An Industry That Was Made-To-Order

Which Races Are Best? · · How Big is a Quantum?

SCIENTIFIC AMERICAN

May • 1931

35c A Copy

HOW THE AVIATOR SEES A RAIN-BOW

WHEN A BEARING GOES TO SEA

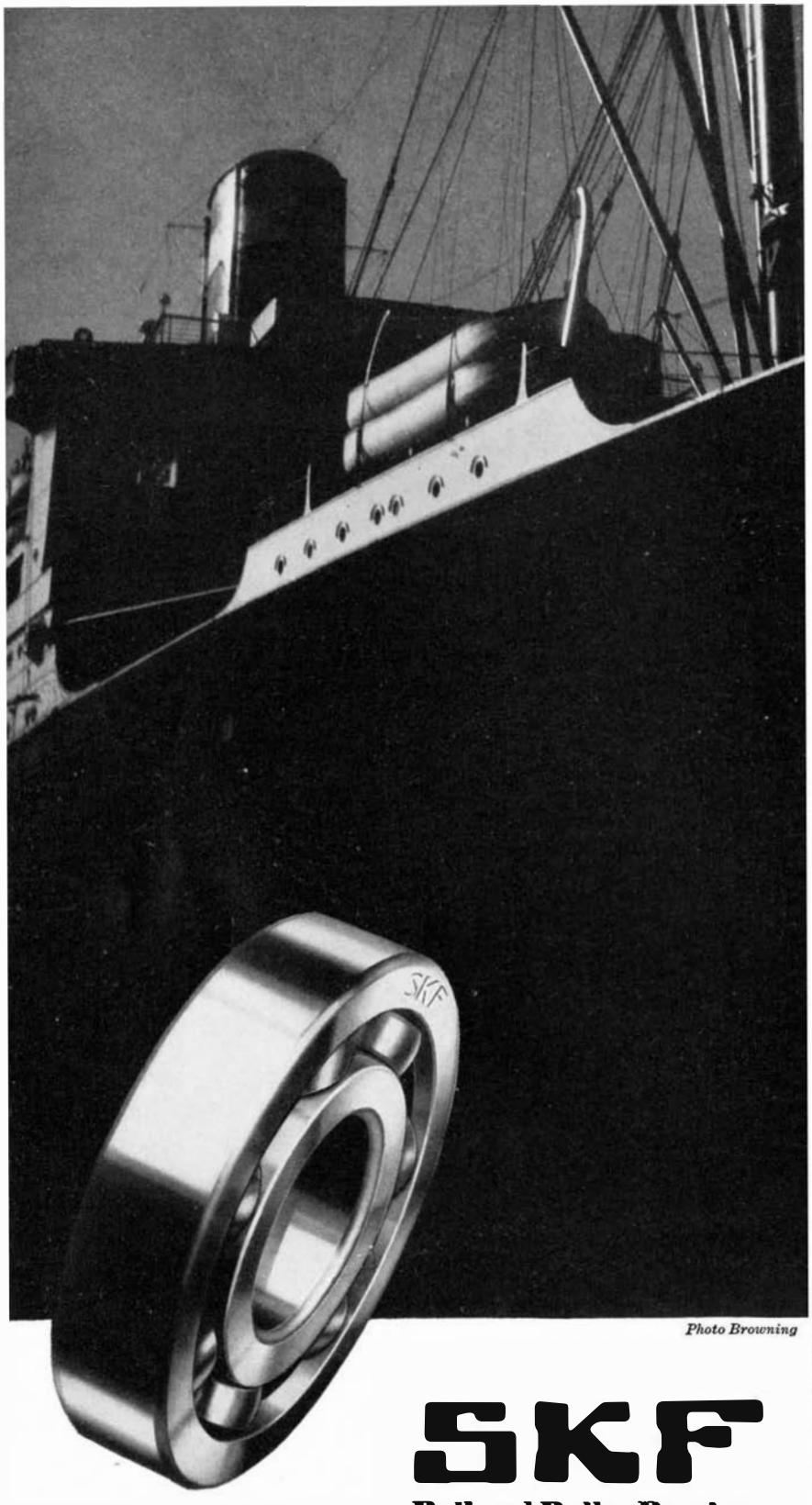


Photo Browning

...there's nothing but PERFORMANCE that counts

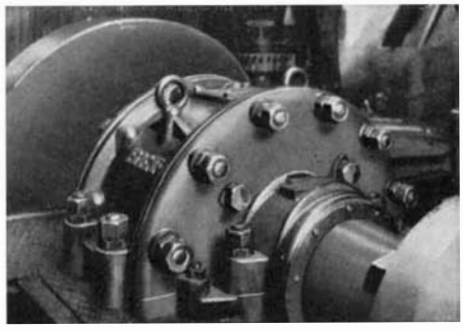
HERE'S to a hail and hearty deep-water bearing that goes sailing over the Seven Seas and gets a nod of approval from salty engineers in every port on the globe. You know the bearing, too. It's SKF.

Ocean-going bearings simply can't fall down... not when they support the whirling propeller shaft... not when they take the thrust of the big screws that push tons of water astern... nor when pumps, fans and other auxiliary equipment depend upon them.

So when it comes to anti-friction bearings, marine engineers write SKF on the specification sheets as a matter of course. They can't afford to take a chance on performance. When a bearing goes to sea there's nothing but performance that counts... which is just as true of a bearing that stays ashore. SKF Industries, Inc., 40 East 34th St., New York, N. Y.

SKF

Ball and Roller Bearings



Propeller Thrust Block, SKF equipped, on the S. S. "Robur 4th." SKF Bearings are also used on auxiliary equipment of the S. S. "Leviathan" as well as on many other trans-Atlantic liners.

SCIENTIFIC AMERICAN, May 1931, Vol. 144, No. 5 entered at the New York, N. Y. Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Scientific American Publishing Company, 24 West 40th Street, New York City. Subscription price $4.00 per year. Foreign $5.00.

SCIENTIFIC AMERICAN

Owned and published by Scientific American Publishing Company; Orson D. Munn, President; Louis S. Treadwell, Vice-President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

EIGHTY-SEVENTH YEAR • ORSON D. MUNN, Editor

CONTENTS • MAY • 1931

THIS MONTH'S COVER

When the horizon or some other obstruction does not intervene, the familiar rainbow becomes a full rain circle and, in cases where a secondary bow would form, a secondary circle will form also, as shown in our cloud-top cover painting. The shadow of the airship will fall in the center of the circle and the whole will be a striking spectacle. Generally the radius of the inner red spectral band is about 42 degrees; that of the red in the secondary bow about 50 degrees; but as stated in that final authority on all kinds of peculiar phenomena, "The Physics of the Air," by W. J. Humphreys, United States Weather Bureau meteorological physicist, "rainbows differ, among themselves, as one tree from another." Always, however, the red of the primary bow will be outside; that of the secondary bow inside.

SCIENTIFIC AMERICAN DIGEST

ACROSS THE EDITOR'S DESK

WHEN we scheduled for publication in our March issue the article entitled "Companions in Depression," by Raymond B. Fosdick, we were uncertain as to its reception by our readers. The way in which it treated an all-important subject made it seem foreign to the pages of SCIENTIFIC AMERICAN, yet it was so concise, so thought-provoking, so thoroughly scientific, that we decided to publish it. That our decision was sound was immediately evident when the March issue reached our readers and we began to receive letters commending this particular article. We quote from one as an example: J. R. Edwards of Cincinnati, Ohio, writes: "For over 20 years I have been reading the SCIENTIFIC AMERICAN from cover to cover and I have never read a better scientific article. . . . Its logic carries so much conviction." We thank Mr. Edwards and many other readers for comments received, and promise them many more articles in the future that will be just as interesting and informative.

●

Looking ahead, we find another article on that inseparable pair—science and industry. It deals with new ideas in business and points out the indisputable fact that if a business or industry is to continue to exist and prosper, it must keep up with the times. This means that it must keep up with science, for it is science that supplies the ideas which open new fields and make possible the expansions and changes which spell good business. In this article, scheduled for publication in our June issue, the author draws a series of parallels that forcibly drive home his points and offers a vast field for thought regarding our economic future.

●

When our forefathers struck out from civilization and made their homes in what was then an untrodden wilderness, but is now criss-crossed with railroad tracks and concrete highways, their map-making facilities were of the crudest, but were sufficient unto the purpose. Now, however, with the advances made in transportation, the day of the surveyor's compass and chain has passed and instead we find the theodolite and the invar base tape; the topographic map has replaced simple route maps or sketches; triangulation has become the order of the day. The author of a comprehensive article on this subject states; "There are two important phases of triangulation; first, how is it done and, second, what is the practical value of the results obtained?" He then goes on to answer these self-imposed questions and the story that he unfolds is one which will give to the reader a better understanding of the science of map-making. A map, *per se*, is an object that commands immediate interest; an intimate knowledge of the background of map-making increases that interest many-fold.

