute (Reprint from *Textile World*) by Lawrence W. Bass shows how small an amount is being invested by this industry in research and indicates some of the outstanding results of research in this field. *Mellon Institute of Industrial Research, Pittsburgh, Pa.—Gratis.*

Reports of Excavations at Jemdet Nasr, Iraq (Anthropology Memoirs, Vol. I. No. 3) by Ernest Mackey describes some of the results of excavations by the Field Museum-Oxford University Joint Expedition, with particular reference to pottery tools and implements. *Field Museum of Natural History, Chicago, Ill.—$2.00.*

Wrought Steel Pipe deals with the process of manufacture of butt weld pipe, lap weld pipe, and electric weld pipe. Full tables are provided as well as advice on the care of pipe, casing, tubing, and drill pipe. *Republic Steel Corporation, Youngstown, Ohio—Gratis.*

Treatment of Water for Ice Manufacture (Bulletin No. 219) by Dana Burks, Jr., gives a report of an investigation conducted by the Engineering Experiment Station and the Utilities Research Commission. The industry is composed of manufacturing units operating independently and locally. We learn one interesting fact that is not concerned with the water. A ton of coal burned in a steam driven ice-plant produces four to six tons of ice while the same fuel consumed in a power station for ice-plant consumption will make from 15 to 18 tons of ice. *Engineering Experiment Station, University of Illinois, Urbana, Illinois—60 cents.*

Christmas Trees as a Cash Crop for the Farm (Farmer's Bulletin No. 1664, U. S. Department of Agriculture) by F. H. Eyre shows that the growing of Christmas trees as a crop affords a profitable side line for the farmer in some sections of the United States. The market for Christmas trees is well-nigh universal. The pamphlet gives full directions for growing. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page 46*)

however, in the methods of securing control without the usual fuselage and tail surfaces.

If our photographs are examined closely, it will be seen that on the trailing edge of the wing, on each side of the nacelle, there are *two rear flaps.* The inner rear flap serves as the longitudinal control, or elevator. Because the wing is swept back, the elevator lies a fair distance behind the center of gravity, and hence has sufficient arm or leverage about the center of gravity. Of course an elevator placed at the end of a fuselage would have a greater leverage, but apparently the Nurflügel has sufficient elevator control. The outer flaps on each side of the wing serve as ailerons and do not depart from convention. At the extreme tip of the wing on each side is placed a vertical fixed fin, and behind it a movable vertical rudder. When the vertical rudder is placed at the end of the fuselage and displaced, reflection will show that it is the side force on the rudder which provides the necessary leverage about the center of gravity to turn or steer the airplane. In the Nurflügel, the leverage of the side force on the rudder is very small. Therefore it is the drag force or force in line with the direction of flight which steers the machine. If the rudders on the two tips of the wing were turned simultaneously the result would be nil. Therefore the rudders are independently controlled. The left rudder is connected with only the left pedal in the pilot's cockpit and the pedal is applied for a left turn. For a right turn only the right pedal and right rudder are put into action.

Tests demonstrated that sufficient control and maneuverability could be obtained. Whether sufficient stability is available with the short coupling of the elevators is another question. In all probability the longitudinal stability entails some sacrifice in aerodynamic efficiency due to turning up the wings at the trailing edge. Granted this sacrifice in efficiency, the gains are: first, the weight saved by having no fuselage; and second, the resistance saved by having only a short nacelle. Also it is possible in this type of craft to build a "pusher" with noise of engine and propeller carried to the rear, without the need for the rather clumsy outriggers of the usual single-engined pusher.

While not revolutionary, this development is extremely interesting.—*A. K.*

Oppose Helium Export

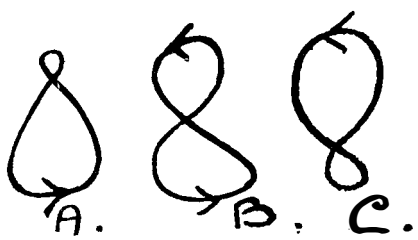
UNCLE Sam has a monopoly on that non-inflammable gas, helium, with which he inflates all the Navy's dirigibles and if American aviation interests have their way, Uncle Sam will use that monopoly to obtain control of future inter-oceanic airship services. At the annual meeting of the National Aeronautical Association in Washington, opposition was expressed to proposals for permitting the unrestricted exportation of helium.

At present, the government's approval is necessary before any helium can be shipped

out of the country. It was brought out that the removal of this restriction would deprive the United States of its bargaining power in working out agreements with foreign airship services for the pro-ration of services.—*A. E. B.*

How Can a Dragon-Fly Soar?

A CORRESPONDENT writing to the London *Sailplane* propounds the following query: "A sailplane cannot hover in still air. A dragon fly can. How does it do it? Does it obtain a forward pull from its fore wings, a backward pull from the rear ones and lift from both pairs? Apparently, in a very mild wind, a dragon-fly can hover facing down wind. If this is so, a dragon-fly can fly backwards. Can the movements of a dragon-fly's wings be reproduced by mechanical means, and if so would it be possible to construct a machine to fly on the dragon-fly principle?"



Looking at the tips of a dragon fly's wings, they move in figure 8's as the insect sails or soars

The correspondent continues somewhat plaintively to say that no information from any source was forthcoming. His query was a worthwhile one, since successful imitation of a dragon-fly by man would give us a perfect helicopter. Sir Gilbert T. Walker, an eminent British entomologist came valiantly to the rescue:

"I know nothing at first hand about the hovering of dragon-flies, but the *syriftidae*, or 'hover-flies,' which imitate bees and wasps and have but a single pair of wings can hover perfectly. Since hovering can be done with one pair, it is not necessary to assume that in a dragon-fly the two pairs are used in opposition, and the real question is how do the *diptera* manage it. I guess that as the ordinary path of one wing is usually stated to be something like B, (see drawing) faster flight to the right could be secured by a path like C with a larger backward sweep of the wing, and slower flight by a path like A.

"In other words, given varying inclinations of the wings to the horizon, and a variable shape of path, an absence of forward thrust, when taken round a complete path could be secured. I see no reason why, with an appropriate wing path an insect should not fly backwards, though I have not seen it. I feel sure that a machine could be made with wings to imitate the motion of a dragon-fly or a 'hover-fly,' given sufficient slow-motion pictures of the fly and sufficient money. But I expect it would be too heavy to maintain itself in the air."

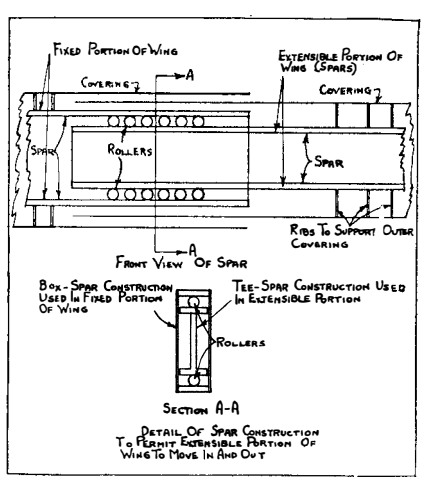
Sir Gilbert's letter is most interesting but his answer is incomplete in one respect. It is not necessary to imitate the dragon-fly's wing path exactly. A similar hovering result could be achieved by rotating airfoil blades about a horizontal axis, at right angles to the general line of flight, and at the same time changing the angle of incidence along the circular path in appropriate mechanical fashion. Such an idea has been suggested many times, and we venture the prediction that some day a machine of this type may yet be tried out.—*A. K.*

Variable Speed

IN moderate weather the yachtsman lets out his sails to the full. In rough air he "reefs" his sails. The suggestion has often been made that a similar process should be employed with the airplane. To fly fast, the area of the wings should be reduced so that their air resistance is cut down to a minimum; to land slowly, the area should be increased. A Russian working in France has presented a novel solution of this problem.

M. Makhonine's machine is quite large, and is provided with an extensible wing, consisting of three portions. The middle part is built into and through the fuselage; the two outer sections of the wing are of conventional wooden construction and slide within the middle portion. Rollers are placed at the extremity of these sliding parts to transmit the loads to the metal box girder over which they slide, and other rollers are placed at the extremities of the middle portion to ease the passage of the sliding sections. The wings slide in and out by an arrangement of levers. The ailerons are placed along the middle portion only, and may therefore be partly ineffective.

When the wing is "out" the span is 69 feet, the area 355 square feet. With the wings "in," the span is only 43 feet and the area 226 square feet. Theoretically it should be possible, with a given load, to decrease the landing speed by sliding out the wings; or with the same landing speed to increase the gross weight and the pay load.



Construction of extensible wing

The criticism has been offered that the increased weight of the structure will more than offset the theoretical advantages to be gained. Nevertheless the experiment is worth while.—*A. K.*

Cheap Helium Made Possible Novel Features of the "Akron"

THE new giant naval airship which was recently christened the *Akron* and at present is stationed at Lakehurst, depends for the helium used in its navigation

on the Government plant near Amarillo, Texas.

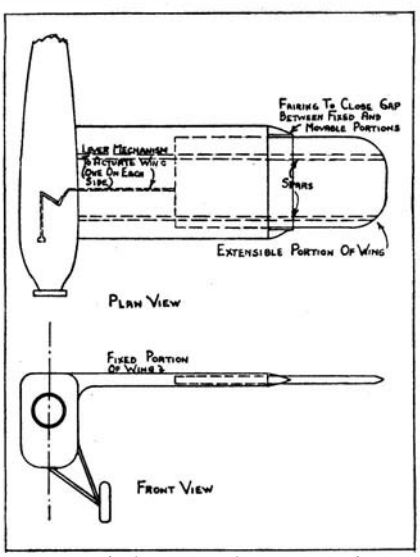
Although the establishment at Amarillo has been in operation only a little more than two years, it has produced more than 22,000,000 cubic feet of helium at an average net cost for that period of $11.47 per thousand cubic feet. An indication of present improved plant performance, brought about through experience in plant operation and improvements in process and equipment constantly introduced is given in production figures for June, 1931, when the net cost of $5.95 per thousand cubic feet was attained.

It is interesting to recall that not more than 16 years ago, helium was an extremely rare gas, only a chemical curiosity. There was not a cubic foot of it in the United States, though small amounts had been sold at the rate of 2500 dollars per cubic foot. At that price, to have filled a ship the size of the *Akron* would have cost more than 16 billion dollars. The present cost of production is a good example of what may be accomplished by applied research.

Prior to the advent of helium for lighter-than-air craft, hydrogen found universal use for this purpose. Hydrogen is, of course, inflammable and, when mixed with certain percentages of air, is explosive. The elimination of this attendant hazard, was, unquestionably, the thought back of the original suggestion covering the use of helium for the purpose. Helium is non-inflammable and non-explosive. The removal of the fire hazard, alone, justified the idea. However, the *Akron* has many innovations which have been made possible through the use of helium.

On the *Akron*, due to the use of non-inflammable helium, the motors have been placed in the body of the ship, thereby decreasing wind resistance and increasing speed of the craft. This also obviates the necessity for the crews to climb up and down open ladders from ship to gondolas when the watch is changed—not such a pleasant experience when the ship is several thousand feet in the air and moving at a high speed.

The *Akron* has a gas-fired cooking range. So far as is known, this is the first time an open flame has been used for cooking on board an airship. The location of machine gun nests, airplane hangars, and so forth, all of which will be found on the *Akron*, is entirely feasible, due largely to the use of an inert lifting gas.—*A. E. B.*



One of the extensible wings of a plane with which, because of these wings, variable speed is possible

New Battery Wall Light

LIGHT for the attic, clothes closets, basement stairways, for the many dark corners not reached by light lines, is now available in the form of an attractive battery light which is the latest addition to National Carbon Company's Eveready line. Called the Wallite, this new light is screwed to the wall at any point regardless of electric wiring because it is operated by standard flashlight batteries. It is equipped with a pull chain switch which will operate from any direction. It is made in two finishes: old ivory and black Morocco, both finishes having nickel trimmings.

The new wall light, operated by a pull chain, in use in a closet

Smallpox Germ Discovered

DEMONSTRATION that the germ of smallpox is probably a minute spherical body 1/125,000 of an inch in diameter, near the lower limit of microscopic visibility, has been announced by Prof. J. C. G. Ledingham, director of the Lister Institute of London.

This climaxes the medical war against smallpox, which began with Jenner's discovery of vaccination, long before Pasteur founded bacteriology. Although smallpox has been controlled for decades, its causative organism heretofore has been unknown. For a quarter of a century, minute spherical bodies have been found in certain virus diseases, such as smallpox and cowpox, but these have always been ignored. Their agglomerations constitute large inclusions which are striking features in the body cells and in the pox lesions of patients.

Professor Ledingham made practically pure suspensions of minute bodies from fowlpox and vaccinal lesions, and found that they reacted specifically with serum from animals that had recovered from attacks of fowlpox or vaccinia. He also demonstrated the presence of specific agglutinins in the blood serum of a rabbit inoculated with vaccinia. Agglutinins are substances of as yet unknown nature the presence of which in the blood causes bac-

teria and other foreign bodies to gather together in clumps.

Professor Ledingham believes "that in a fairly large group of virus diseases of both plants and animals such minute elementary bodies are very likely to be found if carefully sought. Such demonstrations would materially assist the study of virus infections whose infective particles are below microscopic vision."

The cultivation of virus vaccinia in a medium containing no living cells was announced by Dr. G. Hardy Eagles of the Lister Institute. He used a medium composed of extract of rabbit kidney, rabbit blood serum, and salt solution. This first successful attempt to cultivate a virus in a cell-free medium may eventually allow the production of vaccinia in the laboratory instead of in experimental animals. It is also important from a theoretical viewpoint. —*Science Service.*

George Washington Bridge Dedicated

A REVIEW of the major economic and engineering questions involved in the construction of the new George Washington Bridge, which was dedicated on October 24, 1931, and opened to vehicular traffic the following morning at 5, was given by O. H. Ammann, Chief Engineer of The Port of New York Authority, at a meeting of the American Society of Civil Engineers recently.