●

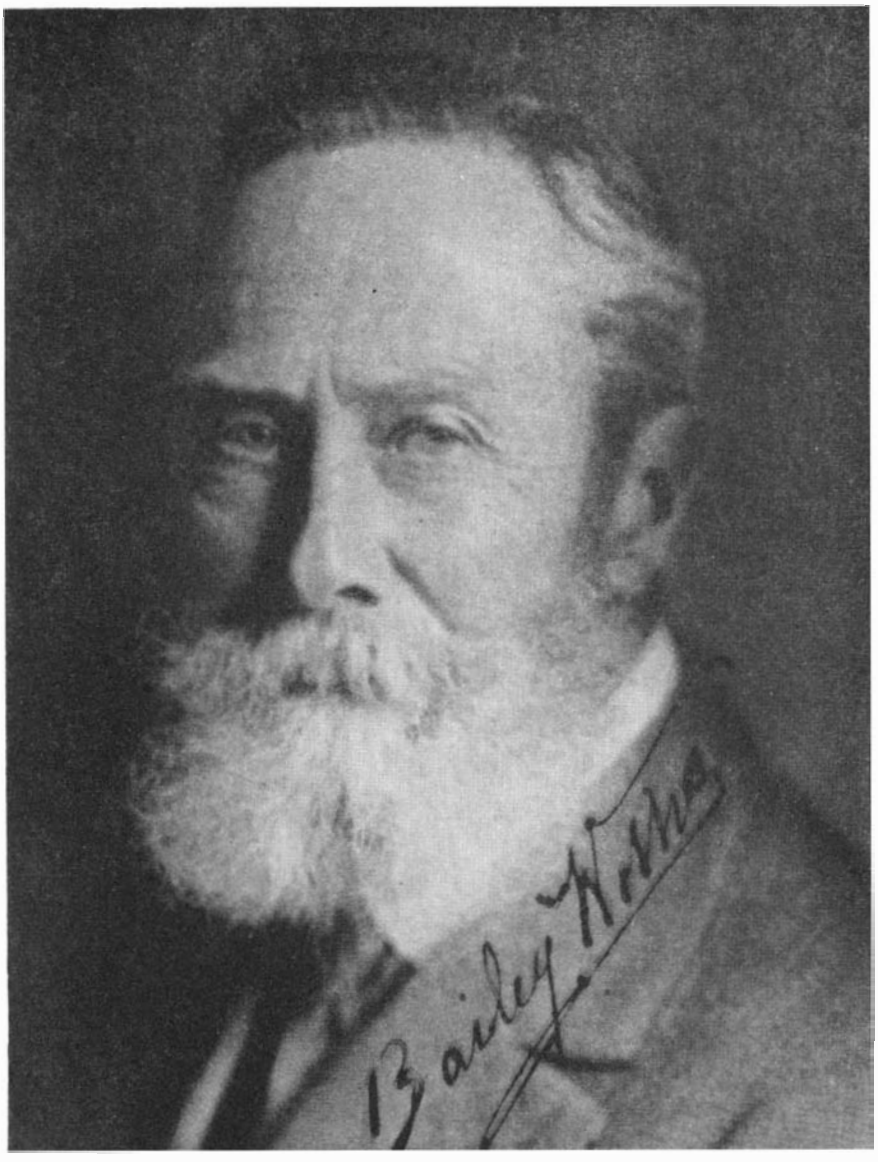
The 12-month calendar, handed down from earlier times, has many inherently bad qualities; even opponents to calendar reform will admit this to be true. But what shall we do about it? Several business firms have adopted modified calendars for their own inter-office operations, and the fact that they retain them after trial seems to indicate that they hold merit. We are fortunate in obtaining from one of the foremost proponents of calendar reform, George Eastman, an article setting forth the problems encountered, and some of the attempts that have been made to solve them. This article, to appear in our June issue, will turn the discerning light of clear thinking on a subject that, because it affects directly each and every one of us, will command more and more attention as time goes on.

●

A short time ago, Henry Ford made the statement that the day of the small farmer is nearing an end, that soon all farms will be mechanized and be assimilated by large farm companies. The tendency seems to be that way, but few realize that gardening in some localities is already in the field of big business, with mechanical equipment that promotes efficiency and increases profits. This particular sort of progress means better and cheaper food for city-dwellers and greater prosperity for the gardener, and therefore the discussion of it in our June issue will interest the nation.

●

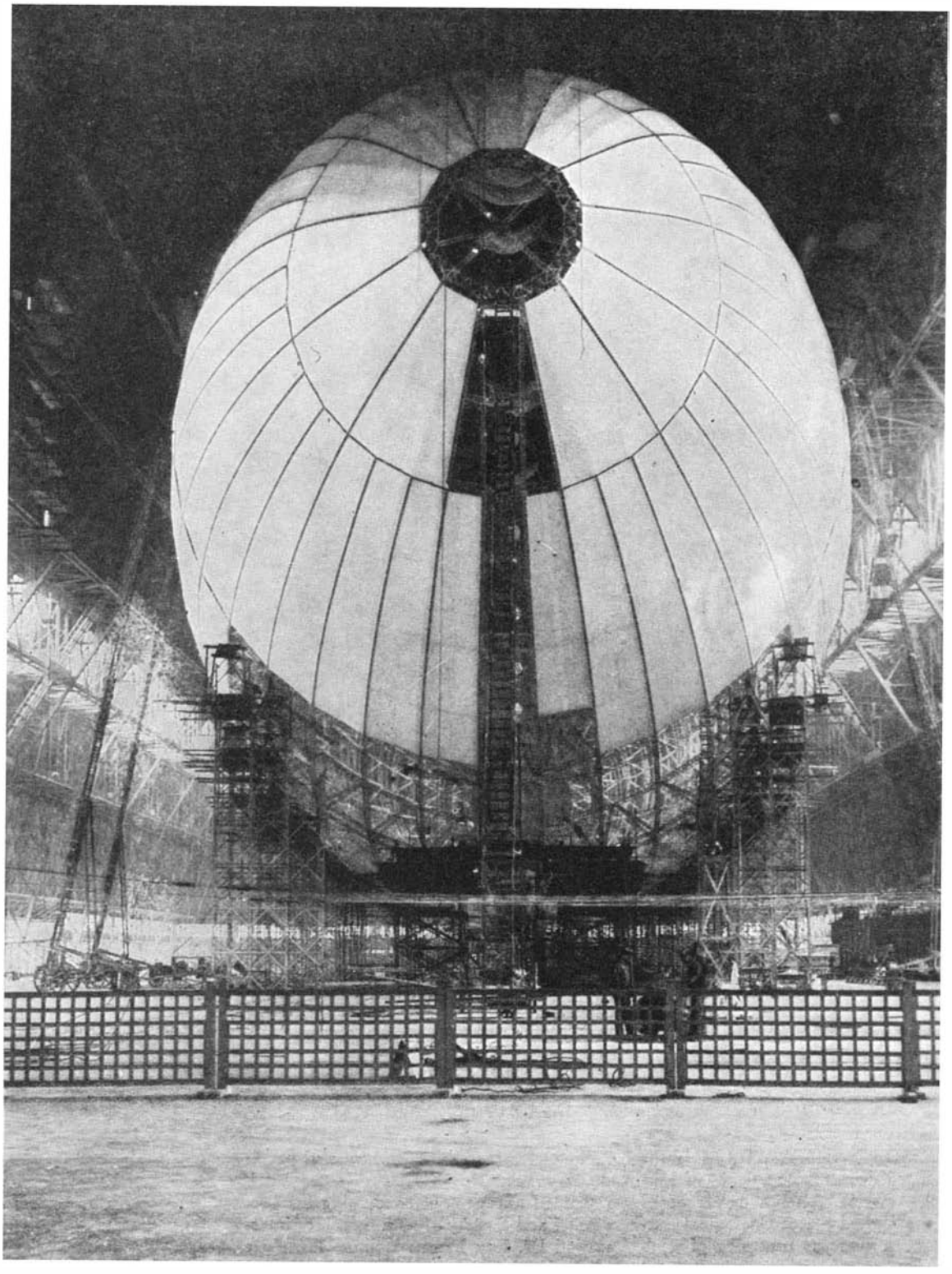
Probably the majority of us have a feeling of loathing for insects in general, yet it is well known that many of them are of great value to the human race. One of the latest examples of this value has been strikingly demonstrated in Australia, where the unwanted prickly pear has developed to a point where it has become an economic problem of large proportions. Land on which the prickly pear has obtained a foot-hold becomes valueless for grazing or agriculture and so some method of curbing its growth and spread becomes necessary. Enter the insect. By a selective process of experimentation it was found that certain insects would attack and destroy the prickly pear but have an antipathy toward plants of economic value. The experiments made, and the results obtained, will be found in an article to be published soon.



PROFESSOR BAILEY WILLIS is the recognized dean of the science of seismology in America. After a career of 32 years in the United States Geological Survey and seven years as professor of geology at Leland Stanford University he still continues his lifetime activities with the vigor of youth, having recently covered 6000 miles in Africa, largely on foot.