Mr. Ammann declared that the George Washington Bridge had answered the question in the minds of some as to the feasibility and economy of a span of such unprecedented length. He said it could now be demonstrated that a modern suspension bridge of even 10,000 feet span could be built with the same factor of safety. The new crossing is 3500 feet long between towers.

"The George Washington Bridge," Mr. Ammann said, in part, "has been designed to carry eight lanes of vehicular traffic and two footwalks on an upper deck and four tracks of electric rail passenger traffic, or at least six additional vehicular lanes on a lower deck. Only the upper deck has been erected so far and on that only four lanes of vehicular traffic and the pedestrian walks are completed for operation. The lower deck is so designed that it may be added at any time in the future at comparatively small expense.

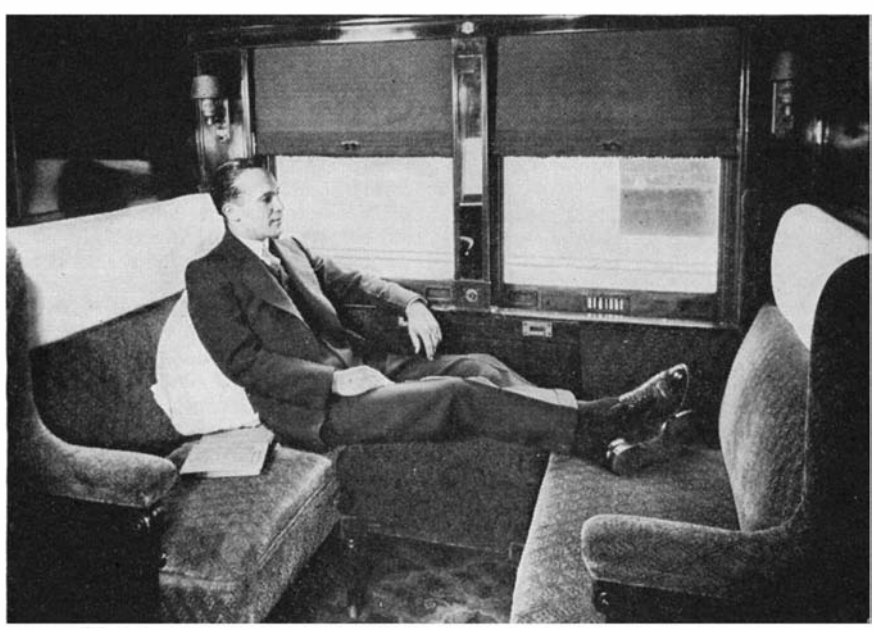
"The construction of this bridge has answered the question raised by laymen as to the feasibility of a span of 3500 feet, twice the longest existing suspension span; and also the question raised by some engineers prior to its construction, whether or not a single span of such length is economical.

"We may now refute the conception held even by engineers that length of span is the major economic factor in the construction of a large bridge, in that it is supposed to influence the cost about in the proportion of the square of the span. Traffic capacity, cost of foundations, and approaches are apt to be far more important economic factors than mere length of span.

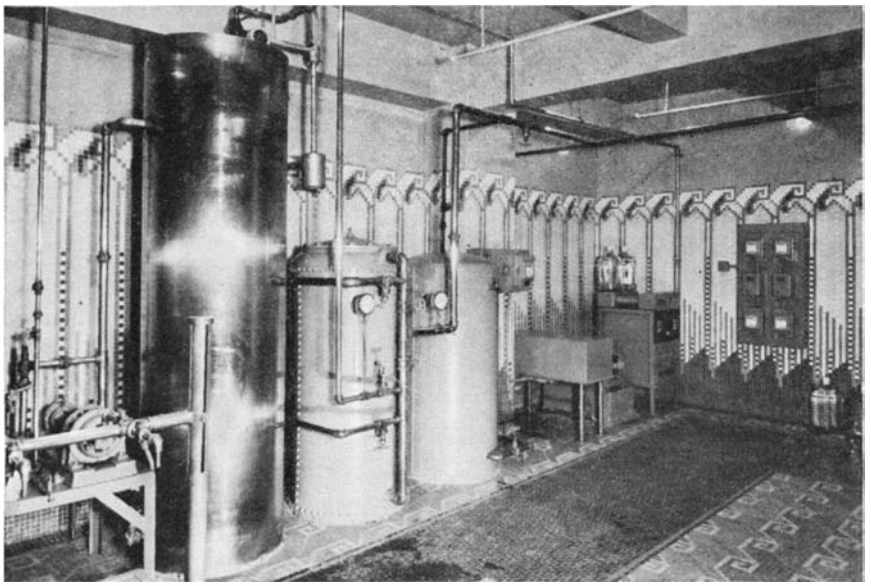
"Based on comparison and on the theories we find in text books and other treatises on suspension bridges, we should expect the stiffening system of the George Washington Bridge to weigh from 13,000 to 14,000 pounds per foot. Actually it weighs only 1100 pounds per foot in the initial stage with only one deck for highway traffic, and will weigh 2350 pounds in the final stage with two decks.

"It is hardly possible, nor is it necessary at this time to enter into a discussion of the reasons and considerations which eventually led to the decision to build the tower initially as a steel frame designed to carry the entire load, and to leave it for future consideration as to whether this frame is to be encased in or surrounded by stone-faced concrete.

"In an effort to produce the best possible solution within practicable and justifiable limits, the approaches as built are more elaborate and more efficient, also more costly, than was originally contemplated. The Port Authority did not shrink from assuming any reasonable additional expenditure for approach facilities as long as they were justified by increased efficiency of



Greater comfort for the Pullman passenger has been provided by the Pullman Company in the form of a cushioned stool which fits snugly between the regular seats. With this in use the passenger may stretch out very comfortably



The Hydrozone plant in the Chrysler Building in New York City

traffic distribution and satisfied the municipal and state governments.

"As the planning proceeded it became apparent that certain principles to meet the requirements of modern traffic would have to be set up and, as far as reasonably practicable, adhered to. Foremost among these was the avoidance of crossing of traffic lanes at grade, not only on the bridge and approaches proper, but at the points of convergence and divergence of bridge and street traffic, because such crossings invite accidents and retard flow of traffic."

Water is Purified Electrically

As many people are aware, the well-known inverted bottle of drinking water, supplied for the use of employees in most offices, does not always contain the purest of water. Commonly labelled as containing spring water, it very often contains water drawn from a faucet in the building. The water, in such cases, may be relatively pure but that purity has most likely been achieved by a too-liberal use of chemicals so that a chemical taste remains; and there will be dissolved minerals which the ordinary purification process does not remove.

In a number of large office buildings in New York, however, water for these office bottles is purified, clarified, and rendered odorless by a new process plant on the premises. The plant that does this job is a product of the Hydrozone Company, Inc., is entirely electrical in character, and uses no chemicals. City water entering the plant first passes through a coagulator, thence through filters to remove undesirable coagulated minerals and any vegetable matter which may be present. Next, it passes through a mixing tower where it is mixed with an electrically produced sterilizing agent. This completes the process and the water is now crystal clear and odorless. Pathological laboratories have analyzed water produced by this system and have pronounced it entirely free of pathogenic bacteria and marine algae which cause the scum in untreated water.

Hydrozone plants are not only in use in the Chrysler Building, the Empire State Building, the New York Central Building, and others, but also in a number of swimming pools. Water in the latter is a notorious source of infection of the mucous membranes of the nose and throat both because of the bacteria present and the chemicals dissolved in it to kill these disease-producing organisms. The Hydrozone system of purifying swimming pool water is said to give the same perfectly pure water that it does for drinking purposes, and inexpensively.

The new system has also been applied successfully to the water system of a small town that previously had badly polluted drinking water.

Waste Wood Finds Many Uses

Sawdust, wood shavings, small waste pieces of wood, and even the bark are utilized in a wide variety of methods described by C. A. Basore in a recent issue of *Chemical and Metallurgical Engineering*. Obviously, the easiest thing to do with such mill waste is to burn it as fuel, but sometimes it is more profitable to use it elsewhere. Thus, sawdust and shavings are sold for use as bedding for horses and cattle, ground covering in circus rings, flooring compounds, various molded articles, artificial wood, wood flour, gas purification, and as filler for various types of concrete, stuccos, plasters, clay brick, and tiles. Chemical methods of utilizing sawdust and shavings embrace curing of meat; distillation of raw sawdust to recover charcoal, tar, gas, alcohol, and acetic acid; and extraction of rosin and turpentine with a volatile solvent and producing ethyl alcohol.

The chemical uses of the coarser forms of waste wood are numerous. Much of the hardwood waste is distilled, the chief products being charcoal, tar, alcohol, and acetic acid. Softwood (pine) is often extracted with gasoline or steam and the rosin and the turpentine are recovered. Under certain conditions this method apparently is profitable. The manufacture of paper from wood waste has proved to be a promising outlet for this material.

Waste bark has been employed in a variety of ways. The barks of chestnut, oak, tan oak, and hemlock are used in the manufacture of tanning extracts. The extracted chestnut bark has been made into

paper. Bark is now used for paper of a certain type, in roofing felt for asbestos shingles, in the manufacture of white lead by the Dutch process, in insulating material, and as a sound deadener to some extent.—*A. E. B.*

Breaking into Amateur Radio

A DUAL plan of assistance to beginners wanting to break into amateur radio transmission has been broached by the American Radio Relay League, national amateur organization, in the October issue of its official organ, *QST*. One branch of this plan is the description of a highly simplified and easily constructed amateur short-wave receiver; the other is the first of two articles analyzing in full the questions and requirements encountered in obtaining the government amateur operator's and station licenses.

Amateur licenses are issued free of charge by licensing offices located in many of the principal cities, the only requirements being the passing of a written examination, and demonstration of ability to copy and transmit the international radio code. The code can be readily learned by listening on the simple receiver. Code charts and related information can be obtained from the American Radio Relay League national headquarters in Hartford, Connecticut, where a list of amateur stations broadcasting special code practice lessons can also be had.

Causes of Heart Disease

THE decidedly upward curve in the incidence of fatal heart disease throughout the nation is sufficient reason for everyone of mature years to pause and consider the possible part they may be playing in this unfortunate situation. In fact, without the individual's personal co-operation, the chances for marked improvement in this deplorable condition are somewhat slim.

In the last analysis, heart conditions fall into two main classes. First, those resulting from other diseases—usually childhood ones; and second, those that may be traced to personal conduct of omission or commission.

Preparedness represents the major defense against this pre-eminent hijacker of health. Primarily, individuals of mature age must realize that high-speed living, excessive use of stimulants, and other unnatural drains upon vitality such as consistent lack of proper rest and over-exercise are likely eventually to backfire in the form of a weakened heart. Old Dame Nature apparently takes a lot of punishment, but she never forgets. And one of her most favorite methods of reminder is to hit the heart. Moderation in all things personal is therefore an exceedingly safe and, in fact, the only reasonable rule to follow.

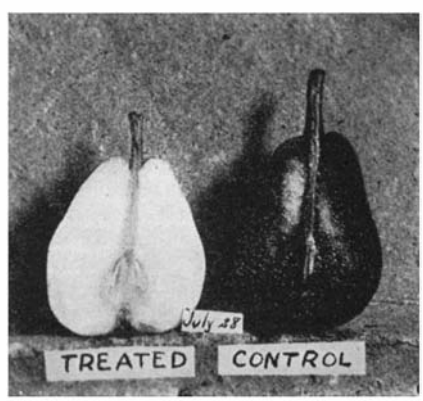
No matter how good one's conduct toward his body may have been, once yearly a complete physical examination should be made by a competent physician. The master detective in the form of scientific investigation thus applied will nip incipient heart conditions in the bud; conditions, by the way, blissfully unsuspected by the individual.

If these two main courses of preparedness against heart disease were conscientiously and generally employed, there can be little doubt that the present deplorable record that it now is making would be effectively curtailed.—By Dr. Theodore B. Appel in the *United States Daily.*

Artificial Ripening of Pears For Canning

LEMONS and oranges, picked green from the trees, are ripened artificially by treating them with ethylene gas. Flavor and color are both developed by this treatment, discovered almost a decade ago by Dr. F. E. Denny, and now generally used by the citrus growers. E. M. Chance, chemist in charge of the Laboratory of Fruit and Vegetable Chemistry of the Department of Agriculture, described in a recent issue of *Food Industries* some of his efforts to apply the same treatment to the artificial ripening of fruits for canning.

Most promising of his experiments to date are the results with pears for canning. This fruit is always harvested while quite hard, and artificially softened before canning. There are good reasons, of course, for such procedure. If the fruit is allowed to



When pears are ripened with ethylene, the starch is converted to sugar as shown in this test where two pears were stained with iodine to show the presence of starch

soften on the tree, it could not be transported without serious bruising, and the resulting heavy trimming would be both unsightly and expensive. The flavor of the tree-ripened fruit is inferior to that softened in storage, and the risk of loss from decay would be greatly increased.

Pears contain starch, a reserve sugar-forming material, which is converted into sugars during the storage period. Owing to the conversion of this starch, the fruit is sweeter after storage than when harvested. Moreover, this fruit is not considered a good source of vitamins, so that the question of the vitamin content at the time of harvesting is not so important as it is in the case of tomatoes.

Many canneries consider the texture of pears of more importance than the color, and ethylene affects the texture to a greater extent than it does the color. The treatment will soften pears in about five to six days and very often the fruit does not require a preliminary sorting before going to the preparation tables.—*A. E. B.*

Stereoscopic X-Ray Device

A STEREO-FLUOROSCOPE X-ray instrument that shows the inner workings of the human body as though it were a moving picture has been perfected at the

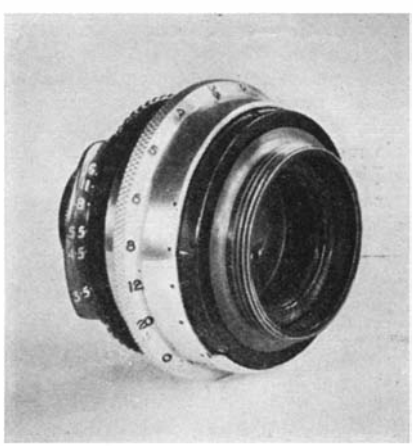
California Institute of Technology and has been sent to the Henry Phipps Institute at Philadelphia where practical medical experiments are to be conducted.