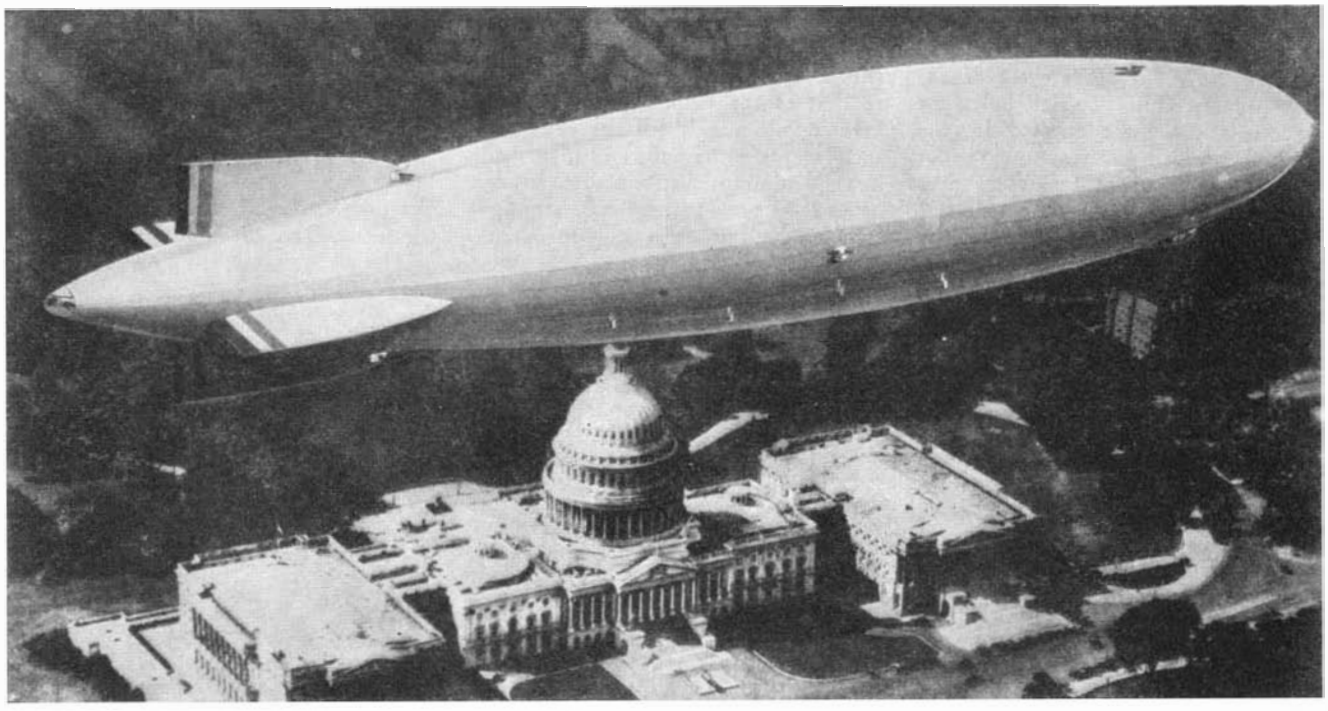
It was Professor Willis who in 1924 made the famous earthquake prediction which provoked a tempest in southern California. "A great shock may come soon," he wrote in the *Bulletin of the Seismological Society of America*, "or within a decade, or not till after more than a decade. But it will come." These few words from so eminent an authority on seismology sent earthquake insurance skyrocketing overnight and threatened to injure real estate development. However, Professor Willis remained unrepentant concerning his prediction and a party of men therefore interviewed Dr. Ray Lyman Wilbur, President of Stanford University (now Secretary of the Interior), asking that pressure be brought to bear in order that a recantation might be forthcoming. Dr. Wilbur is said to have listened patiently but refused to make the requested attempt to coerce the seismologist, adding simply that if Professor Willis had made such a statement it probably was true.

Two articles—"Growing Mountains" and "World Earthquake Belts"—by Professor Willis, were published respectively in the February and April numbers of the SCIENTIFIC AMERICAN for 1928.



MILLIONS OF HAND STITCHES ON ACRES OF CLOTH

A RECENT front-end view of the new Navy dirigible in its hangar-dock at Akron. Riggers hanging from the 200-foot high roof and others on top of 85-foot ladders are now covering the monster airship frame with closely woven, extra-ply, white cotton cloth, of which about seven acres will be needed, while a corps of girls, in another part of the factory, is stitching by hand the 12 gas cells which will take about 21 acres of cloth. The outer covering is tested for a pressure of 60 pounds per square inch, and the cell fabric is made airtight by a special "dope." Goldbeater's skins are not used.



An artist's conception of the Navy's new dirigible flying over the national Capitol

NAVY'S SUPER-AIRSHIP NEARS COMPLETION

THE experience of the Goodyear company in lighter-than-air craft dates back to 1911 when specialized machinery was installed for spreading rubber on cotton fabric. The first Goodyear balloon was manufactured in the following year and in 1913 a Goodyear balloon took first place in the James Gordon Bennett cup race out of Paris.

Aeronautical activities at Goodyear were tremendously expanded with the World War. Kite balloons were wanted for aerial observation and the direction of artillery fire. Airships were wanted for coast defense, mine sweeping, and patrol.

Construction of the *RS-1*, first American-built semi-rigid airship, started in 1923, and in the same year came the acquiring of American rights for full rigid ships from the Luftschiffbau-Zeppelin, Friedrichshafen, Germany, largest constructors of Zeppelins in the world. Dr. Karl Arnstein, chief engineer of Luftschiffbau-Zeppelin and a dozen other expert engineers joined the organization at this time and the subsidiary, the Goodyear-Zeppelin Corporation, was organized.

The interest of the national congress in rigid airships was indicated in 1926 with the authorization of two ships of 6,500,000 cubic-feet capacity as part of a five-year aeronautical program. In March, 1927, a beginning appropriation of 200,000 dollars was made to start construction and in July of that year first place was awarded to Goodyear in an airship design competition held by the Navy and open to the world.

The 70th Congress in 1927 included the item of 8,000,000 dollars in the naval appropriation bill for the construction of two ships. Contract for these was awarded to Goodyear in October, 1928.

When the first of these sister ships, to be designated the *ZRS-4* and *ZRS-5*, takes the air this spring, it will be the largest dirigible in existence. In cubical content it will be equal to about twice the size of the *Graf Zeppelin*, and about 35 percent larger than the *R-100* and *R-101*, built in England. Compared with the United States Airship *Los Angeles*, it will be about two and a half times as large. The accompanying table shows the relative sizes and general characteristics.

Dirigible Characteristics

Name	*Los Angeles*	*Graf Zeppelin*	*ZRS-4*
Nominal gas volume, cu. ft.	2,470,000	3,700,000	6,500,000
Length over-all, ft.	658.3	776	785
Maximum diameter, ft.	90.7	100	132.9
Height over-all, ft.	104.4	113	146.5
Gross lift, lbs.	153,000	258,000	403,000
Useful lift, lbs.	60,000	?	182,000
Number of engines	5	5	8
Total horsepower	2,000	2,750	4,480
Maximum speed, miles per hour	73.1	80	83.8
Range without refueling at 50 knots cruising speed, land miles	4,000	6,125	10,580

The tendency of modern airship design is in the direction of a more curved profile, making the ship appear slightly shorter and fatter. The lead pencil shaped ship, which lent itself ideally to the necessities of mass production during war time, was partially reflected in the slenderness ratio of the *Graf Zeppelin* whose builders had to utilize the hangar facilities they had.

Consequently, the American *ZRS-4* will be only 15 feet longer than the *Graf Zeppelin* while having nearly twice the gas capacity. The American ship is, however, 34 feet greater in diameter, giving it an aspect ratio of 5.9, as against the 7.7 of the *Graf*. That is to say, the American ship will be only about six times as long as it is thick.

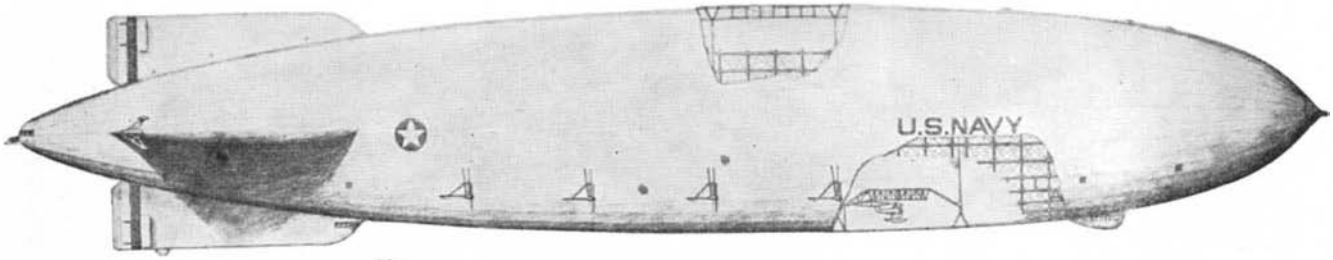
The *ZRS-4* is built on the triple-layer principle of Zeppelin-type ships, having (1) a rigid metal framework to withstand the major stresses from the loads carried, lifting gas forces, dynamic and aerodynamic forces; (2) gas cells within to retain the lifting gas; and (3) a taut fabric outer cover, doped and metalized, waterproofing it, protecting it against the elements, reflecting rather than absorbing heat, and offering a smooth flying surface.