The instrument was developed by Dr. Jeffe W. M. Dumont, research fellow in physics; Dr. Archer Hoyt, teaching fellow in physics; and Clarence Brandmyer, at the California Institute of Technology.

The instrument consists of two X-ray tubes connected to a single transformer so that they are alternately caused to emit X rays by alternations of a 50-cycle alternating current. The alternate X-ray impulses emitted by the tubes project alternate shadow pictures of the object to be viewed on a single fluorescent screen. Since the tubes are spaced apart at approximately the same distance as the distance between the eyes, the shadow pictures projected on the screen differ slightly in the point of view, in the same way that two images in the right and left eye differ respectively from each other when the eyes view any object in three dimensions.

To give the impression of a three-dimensional stereoscopic plastic relief, it is only necessary to arrange that each eye shall see one and only one of the two images formed by the two tubes. This is accomplished by means of a special rotating shutter placed before the eyes and driven by a synchronized motor in such a way that the right eye sees the image at the time the right-hand X-ray tube is emitting rays and the left eye sees it at the time the left tube is emitting.

By observing certain geometrical relationships between parts it is possible to have the stereoscopic image appear in space in front of the screen as an exact scale reproduction. Calipers are provided that can be introduced into the image and brought into apparent contact with any two parts of the image the separation or size of which is desired. Scale measurements on the inside of the human body can be made in height, breadth, depth, or, in fact, any direction whatever.—*Science Service.*



Improved movie camera lens

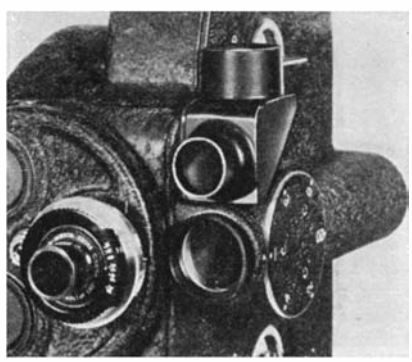
New Lens and Viewfinder For Movie Cameras

AMATEUR movie photographers will be interested in two new accessories for Filmo 70 cameras, recently announced by Bell & Howell. One is a new Cooke one-inch *f.* 3.5 focusing mount lens, and the other a waist-level viewfinder.

The new lens is radically different from the former focusing mount lens for this type of camera. The principal feature is that the focusing and diaphragm dials project out sufficiently into the field of the finder to enable the user to observe his focusing graduations as well as the diaphragm graduations when looking through the finder tube.

The movie maker thus has before his eye a constant reminder to be sure to change the distance setting between shots if the distance has been changed. Quite often, for example, after a close-up has been made, the photographer forgets to change his focus when he shoots a picture at normal distances. This new mount gives him visual notice to make the necessary changes.

Another feature of the new lens is that the front cell is non-rotating. When the focusing diaphragm is turned, the whole lens moves on a spiral without revolving the glass elements. This makes it possible to employ all the attachments which have been developed for the one-inch *f.* 3.5 lens, such as the distorter, duplicator, duplex filter, and sky filters.



With this new viewfinder, the amateur movie maker can easily make waist-level or "worm's eye" shots

The waist-level viewfinder enables the camera user to determine his picture areas while holding his camera at any level lower than the eye. This facilitates taking those interesting unusual-angle scenes, such as "worm's eye" views, without assuming an uncomfortable position. The new unit is not designed to replace the regular viewfinder, which is better fitted for general use, but merely to supplement it when special scenes are to be taken. It consists of two lenses and a prism mounted in a suitable holder which easily attaches to the camera door just above the regular finder. The field is the same as that covered by a one-inch lens, but fields of other lenses of longer focal length can be etched on the face of the prism.

To attach the finder for the first time requires the use of a screw driver and possibly a file, but any one can do this work and do it quickly. After this first simple adjustment, to attach or detach the finder requires only a second or so.

Chemical "Pinch-Hits" For Ice

A SIMPLE chemical method for cooling bottled drinks on picnics is used by Robert M. Pierce, a member of the laboratory staff of Universal Pictures, according to *Chemistry and You.* When Mr. Pierce goes camping, for example, he doesn't

bother with ice, but always takes some ordinary photographer's "hypo," mixes it with water, and cools bottled drinks in the water.

This chemical, hyposulphite of soda, dissolves so fast that it draws heat from the water, just as melting ice freezes the ice cream. Laboratory tests show that two parts of water with one part of granular hypo cool water from 83 to 49 Fahrenheit in three to five minutes. Water at 49 is cold spring temperature. By cooling water with hypo, and then using the cool water to dissolve more hypo, still lower temperatures can be had—down to freezing.

Hypo costs five cents or less a pound. Take a bag on your next outing, cool the drinks, put hypo-cooled water in your ice box, and laugh at the ice man. The hypo can be recovered, as good as new, by evaporating the used solution down to the concentration where it crystallizes again.
—*A. E. B.*

Child Ailments of Greatest Fatality

WHOOPING cough is most fatal in the second month of life and measles in the second year. Over half of the deaths from whooping cough occur during the first year and nearly 90 percent occur in the first two years. If a child escapes getting whooping cough while a baby, it is very apt to pull through, but it is not past danger as the whooping cough may lead to tuberculosis.

With measles the first three years are the most fatal, nearly 80 percent of the measles deaths occurring then. Measles is much more fatal to adults than is whooping cough, about 3 percent of measles deaths being among adults. So, if parents permit children to contract measles they may have the infection brought to themselves, and with fatal effect.

Diphtheria and scarlet fever cause their fatalities in children later than measles and whooping cough. With diphtheria the most fatal years are between two and five, during which time 50 percent of deaths from diphtheria occur. About 5 percent of the deaths from diphtheria occur among adults and 15 percent of the deaths from scarlet fever occur among adults.

Even chickenpox causes a few deaths, as does mumps. So all these contagious diseases are serious things and every effort should be made in the schools and homes to keep them from spreading. Every case should be reported by anybody who knows about it, and be promptly quarantined.—Dr. J. Bruce McCreary, in the *United States Daily*.

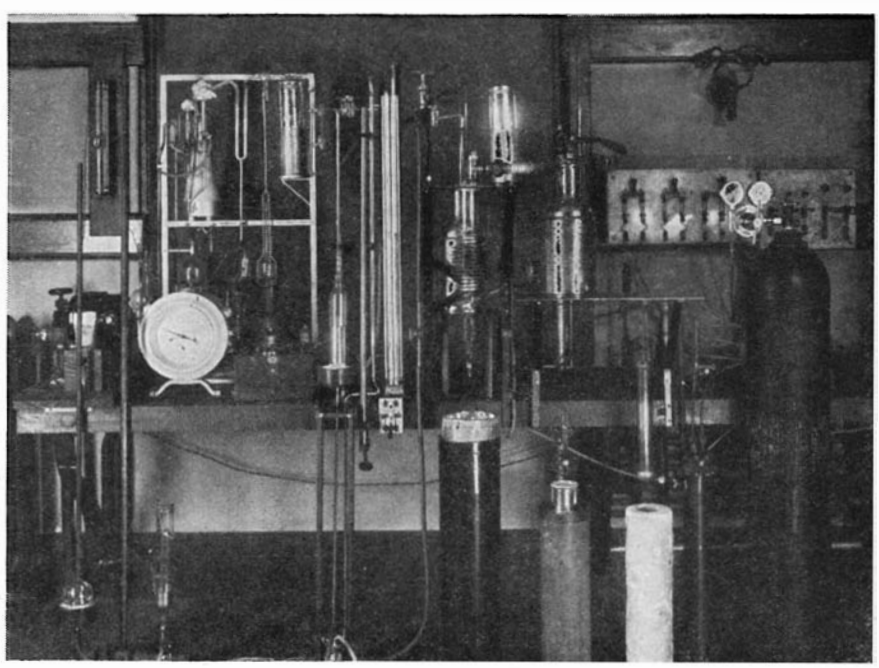
Beryllium Alloys Improve Springs

THE properties of the comparatively rare metal beryllium have been exploited abroad in the manufacture of springs which retain their elasticity even in red heat. Ferrous alloys containing 1 percent beryllium, 12 percent chromium, and more than 8 percent nickel are used. Compared with the best tungsten special steels with high creep limit, these beryllium steels have a temperature advantage of 50 to 100 degrees Centigrade.—*A. E. B.*

Real Speed of Ducks Breaks Hunters' Alibi

THE alibi of the hunter who said that the ducks he missed went by him 180 miles an hour has been "shot to pieces" with statistics on speed of birds compiled by a worker in the Bureau of Biological Survey in the United States Department of Agriculture.

Earlier estimates on the speed of ducks credited these birds with phenomenal speeds, but automobiles and airplanes have made more accurate timing of their flying possible. The most accurate checks thus far made show that ducks and geese do not ordinarily go more than 40 miles an hour,



Helium, the lighter-than-air gas with which the dirigibles *Akron* and *Los Angeles* are inflated, has been liquefied for the first time in the United States by scientists of the Bureau of Standards, using the apparatus shown above. It was necessary to reduce the temperature of the gas to 456 degrees below zero, Fahrenheit, in order to convert the helium from its gaseous to a liquid state

Three pencil marks throw this scale off balance. After balancing weights and pieces of paper, three pencil marks on one paper show the scale's sensitivity

although they are capable of increasing their speed if frightened. They can not, however, maintain the higher speed for a long time. The fastest bird timed was a duck hawk in California, which flew at a speed of 165 to 180 miles an hour while chasing its prey.

Mallards timed in France and England flew 50 to 58 miles an hour, and a flock at top speed in California when timed with an airplane went only 55 miles an hour. Pintails chased by an airplane in California flew 55 to 65 miles an hour, and a canvasback made 72 miles an hour. Canada geese timed in Massachusetts flew 44 miles an hour and a brant in Scotland flew 45 miles an hour.

Topazes Not Always Yellow

IT is a common misconception that all yellow stones are topazes and that all topazes are yellow; but neither statement is true, according to the United States Bureau of Mines. The real topaz is a rather rare mineral, and a large number of yellow stones that masquerade as topaz are nothing more than yellow quartz, known as citrine, but almost universally called topaz. The true topaz is often called "Brazilian" topaz by the jeweler to distinguish it from yellow quartz; nevertheless, both terms are freely applied in trade to other yellow stones. True or Brazilian topaz is noted for its hardness; very few minerals are harder. It will cut quartz and tourmaline easily, but is very brittle and therefore quite easily cracked.

When pure, the crystals are often perfectly colorless and water-clear, but, due to the presence of impurities, they may show a wide range of colors—red, yellow, brown, green, or blue. It is an interesting fact that these colors are by no means stable. The brown and wine-yellow fade upon exposure to light, and the sherry-yellow crystals from Brazil assume a fine pink color upon being heated.—*A. E. B.*

Three Pencil Marks Put Scale Off Balance

A SCALE in the meter laboratory of the General Electric Company at Lynn, Massachusetts, which will weigh up to 50 pounds, is so accurate that three pencil marks, each one and a half inches long and weighing but 35 millionths of an ounce, will put it off balance. This is believed to be the most accurate heavy balance in the country.

World's Largest Locomotive

IN our November issue it was stated that the Canadian Pacific's new "8000" type locomotive is the largest on the North American continent. This was an inadvertent error. We had intended to say that this locomotive is the largest in the Dominion of Canada, inasmuch as the Northern Pacific's "Yellowstone" type locomotive, which we described in detail in our March, 1929, issue, is still by far the largest in the world.

In this connection a few comparative details will be of interest. The Northern Pacific's "Yellowstone" type locomotive weighs, with fuel and water, 558 tons; its normal tractive effort is 140,000 pounds and its total tractive effort is 153,400 pounds; and it is 125 feet long. The Canadian Pacific's "8000" type weighs 400 tons; its tractive effort is 90,000 pounds; and it is 100 feet long.

Sun's Platinum

THE sun is estimated to have 50,000,000 tons of platinum, in the form of a gas heated to a temperature of 11,000 degrees, Fahrenheit.

Spores Travel in Upper Air

SCOUTING trips with airplanes show that spores of certain plant diseases are often found at heights of 10,000 feet in the upper air. This is one explanation for the spread of such diseases as black stem rust of small grains, say specialists of the United States Department of Agriculture in a recent report.

Investigators working with white pine blister rust have found that spores of that disease falling in a perfectly still atmosphere from a height of one mile require 55 hours to reach the earth. Such experiments make it clear that plant disease spores may be blown for long distances unless brought down by rain or some other agency.

COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY

Member of the New York Bar
Registered Patent Attorney

Tire Design Patent Granted

THE Patent Office Board of Appeals recently decided in favor of appellant in an appeal from the action of the primary examiner finally rejecting from design patent No. 85034 the following claim: "The ornamental design for a tire as shown."

The references relied on are: Mitchell, design 63693, Jan. 1, 1924; Reichard, design 67852, July 21, 1925; Schaefer, design 68348, Sept. 29, 1925; Porter, design 73942, Nov. 22, 1927.

The opinion of the Board of Appeals is as follows:

Appellant's design embodies a central rib having at intervals staggered projections which face similarly shaped recesses in other ribs somewhat widely spaced from the rib first mentioned. Projecting outwardly and downwardly from points opposite the recesses in the ribs second mentioned are decorative shapes which appellant describes as triangular and trapezoidal, these shapes alternating and being connected to the ribs second mentioned by short, thick neck members. At the outer ends of the triangular and trapezoidal ornaments rectangular faces project downwardly along the sides of the tire.

The examiner's rejection is based primarily on the patent to Schaefer. This patent shows a central rib having zig-zag projections on opposite sides and adjacent ribs which have recesses opposite the projections. The Schaefer rib is much thicker than that disclosed by appellant and the projections are about the same length as the spaces between the same, whereas, in appellant's design the projections are much smaller than the spaces and the rib as a whole is narrower. In the Schaefer design the units which flank the ribs second mentioned are all of the same kind and lie opposite the recesses of the first rib rather than opposite the projections as in appellant's design.