This arrangement has the advantage that one part may assist and to an extent replace another and is in contrast with the non-rigid airships, wherein a single layer of specially treated fabric holds the bag to shape only so long as there is sufficient pressure inside and must serve all of the above functions.

The framework of the ship is composed mainly of transverse rings con-

Text and photographs courtesy Goodyear-Zeppelin Corporation

nected by longitudinal girders, the latter extending from nose to tail. These so-called rings are, over most of the length of the ship, 36-sided polygons, with their corners connected by the longitudinal girders. Near the tail of the ship the number of sides reduces to 24. Diagonal wires form a network, bracing the outside panels described by the above structure, while another system of wires and cord nettings transfers the gas cell pressure to the framework.



Drawing of the new world's largest dirigible, partially cut away to show interior structure. At the top is the longitudinal passage for the crew, and at bottom is shown one of the airplanes in its interior "hangar." Four propellers are shown

The transverse or ring girders are of two types—main and intermediate. The main girders in the *ZRS-4* and *-5* constitute a new feature in airship construction. Whereas former designs required a great number of wires connecting all possible corners to maintain a stiff unit, the rings in the navy ships are built inherently strong, consisting of two outer annular rings connected by cross-girders, in zigzag fashion, to an inner annular ring, forming a triangle.

The main rings are spaced usually about 74 feet apart, the gas compartments being set between them. There are 12 gas cells in the *ZRS* ships, forming a bulkhead system similar to that in surface ships, since the loss of buoyancy in even two whole compartments in the ship does not seriously endanger the craft.

Again the ring girders are large enough to form corridors for crew members to climb entirely around the circumference of the ship, facilitating inspection and maintenance.

The longitudinal girders connect the transverse or ring girders and run from one end of the ship to the other, forming fore and aft ridges or ribs which are discernible from the outside of the completed ship.

Throughout most of the length of the ship there are three gangways or corridors, triangular in shape. One extends along the top center line of the ship. The other two are placed symmetrically in the lower part, about 45 degrees from the vertical. This arrangement is another departure from the past practice which employed a single corridor along the bottom of the ship, with a "cat walk" running from nose to tail.

The lifting gas in an airship expands and contracts with changes in altitude, temperature, and barometric pressure. While the degree of inflation in a helium ship is calculated for any given flight so that at the peak of expansion the helium will merely fill the cells completely, yet provision is always made in rigid airships for immediate release of any surplus expansion that might come under unusual conditions.

The various cells of the *ZRS-4* meet this by over-pressure valves. Since the gas is lighter than air, these are located in the gangway at the top of the ship. In the largest cells there are as many as four of these valves spaced along the top.

The valves open automatically under pressure to release any surplus. In addition, however, each cell has one valve which may be mechanically operated from the control car, so that the ship commander may immediately release gas in all compartments if operating conditions make this desirable.

Location of the valves in the top gangway makes it easier for them to be inspected and kept in perfect working order than in any airship previously built.

THE control surfaces, by which the ship is steered—either as to direction or altitude, are arranged in pairs near the stern of the ship. The main fixed section gives stability to the ship and the hinged after-sections or rudders give it altitude and direction control.

The fins, or fixed sections, are of triangular cross-section—rigid enough in themselves so that little external bracing is required. The rudders are controlled by cables leading to the control car or may be steered by emergency helms in the lower fin. Exertion at the wheels in handling so huge a ship is reduced by providing each rudder with balancing vanes.

The control car is placed forward, projecting below the streamline of the lower half and is built as an integral part of the structure. Here the commander and his staff are stationed, directing operations. The control car contains all of the latest devices known for efficient navigation and control. The car has been made only large enough comfortably to take care of only these operations, thereby reducing the air resistance to a minimum. The radio cabin and commanding officer's quarters are placed directly over the car inside the hull.

Near the middle of the ship and along each side gangway are located a number of rooms for officers and crew. Each sleeping room is provided with four comfortable berths. A large galley with ample cooking facilities, mess rooms, and toilets make up complete and comfortable living compartments for the men while in the air.

The use of helium as a lifting gas has made possible other improvements in the new Navy dirigibles. The use of hydrogen gas, inflammable and under some conditions explosive, in ships built outside the United States has necessitated that power plants be placed outside the ship in cars attached by outriggers so as to supply ample ventilation and prevent the possibility of a spark from the motors reaching the hydrogen. This arrangement, even when the size of the cars was reduced to a minimum, still contributes considerably to the air resistance of the ship and hence affects the speed and makes cramped working conditions for the engine crews.

The American ships, using the non-inflammable helium gas will house all the motors within the ship's hull with only the propellers extending outside the ship and will have a roomy engine room instead of a cramped car for the crew built along the gangways. There are four engine rooms on each side of the airship.

Another important change is the use of bevel gears at the outboard ends of the rigid drive-shafts, making it possible to use the propellers, not only for thrust in a fore or aft direction (the engines themselves being reversible), but also in a vertical direction, by tilting the propeller axes through 90 degrees. This feature of tilting propellers will be of great importance in starting and landing maneuvers. It will also permit carrying a greater load and avoid the loss of lifting gas when the ship has to be landed against surplus lift.

When liquid fuel is used in an airship engine, a definite loss of weight is experienced from hour to hour as fuel is consumed. In past practice this has required the release of a corres-

ponding quantity of the lifting gas. In the *Graf Zeppelin* this difficulty was met by the ingenious device of using a gas fuel, the well known blau gas, which has approximately the same weight as air, so that fuel consumption does not affect the ship's weight or lift. The United States Navy Department met the difficulty in still another way—namely, by installing condensers on the motors at the exhaust, liquefying the combustion vapors.

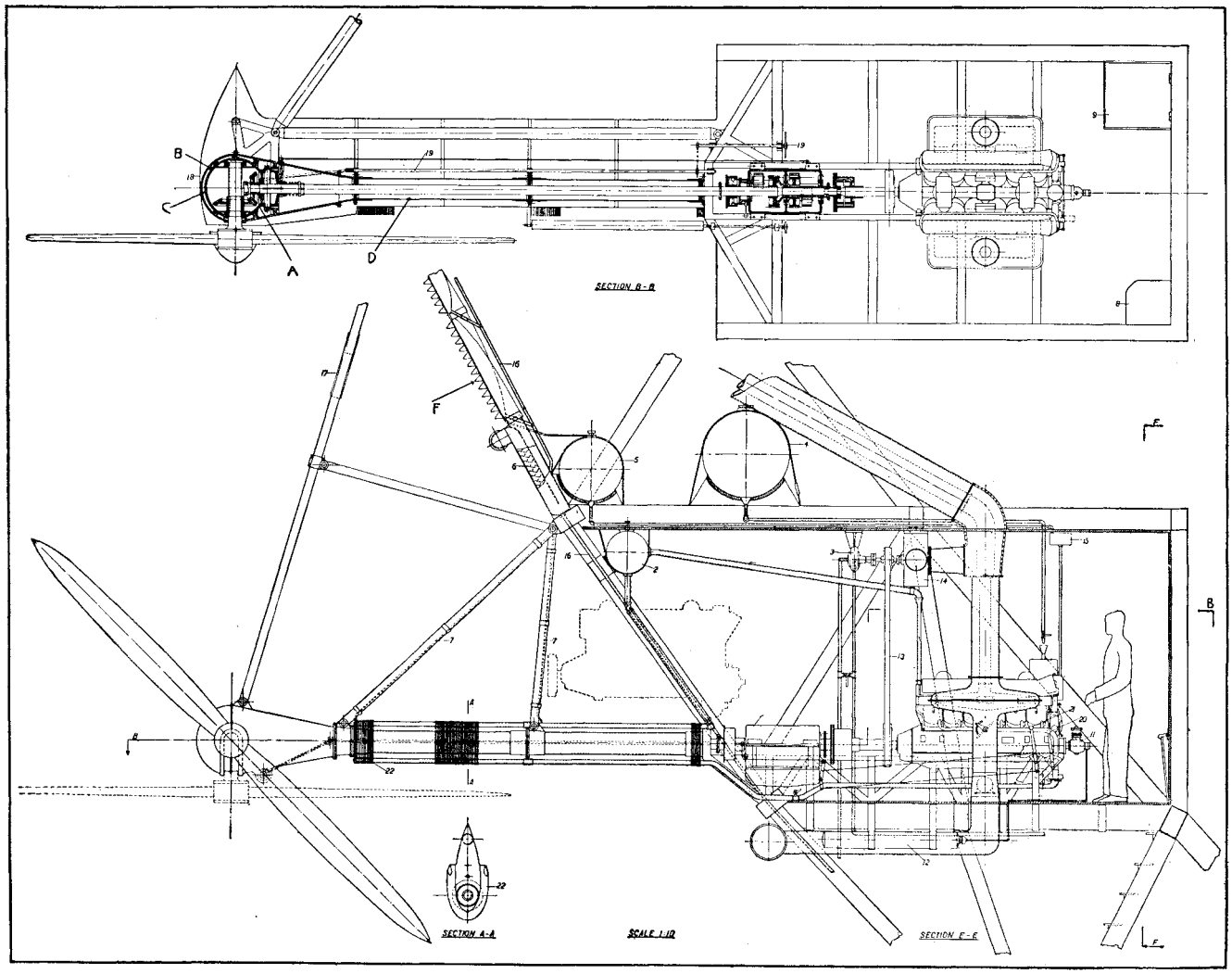
Due to the oxygen taken from the air in the combustion of gasoline, the exhaust gas contains water vapor in greater quantity than there was fuel burned. Therefore the consumption of fuel does not lighten the ship but builds up a supply of water ballast (this being also a highly useful feature in flying the ship) and maintains constant equilibrium.