The examiner relies on the patent to Porter to show "similarly positioned forms." The forms shown are somewhat similar and they alternate in somewhat the same way but inasmuch as the central ornamentation is quite different in our opinion they cannot be said to be similarly positioned. Moreover, their form is quite different from that disclosed. The trapezoidal elements of Porter extend outwardly along parallel lines before extending downwardly in the form of a rectangle and similarly the triangular elements have side extensions and an intermediate V-shaped notch which gives them the form of a Y rather than a triangle.

The Reichard patent shows side ornamentation which comprises alternating elements which externally are triangular and trapezoidal but these elements are so modified as to give quite a different appearance than the elements disclosed by appellant.

Mitchell also shows triangular and trapezoidal elements but they also are much modified and do not create an appearance at all resembling that of the present disclosure.

In our opinion even though we select features from the various references, the composite thus formed will not bear such a close resemblance to the design before us as to warrant a holding of anticipation. In our opinion the design is sufficiently distinctive to warrant the grant of a patent.

The examiner's holding is therefore reversed.

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.

Conflicting Mark not Registrable

IT was recently held by Assistant Commissioner Moore that Boott Mills, of Lowell, Massachusetts, is not entitled to register, under the Trademark Act of 1905, as a trademark for scrim, a mark consisting of three stripes of equal width in the selvage, spaced from each other by stripes of contrasting appearance, in view of the previous registration by another of a mark for two-ply cotton-yarn marquisettes, consisting of three stripes woven into the selvage.

The ground of the decision is that the goods are of the same descriptive properties and the marks as applied thereto confusingly similar.

"As to the respective goods," said Mr. Moore, "while they are specifically different from each other, yet they fall within the same class.

"The similarity of the two marks is believed to be such as to be likely to cause confusion or mistake in the mind of the public as to the origin or ownership of the goods. While there are specific differences between the marks, yet such differences would not be apt to attract the attention or to be remembered by the average member of the purchasing public."

Food and Drugs Act Violators Apprehended

INDICATIVE of the activity of government agents in enforcing the national pure food and drugs law is the fact that the Federal Food and Drug Administration seized in September 73 consignments of foods and drugs found to violate the law, according to a report by W. G. Campbell, Director of Regulatory Work, Department of Agriculture.

Late in September, Ferris Habib, Albert Hadad, and Malkoun J. Sayegh were indicted by a Federal Grand Jury under Section 37 of the U. S. Criminal Code, on the charge of conspiracy to violate the food and drugs act and the oleomargarine laws, according to Mr. Campbell. The indictment resulted from an investigation by the Food and Drug Administration, with the co-operation of the Bureau of Internal Revenue. It charges that the three men bought oleomargarine, removed it from the cartons, and placed it in one-pound boxes labeled "pure creamery butter." The food was sold in New York City and was also shipped interstate. The fraud being detected, the Government seized 1140 pounds of the oleomargarine under the charge that the goods were misbranded and adulterated under the pure food law. Hadad had been guilty of a similar offense before. In one instance he had mixed butter and oleomargarine, selling the product as "butter," thus violating the food and drugs act. But in the case for which he has been indicted, he made no attempt whatever to mix the margarine with butter, but sold it in labeled cartons as pure butter.

The Department instituted seizure proceedings in September against 11 shipments of a preparation which is represented by statements on its labels as having curative properties for such serious diseases as tuberculosis, pneumonia, bronchitis, influenza, and so on. "This preparation," said Mr. Campbell, "is a liniment, and Federal investigation shows it has no remedial effect whatever for the diseases named on the label. Wholly aside from the legal aspects of the case, it is a contemptible practice for a manufacturer to delude the afflicted with the idea that a preparation will have value in treating devastating diseases when, in fact, it will have no such effect. Those afflicted with illness and disease are frequently unduly credulous—will try almost anything once—and will resort to worthless preparations when they can ill afford the cost, and when such money is needed in making provision for competent treatment."

The activities of the month included several seizures of medical preparations manufactured at Colorado Springs, Colorado, and recommendation for criminal prosecution of the firm. The manufacturer stated upon the labels of his preparations that they had curative value for high blood pressure, cancer, tuberculosis, pneumonia, Bright's disease, diabetes, syphilis, and other highly serious maladies. "Analysis of the so-called remedies did not give any evidence that they would have any value whatever in the treatment of these diseases," said Mr. Campbell.

Business Use of Aircraft Increasing

BUSINESS interests are making increasingly greater use of aircraft for business travel, according to Col. Clarence M. Young, Assistant Secretary of Commerce.

Although there are no statistics which will give definite indices of the amount of commercial air travel, there is no doubt that executives, bankers, salesmen, and other business representatives are included

in greater numbers in the steadily growing volume of airline passengers.

"Judging from the number of inquiries we receive and the amount of discussion I hear, I think there is no question that even private aircraft are being used more frequently by commercial travelers," the Assistant Secretary explained.

"There is one thing which must be remembered, however, and that is that it took a comparatively long time before the automobile was used regularly and extensively in the conduct of business," he added. "Commercial air travel has been before the public not more than five years and yet in that brief period we have seen many business houses, sales organizations, and other firms making frequent, and often regular, use of the airplane."

The commercial traveler has been shown that when the value of an hour is considered the airplane is an economical means of transportation. Consequently more and more business people are regarding air transportation as a justifiable expense.

The increased flexibility of air transportation is one of the reasons for increased commercial use of airlines and private airplanes. While airline schedules must be observed, the frequency of service, the possibility of combining air and surface transportation, the saving in time, and the opportunity of flying at night partly compensate for the lack of flexibility as compared with the independence of schedules gained by using private planes.

With an estimated increase of 500,000 persons anticipated in the volume of air travel this year, it is practically unquestionable that business travelers have used aircraft more in 1931 than ever before.

The outstanding examples of employment of private aircraft by executives, salesmen, and similar travelers are found, naturally, in the aviation industry itself and allied lines. Salesmen for oil companies, aircraft instrument manufacturers, accessory dealers, airport equipment producers, and similar commercial representatives employ privately owned aircraft extensively for their own transportation. The publicity value of such action appears to be decreasing, however, so that the logical explanation for this expansion is the commercial value of aircraft in business.

Refrigerators Gain Popularity in China

CHINA is proving to be a good market for refrigerators, especially those of the small household type, according to a report received from Commercial Attaché Julean Arnold, Shanghai.

In cities like Shanghai, Tientsin, Hong Kong, Tsingtao, et cetera, where electric power facilities are so perfected as to guarantee certain uniform voltage, it has been possible to install a large number of American electric refrigerators. But there are comparatively few cities in China where a uniform voltage can be obtained. Furthermore, there are numerous cities and towns throughout this country which have no electric power facilities. Thus there should be a very good market in this country for a household type of non-electric refrigerator, Mr. Arnold points out.

An interesting phase of developments in the country is that the Chinese people, at one time decidedly adverse to the idea of consuming anything cold, have in recent years become very fond of ice cream, iced drinks, and various other foodstuffs that involve the use of ice in their preparation. Furthermore, there is a growing appreciation of the use of ice in preserving foodstuffs during the higher temperatures.

Trade observers believe that Chinese silk producers would find refrigerators helpful in preserving the silkworm eggs and preventing them from being hatched out before the mulberry was ready for feeding.—*Issued by the Department of Commerce.*

Patent Claims Ordered Divided

HOLDER of patent No. 1720364 appealed from the decision of the Examiners in Chief of the Patent Office, who required division between the groups of claims 1 to 9, inclusive, and 16, directed to an electric motor structure, and the group 10 to 15, inclusive, drawn more specifically to a mining machine. The following decision was handed down by First Assistant Commissioner Kinnan:

"The disclosure of the application relates to a flame-proof mining machine. It is to be observed that claim 7 and the other claims in the first group, although mentioning a mining machine in the preamble, recite as elements only motor structure of general application and those features of construction which are provided to prevent sparks produced by the motor from igniting gas which may surround the motor in the place where it is used, whereas claim 10 and the other claims of the second group recite not only the motor and its protective means, but also include the cutting and feeding mechanism of the mining machine and recite frame structure which is of special use only in a mining machine where it is desirable to confine the limits of the frame structure within the cross sectional area bounded by the coal cutting mechanism.

"Appellant admits that the second group of claims contains limitations which might limit the field of search of these claims more narrowly than the first group, and that in such case a requirement for division so as to make it more convenient for the Office in searching such claims is quite proper where no injury may come to the applicant as a result thereof. However, appellant contends that in the present case the two groups of claims are so closely related that there is grave danger of a holding of double patenting, should two applications be submitted and two patents issue.

"Nevertheless, the additions of the elements and features of the second group of claims to those covered by the first group either do or do not involve invention. If they do involve invention, that invention is sufficient to support a second patent, and if they do not applicant is not entitled to claims therefor over the allowable claims of the first group either in a separate application or in the present application.

"The patentability of the two groups of claims should accordingly be determined in separate applications more particularly as the structures claimed are separately classified in the office and may well be said to have attained a distinct status in the art. It seems obvious the manufacturer of electric motors would not be likely to manufacture mining machines and the manufacturer of the latter would be quite likely to obtain the electric motors to be used with the mining machines from a separate manufacturer. It is fair to hold, therefore, the subject matter of the two groups of claims are structures of separate manufacture and sale.

"The decision of the Examiners in Chief is affirmed."

Mail Frauds Cause Large Losses

THE American people are investing more heavily than ever in worthless, fraudulent enterprises, it was stated recently by Horace J. Donnelly, Solicitor of the Post Office Department.

"The American public is swindled of more than a billion dollars annually in mail fraud schemes," he said. "The Department is doing everything in its power to control such enterprises, but for each fraud order issued, one or sometimes two new schemes spring up to take the place of the one apprehended."

Mr. Donnelly furnished the following information:

It is not extravagant to say that a million gullible Americans yearly lose money and property in mail fraud schemes and that more than a billion dollars are so lost. The public snaps up hundreds of obviously fraudulent schemes in hope of getting rich quickly and without work.

The Department does all it can in enforcing the postal laws governing these matters. Equally important is the part played by the press in educating the public to the fraudulent schemes through proper publicity. Leading press associations have agreed to carry no more news of lotteries in an effort to help the Department rid the country of this menace.

Two types of publicity are found in the press today regarding fraudulent enterprises. One is helpful to the Department; the other harmful. For example, news of a successful lottery will induce more persons to patronize such schemes, and will thus make the Department's task harder. On the other hand, news of fraudulent concerns being apprehended, with explanation of their illegitimate tactics, will keep people from subscribing to such enterprises and simplify the Department's work.

Fraud orders are issued daily for hundreds of different "rackets." The principal offenders are those operating medical, oil-stock selling, and so-called "work-at-home" schemes by mail. Activities of concerns selling worthless oil stock call for numerous investigations by the Department, and issuance of orders closing the mails to many such promoters and concerns.

The pernicious trade in nostrums and worthless alleged curative devices continues, and during the last year a considerable number of promoters and concerns operating such schemes were denied use of the mails.

The efforts of the Department in curbing these activities have undoubtedly resulted in saving millions of dollars to the small investor.

If the American public would realize the illegitimacy of such enterprises, and refrain from subscribing to fraudulent schemes, it would save millions of dollars each year, and greatly simplify the Department's task of enforcing postal laws forbidding that mails be used for fraudulent enterprises.

Books SELECTED BY THE EDITORS

ELECTRICITY: WHAT IT IS AND HOW IT ACTS. VOL. II

By Andrew W. Kramer, Asso. Editor, Power Plant Engr.

VOLUME 1 of this set was reviewed in the February 1930 issue of SCIENTIFIC AMERICAN. It was so generously received and so highly commended that this complement volume undoubtedly will be likewise acclaimed. Electromagnetic radiation of energy is here extended to include radiation phenomena of various kinds. The subject matter is entirely of a fundamental nature, no attempt is made to present practical development in radio, X rays, radioactivity, magnetism, and crystal analysis, as these are adequately covered in many excellent books. But the intent is to dispel some of the unnecessary mystery which often surrounds electrical phenomena in the mind of the layman.—$2.10 postpaid. Volumes I and II bound as one.—$4.20 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.—$10.00 postpaid.

HAS SCIENCE DISCOVERED GOD?

Edited by Edward H. Cotton

THIS symposium of selected scientific opinion in matters of theology contains lengthy discussions of the scientist's concept of God, by Millikan, Eddington, Einstein, Huxley, McDougall, Thomson, Pupin, Jeans, Lodge, and several others. Whether, as the editor of this volume appears to assume, these men have been ordained to speak for science as a whole remains a question, but the book will arouse much discussion and comment. It is amusing to read in the introduction the frank—perhaps unconscious—confession that the various contributors "were selected through the process of elimination." This does not seem anything like the scientific method of arriving at truth. Readers who disagree with the main theme will find an answer in a chapter entitled "Science and Religion" in Bertrand Russell's book "The Scientific Outlook," reviewed in the following paragraph. —$3.70 postpaid.—*A. G. I.*

THE SCIENTIFIC OUTLOOK

By Bertrand Russell

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By W. Maxwell Reed (Edited by C. E. St. John, Mt. Wilson Observatory)

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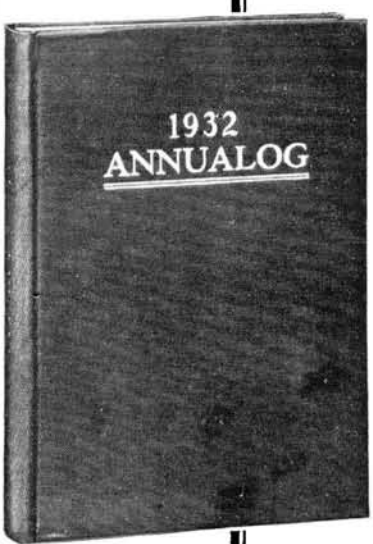

ACROSS THE EDITOR'S DESK passes an abundance of interesting material that does not find place in the magazine for any one of a number of reasons, yet the information, facts, records, histories, etc., are of enough importance as indicating what has transpired or has been developed during the year, to warrant preservation in

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