The equipment now used by the Navy consists of a system of connected tubes exposed to the airstream and installed between the engine car and hull. This device has proved satisfactory as to thermal effect, but involves considerable parasite resistance. In the *ZRS-4* the possibility of eliminating much of this drag by locating the condensers along the surface of the hull has been investigated. The system as designed is equipped with a counterflow pre-cooler that takes the exhaust gases directly from the engines and drops their temperature about 80 percent. After taking up the heat, the air used as a cooling medium is piped away and used for heating the control car and quarters.

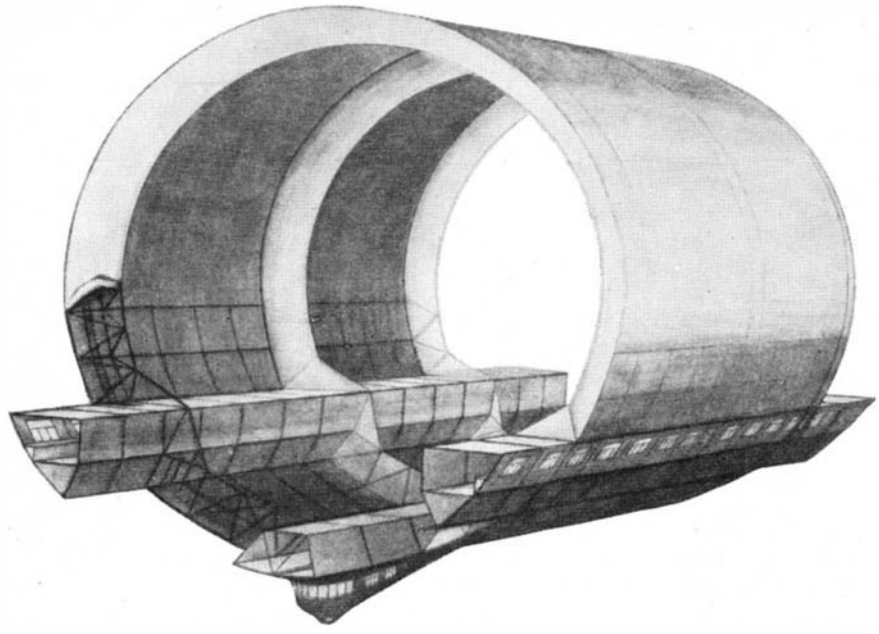
FROM the pre-coolers the gases pass into condensers. These are large, metallic panels which extend from the engines up to the sides of the ship. The outer surface is ribbed longitudinally and projects into the airstream so as to provide the maximum cooling effect with a minimum of resistance. Water separators are located at the bottom of the condensers, and the recovered water is piped from them to ballast bags along the side gangways of the ship.

A novel feature of the design of the Navy airships is the provision made for the storage of five completely assembled airplanes. A storage compartment, about 75 feet long by 60 feet wide, is located about one third of the ship's length from the bow, (between the crew's quarters). Collapsible doors in the bottom of the ship cover a T-shaped opening through which a trapeze with an airplane attached can be hoisted or lowered. The airplanes may attach or detach themselves from the trapeze during flight. Such a possibility increases the scouting value of an airship and aids her in warding off an attack.

Too much emphasis cannot be given to the structural strength of these ships, which is considerably in excess of that found in previous ships. Sufficient strength has been provided to meet such conditions as (a) violent maneuvers of the rudders, vertical and horizontal, both alone and in combination; (b) flying at excessive angles of pitch



One of the eight power plants and its swiveling propeller. Directly reversible engines are installed in separate engine rooms inside the hull and connected through rigid driveshafts and bevel gears (A) to the propellers which can be used for forward and reverse drive and, by tilting their axes 90 degrees, also for vertical thrust. The swiveling device is in an inner spherical case (B) inside an outer case (C) which is rigidly attached to the hull by a braced outrigger (D). The inner case can be turned by a worm driven by rod (19) from the engine room and the case and propeller are held in any position by a clutch. Longitudinally ribbed condensers of the water recovery system are at (F); water separators at (6)



Drawing to show the side longitudinal passages which the crew may use in going from one end of the ship to the other, and the control car below in front

due either to surplus buoyancy or to using the maximum available dynamic lift; (c) ship flying at full speed into a perpendicular gust region having a speed of 60 feet per second and a sharp border line.

The ship may still maintain progress if several engines should fail. Moreover, the ship may keep in the air by use of its dynamic lift, which results from flying her at a slight angle of pitch, to compensate for the extreme case of losing more lifting gas through large ruptures in the cells than can be compensated by jettisoning ballast.

THE fire risk has been reduced to a minimum through the use of the inert helium gas. The possibility of a gasoline fire is no greater than in an automobile. In fact, fire usually results only from a fuel tank ruptured in a collision—a remote possibility in an airship. Precautions are taken, however; the engine rooms have fireproof walls and elaborate fire-fighting systems; ventilation of the entire ship prevents the accumulation of any possible gasoline vapors; gas-tight electrical connections prevent the ignition of any local fumes.

There need be no fear of lightning—contrary to general opinion. Records show but two ships having been fired in this manner, and had they not been inflated with the inflammable hydrogen, even these would not necessarily have been lost.

Any damage to the hull due to a direct hit by lightning has been proved to be remarkably small and localized; this is due to the fact that every metal part is bonded to another, and the entire structure acts as a Faraday cage, rapidly dissipating a lightning charge.

Finally, there is the feature of accessibility, which is really one of safety. There is not a place in the ship which cannot be reached even while the ship is in flight. Thus inspection and repair may be carried out at any time, preventing minor damage from growing serious.

The structural design of the navy ships may be easily adapted to a commercial ship, one for carrying passengers and mail over-seas.

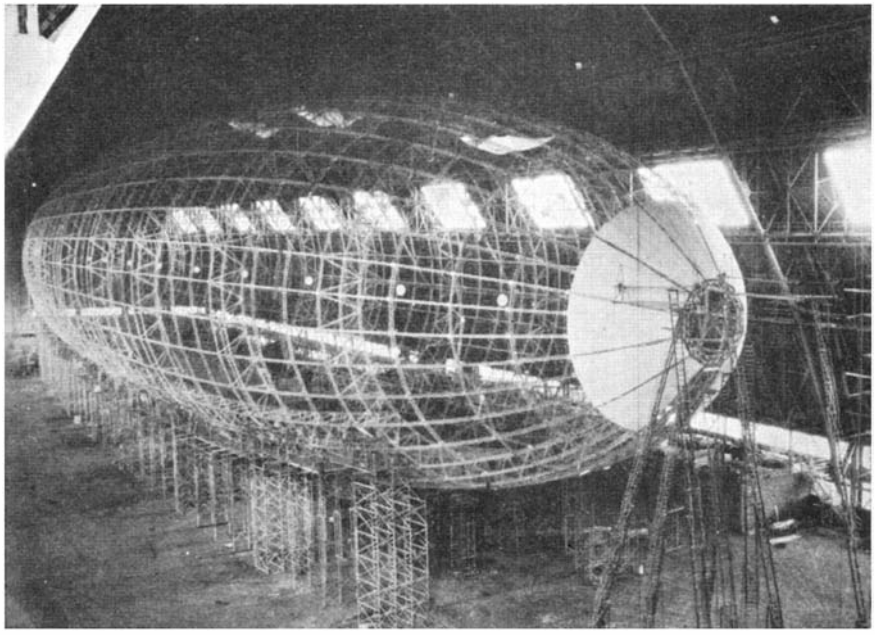
Here again the advantage of a helium-inflated ship presents itself. In previous passenger-carrying rigid airships, the presence of hydrogen practically demanded that the accommodations be placed outside the main hull structure. On the other hand, air resistance consideration necessitated keeping all protruding structures as small as possible. More or less cramped cabins was the result.

In a ship of the general dimensions of the *ZRS-4* and *-5*, accommodations may be built in comfortably providing for up to 100 passengers, according to the weight of fuel required for any certain route.

In the case of a 100-passenger ship the following dimensions are interesting: a total deck area of 12,000 square feet, of which each state-room (for two persons) uses an average of over 70 square feet; promenade decks and corridors have a total length of about 900 feet and an average width of five feet, while about 3500 square feet are used for public compartments. Promenades, lounges, dining salon, and smoking rooms are not dreams, but may soon be actualities.

Spacious compartments, the lack of noise and odors and sea sickness, speed of travel over the oceans greater than is possible to any surface craft—these are some of the advantages the airship has in store for travelers.

ITS contribution to overseas transportation will not be in competition to the surface carriers but supplementary to them—for that proportion of passengers and merchandise to whom higher speed is essential. It will do this without subtraction of business from existing carriers, for all history has shown that speed of travel means volume of travel. Surface lines and air lines will alike be beneficiaries as this new vehicle takes its place in the field of transport, applying in the international field what America has long learned nationally—namely, that better communication means better understanding, has vast economic advantages, and is equally impressive in the field of human relations.



After the frame was completed, the next job was that of covering it with a special cloth which is later to be "doped" and painted with metallic paint

OUR POINT OF VIEW

France and Italy Agree

THE differences between France and Italy relative to naval claims having been the cause of much dissension and suspicion on the continent since the London Conference, the recent Franco-Italian naval accord is a welcome sign-post pointing the way to peace. And while, in a sense, it is the rounding out of the three-power London Treaty into a five-power one, there are certain significant differences that will bear clarification.

The London Treaty set maximum submarine tonnage at 52,700, provided for a reduction of cruisers and destroyers, suspended construction of armored cruisers, and forbade transfer of tonnage between submarines and surface vessels. France's obstinacy won for her advantages in all these features. Under the Paris-Rome agreement, France is given 81,900 tons of submarines; she is allowed to maintain her present tonnage in cruisers and destroyers by replacing old vessels; she can build two armored cruisers of 23,333 tons each (and so can Italy); and she can utilize for surface vessels the difference of 15,000 tons between the 97,000 tons she demanded at the London Conference and the actual figure of 81,900 tons she accepted.

Final acceptance of this new agreement, not only by the two most concerned but also by the three signatories of the London Treaty—England, Japan, and the United States—lessens greatly the tension under which the world has been laboring for some time; the flame under the continental war caldron dies down somewhat and the war brew boils less vigorously. Some may say that France got more than her share; nevertheless the agreement has proved acceptable to the five naval powers, and we now know where we stand. If only Americans were not so apathetic regarding naval affairs, we could now proceed with a proper naval program which would give us our Treaty Navy by 1936. Unfortunately we seem to have lapsed from apathy into a coma.

Cynics Notwithstanding

IN these days one frequently—too frequently—hears of "jerry" builders and "gyp" contractors who skimp and scamp on materials and labor; and it is the custom for the modern cynic to contrast such reprehensible building methods with the solid, honest workmanship of the "good old days," those times before the art of skimping and scamping had even been thought of—usually, of course, with the added implication that in these modern times of sophistication, honesty has undergone a sad change for the worse. Therefore some recent revelations concerning skimping and scamping in a famous 15-16th Century structure, St. George's Chapel, where England's later kings are buried, as described by the Dean of Windsor before the Royal Society of Arts, may prove illuminating.

It appears that some cracks previously concealed by plaster recently indicated the need of restoring a part of the chapel. This work from the outset revealed a condition little short of astounding. The great stone ceiling vault of the edifice had been supported largely on brackets or "springers" attached to the walls, a construction which is safe if built with care. But as the Dean of Windsor says, "the builders took such chances and scamped their work so flagrantly that the brackets were not even bonded into the walls at all" and, he continues, "the architects have pointed out that there was consequently no scientific reason why the vaulting stood in its place. That it did not crash was an instance of the way in which buildings sometimes 'stick'—that is the only miracle which kept the vaulting in its place."

It further appears that one main wall of the structure had moved seven inches, though the foundations of the chapel supposedly rested on solid rock. An investigation revealed that while one of the walls was thus bedded, the excavation for the other had been carried down only within 18 inches of the rock and stopped in clay. This of course had gradually let the heavy walls down, allowing hundreds of tons of rock in the ceiling vault to sag 11 inches. St. George's was no place to venture into, but no one knew of the imminent danger and so all were blissfully happy.

Safety in Construction

NOT so many years ago when any large building was in course of construction, people used to say that a workman would be killed for each floor of the structure. No one knows how this peculiar form of fatalism originated but, strange to say, it persists even now to some extent.

Some time ago a statement gained wide currency that more than a hundred workmen were killed in the construction work on the Empire State Building which is described on another page of this issue. Actually, the records show the deaths of only five men; and only one of these five was entirely blameless in his own death. This man was sawing a plank when the opposite end was hit by a truck. Of the other four, one ran into a blast area, a second stepped off a scaffold, a third fell down an elevator shaft, and the fourth leaned into a shaft and was struck by an ascending hoist.

It is ridiculous to put any stock in tales of hundreds being killed on such jobs. At such a tremendous price in human lives, progress would indeed be but a great conceit of man. Happily, however, few lives are ever lost on large jobs—or small—because business and industry are making every effort to make carelessness an obsolete word and are helping the campaign by utilizing all manner of precautions.

Evolution

AFTER an interim during which it suspended publication due to early financial struggles, our contemporary, *Evolution*, now reappears and we gladly welcome it once more to the family of scientific journals. In all the world with its 23,000 scientific periodicals this, as far as we know, is the only one devoted wholly to the spread of information concerning evolution and the refutation of the silly arguments daily dinned into the ears of the millions by the well-organized anti-evolutionists.

Among our own readers we have discovered comparatively little interest in the purely controversial aspects of evolution, a fact which we interpret as evidence that our readers accept the basic principle as established and undebatable. The articles which we have published therefore have concerned only particular phases of evolution, not arguing the elementary fact of it at all. Doubtless, however, there is room for a specialized journal like *Evolution* which seeks in a rather lively manner to demonstrate to a wider audience of less well informed general readers the fact of evolution and refute the wordy opposition. The journal now carries the moral backing of a number of eminent men of science, among whom are two of our own Corresponding Editors, Professor Elihu Thomson and Professor William K. Gregory. Such names may be taken for what they are worth—and they are worth much.

INCANDESCENT REFRIGERATORS

By HENRY NORRIS RUSSELL, Ph. D.

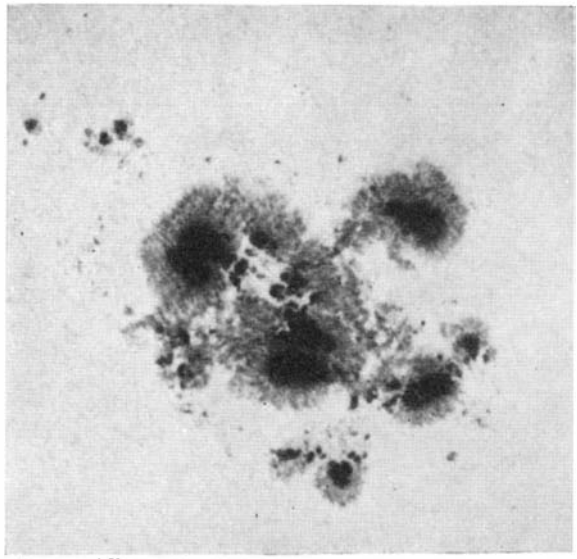
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

FOR many years it has been recognized that sunspots were cooler than the rest of the sun's surface. The evidence is conclusive and varied. The spots are darker than the photosphere —though by no means black, as is conspicuous when Mercury in transit across the sun's disk can be compared with them. At such a time it is also obvious that the light which comes from the spots is not merely duller but also redder than that from the rest of the solar surface, and this affords an independent proof of lower temperature. Finally and most decisive of all are the differences between the spectra of spots and of the disk. Some lines are weakened in the spot spectrum, many are strengthened, and many more appear in the spots which do not show at all in the light from the disk.

THE investigations of Hale and his colleagues at Mount Wilson about 25 years ago showed that the lines which are weakened in the spot-spectrum can be produced in the laboratory only at high temperatures or by the more violent excitation of the electric spark. Those which are stronger in the spots show just the opposite behavior, being relatively strongest in terrestrial sources when the vapor is as cool as is consistent with its being luminous. Some of the lines which appear only in the spots are of this sort but the majority are due to absorption, not by free atoms but by the molecules of chemical compounds which are evidently decomposed at the higher temperatures prevailing over the photosphere at large.

This cumulative evidence settled once for all that the spots are considerably cooler than their surroundings. But how much cooler? This proved a harder question to answer—as questions demanding a numerical answer almost always are—and a decisive solution has come only recently.

Pettit and Nicholson, working with the great tower telescope at Mount Wilson and thus having at their disposal an image of the sun 16 inches in diameter, and applying to this one of their delicate vacuum thermocouples, have measured the energy of the radiation from a small area in the center of a spot for various wavelengths in the spectrum and compared it with that from a corresponding area of the undisturbed disk. Their measures, which are numerous and consistent, show that at the violet end of the spectrum a spot gives out less than 30 percent as much light as the disk. In the red the proportion rises above 40 percent, and in the invisible infra-red it increases slowly to 80 percent. Averaging all together the total heat radiation from the spot is found to be 47 percent of that from an equal area of the photosphere, a result checked by direct observation without the intervention of the spectroscope.



Courtesy of Yerkes Observatory

A great group of sunspots. Diameter 250,000 miles. Though really hotter than the electric furnace, a sunspot is relatively cooler than the sun's surface

Part of this radiation comes from a scattering of sunlight by the air above the mountain. Measures on the sky just outside the sun's limb showed that allowance for this would reduce the real radiation from the spot to 40 percent of that from the disk.

After this correction the measurements, both of the total radiation and of its distribution among the different wavelengths, lead to accordant values of the spot temperature, 4750 degrees K.—measured on the Centigrade scale from the absolute zero. This is about a thousand degrees higher than even the most powerful electric furnace can reach, so that it seems pretty queer to call the sunspots "cool." But the temperature of the sun's undisturbed surface, measured in the same fashion, comes out 5950 degrees K., so that the spots are 1200 degrees cooler than their environment.

These are what are called "effective temperatures" and represent a sort of average of the temperatures of the various layers in the solar atmosphere down to the depth at which its increasing opacity prevents us from seeing farther. At a high level the actual temperature is doubtless lower than the values given above—perhaps by as much as 800 degrees. At the lowest depth to which we can see it may be 1500 degrees higher, but in both cases the temperature in the spot will be lower than elsewhere in about the same proportion. Sunspots may therefore be regarded as vast refrigerators, cooling the material of which they are composed by almost 2000 degrees Fahrenheit over a region thousands of miles in diameter and keeping it cool for weeks on end.

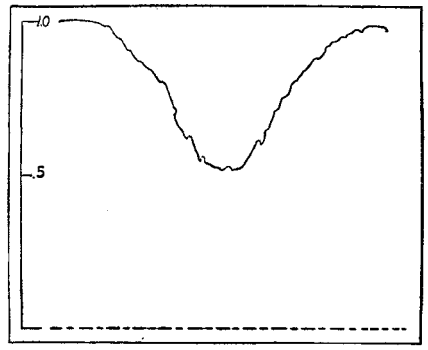
THE cause of this cooling is not far to seek. Hale's classical observations show that the spots are great whirlpools—vortices—in the sun's atmosphere. Evershed has shown that all around the perimeter of the spot the gases are moving outward from it at a speed which reaches a mile per second in the lower levels of the atmosphere. Hence the vortical motion is upward and outward—the exact opposite of that of water running out of a wash basin. The ascending column of gas must be forced to expand greatly, and forced expansion will cool any ordinary gas. Of course it comes from hot regions below the visible surface. Whether after it has ascended and expanded it will be cooler than the surrounding gas at the level it reaches, depends on the rate at which the temperature changes with depth in normal regions. This latter rate depends upon the way in which the flood of heat from the deep interior escapes to the visible surface and thence into space, and it can now be calculated. It is then found that the gases in an ascending vortex will indeed be cooled

below the temperature of the surroundings. The latest calculations by Professor Milne show that an ascent of not more than 30 miles would account for even more cooling than occurs in the greatest spots.

The reasoning on which this conclusion is based appears to be very strong, but the results are, to say the least, perplexing. Sunspots are thousands of miles in diameter—often ten times this—and it is quite incredible that they can be less than a hundred miles deep. Yet if the material which streams out of them had come from a depth of thousands of miles, why is it not much more cool by expansion than the observations indicate? Another and even more serious difficulty arises. To keep any kind of refrigerating engine at work requires the steady expenditure of power. It is one of the most fundamental principles of physics that "work can never be obtained from any mass of matter by cooling it below the temperature of the coolest part of its surroundings." To produce such an effect work must be *done on* the cooled material. This is why it takes power to keep an electric refrigerator running, as everyone knows. Where does the power come from to run the enormous solar refrigerators which we see in spots?

THE first rational answer to this question, and a very convincing one, was given a few months ago by the brilliant young German astrophysicist Unsöld. To understand it we must consider more fully what happens in an ascending column of gas. The statements which have already been made refer to a gas which has no stores of energy within it except the energy of motion of its molecules. If a mass of such gas should be forcibly raised from deep in the sun's atmosphere to a higher level it would expand till its pressure matched that at the new level, pushing aside the surrounding atmosphere and doing work at the expense of its own internal energy, so that it would become cooler. When it had done this it would be cooler than the surrounding medium and therefore denser (since the pressure was the same and we are dealing with gas of the same composition throughout). Being denser than its surroundings it would immediately start to sink back to its original level.

But now suppose that the gas in its initial hot and dense condition at the deeper level contains stores of latent—apparently concealed—energy of some sort. It might, for example, consist of two elements like hydrogen and oxygen, ready to combine but prevented from doing so at a great heat. As it rose and the pressure and temperature fell the combination might begin. This would liberate an additional store of "sensible" heat, so that when it reached the higher level a mass of gas of this sort would be considerably hotter than in the case previously described. If the latent heat thus liberated were great enough the ascending gas might even be hotter than its surroundings. If this happened it would also be lighter and would continue to rise. Other masses of gas from the lower level would follow it in a continuous stream, and a great ascending current of gas would be formed and keep on indefinitely until the available energy-containing material was exhausted, or perhaps until some ex-



Courtesy *The Astrophysical Journal*

Curve of temperature taken across a sunspot by means of a thermocouple, by Pettit and Nicholson

ternal disturbance stopped the stream.

Now the temperature inside the sun's photosphere is far too high to permit any chemical combinations; but just because it is high it encourages the more drastic process of ionization—the separation of electrons from atoms. The most abundant element in the sun's outer layers is known to be hydrogen. This is rather hard to ionize and, at the visible surface and even a little below, the proportion of ionized atoms is very small. But Unsöld's calculations show that a thousand miles or so below the photosphere where the temperature is about 15,000 degrees (if the gas is largely hydrogen) almost all the hydrogen atoms are ionized. If a mass of gas were to rise from this level to the surface the re-combination of the hydrogen nuclei (protons) and the electrons would liberate a great amount of heat—more than enough to heat the rising column and keep an ascending current running.

A little below the photosphere the hydrogen would be practically all neutral, and the heat-producing process would be turned off; but the ascending column of gas would persist by its own momentum, still rising but cooling by expansion in the last stages of its way, so that it would reach the photosphere as a cold current to spread out in all directions along the surface and use up the last of its energy in pushing out the surrounding gases.

Here, then, we have the long sought source of power to operate the sunspot "refrigerating machines." They appear as real heat engines, burning fuel composed of electrons and protons and discharging the waste gas—hydrogen resulting from the combustion of the two—at the top of the chimney-like vortex of the spot.

THE rotary motion is a by-product free to arise if there were the least initial tendency of the sort—as we see in wash basins, dust whirls in the air, and on a larger scale in tornadoes.

Many details of course remain to be cleaned up—what additional effect is produced by the combination of electrons and partially stripped atoms of the metals or of gases like oxygen, what starts and stops the motion, and the like—but a great advance has certainly been made.

One long-standing puzzle is immediately solved. The temperatures of all sunspots big and little appear to be nearly the same. This used to be perplexing but in a rising current such as Unsöld discusses, the temperature would reach equality with that of the surroundings at a definite level at which the ionization of the hydrogen had become small, and the cooling at the surface would correspond to ascent from this level and hence be always about the same. Unsöld's figures indicate that this level would be only a little below the photosphere and not far from the depth suggested by Milne (which, by the way, would be increased from 30 to some 300 miles if the atmosphere is composed largely of hydrogen instead of heavy metallic vapors as he supposes). There is therefore good reason to accept Milne's conclusion that the cool part of the sunspot is at most a few hundred miles deep and therefore very thin compared with its diameter, "like a penny" as he suggests. Below this level the ascending currents presumably exist but if we could study them 500 miles deeper down we would find the spots hot and not cold.—*Princeton University Observatory.*

●

Editor, Scientific American:

I much regret that, owing to an error in the preliminary carbon copy of the paper on the mass of Pluto, which Dr. Nicholson generously put at my disposal, one of the statements in my recent article [February, page 90.—Editor] *failed to report his final conclusions.*

If the earlier observation of Lalande is disregarded, the remaining observations of Neptune are insufficient for any precise determination of the mass of Pluto. If Lalande's observation is included, Dr. Nicholson's value is as stated. A different estimate of the accuracy of this early observation would lead to a different value of the probable error of the final result.

—Henry Norris Russell

BELLS

By ALBERT A. HOPKINS

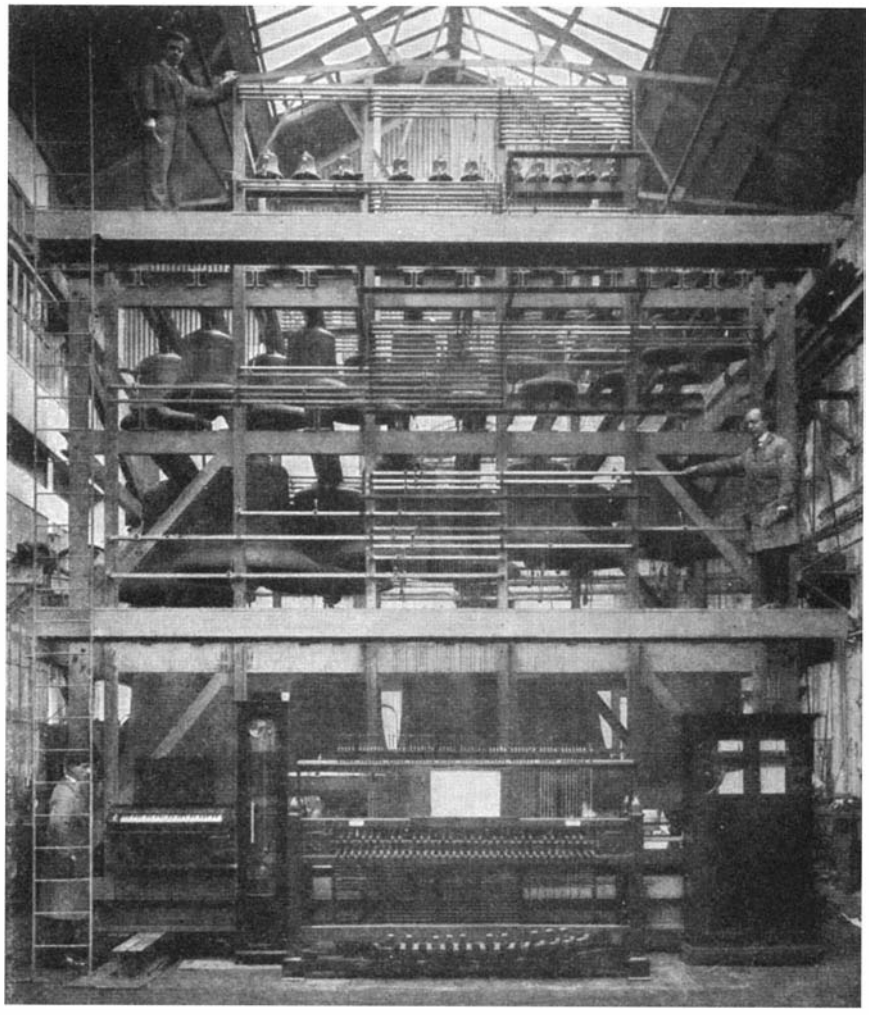
BELLS have a peculiar charm, like the organ, for most people. Formerly the best place to hear them was in the Low Countries, Belgium and Holland, but now New York City can claim the finest set of bells in the world. The Riverside Church, overlooking the Hudson River, has a carillon of 72 bells. Fifty-three bells were removed from the Park Avenue Baptist Church and 19 more have been recently cast in England. All are now in place and the formal dedication took place February 8, 1931. This largest of carillons is a memorial to Laura Spelman Rockefeller, mother of J. D. Rockefeller, Jr.

There is probably nothing which requires more patient skill and craftsmanship than the founding and finishing of a bell. Strange to say it is the small bell which is the most troublesome. Sometimes twelve casts may be made before a small bell with a true tone is secured. The large bells are made by exact formulas and there is no guesswork. Bells do not improve with age, neither do they retrograde.

FROM olden to modern times the number of bells in bell towers was increased from four (we derive the word "carillon" from the Latin *quadrilionem*) to a considerable number, but the name remained unchanged. By "carillon" we now understand a set of bells of the finest musical quality and tuning. Twenty-three bells are the minimum and 72 bells the maximum. The bells are usually sounded with the aid of "claviers" arranged somewhat after the manner of the ivory keys in the console of an organ; they take the form of light wooden levers. These levers are attached by means of wires and cranks to the clappers which strike the bell on the inside surface at a point near its largest diameter; the travel of the clapper is about one inch, which is sufficient to bring out the full volume of sound required for carillon playing, while still allowing the delicate touch necessary to enable a single operator to manipulate so many bells. Pedals are attached to the levers connected with the heavier bells, so that these can be played by foot or hand. This enables the player to strike them more forcibly than would be possible with the hand levers, and it also allows him to execute the more intricate passages of music by leaving his hands free for the rapid manipulation of the levers connected to the smaller bells, playing the bass accompaniment with his feet. On a large carillon, mechanical devices assist the player; the so-called "deep-end," up to 24 bells, can also be played from the remote organ console. The player of a carillon is termed a "carillonneur" or "bell organist" and is a person of musical ability who has become expert in mastering the capabilities of the huge instrument.

In Croydon, England, is located the world-famous bell foundry of Gillett and Johnston, Ltd. Many of the artisans are descended from families of bell founders and their skill is most remarkable. On the molding floor of the plant in the charming Surrey suburb of London, the first thing that draws attention is what looks like a huge bell of sand. This is one of the cores which is formed to the exact shape of the inside of the finished bell. Over this fits a cast-iron case, also bell-shaped, and the molten metal is poured between the exterior of the core and the interior of the case to form the bell.

The core is built up on a brick, bell-shaped foundation which is erected on an iron plate fitted with lugs for hoisting. Upon this foundation sand and loam are applied and scraped smooth with a revolving template called a "strickle" board which gives the proper contour of the inside of the bell. The core has to be dried several times in an oven. The shaping and drying processes may take two or three days for a small bell or two or three weeks for a large one. If the hot metal should strike wet sand there would be an explosion and the casting would be ruined.



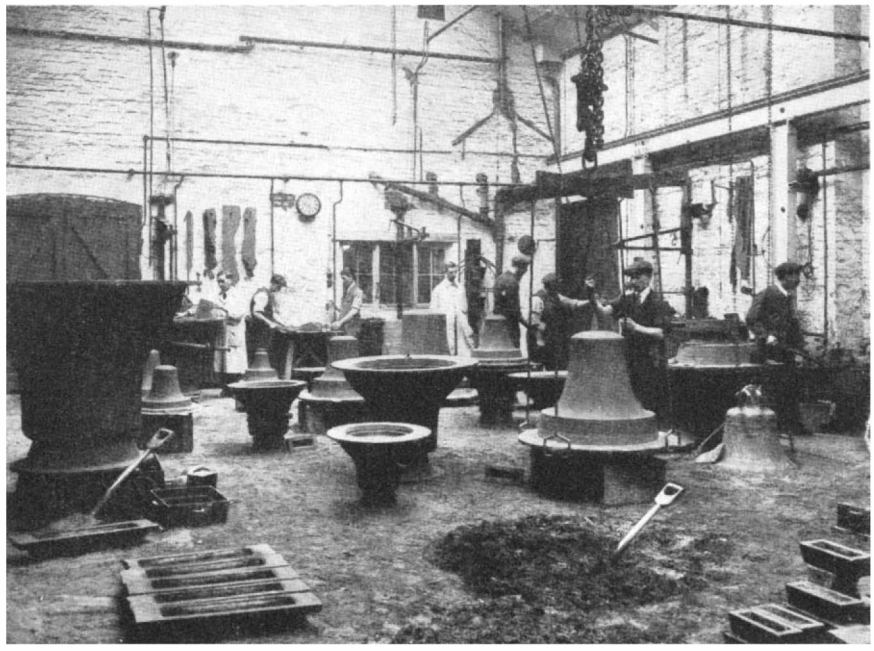
A carillon of 49 bells for a war memorial at Wellington, New Zealand. The carillon bells are hung in steel cages. The larger bells are often placed below the operating room. The console has claviers (handles) and pedals for large bells

The final operation on the core is to cover it with black lead (plumbago) to give smoothness to the casting.

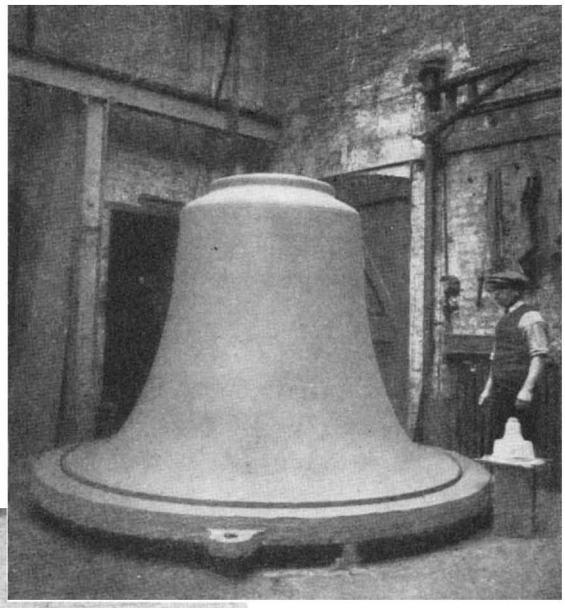
THE cast-iron case is solid for the small and medium sized bells, but built up in sections bolted together for the largest bells. The case is first turned mouth upwards and lined with a layer of damp sand two or three inches thick; this layer also is shaped with a revolving template or "strickle" board to give the exact shape of the outside of the bell. When completed to shape and before final drying, any inscription or ornamentation is provided for by stamping the figures or design into the still soft sand. This requires considerable skill to ensure clean cut, evenly spaced lettering in perfect alignment. To facilitate handling and turning over, the case is fitted with trunnions extending beyond the rim; these form pivots when suspended by two chains. The lining of the case also is dried in special ovens several times while being made, between each layer or coating of sand. When entirely dry the surface of the sand in the case also is coated with plumbago to give a smooth surface to the finished bell.

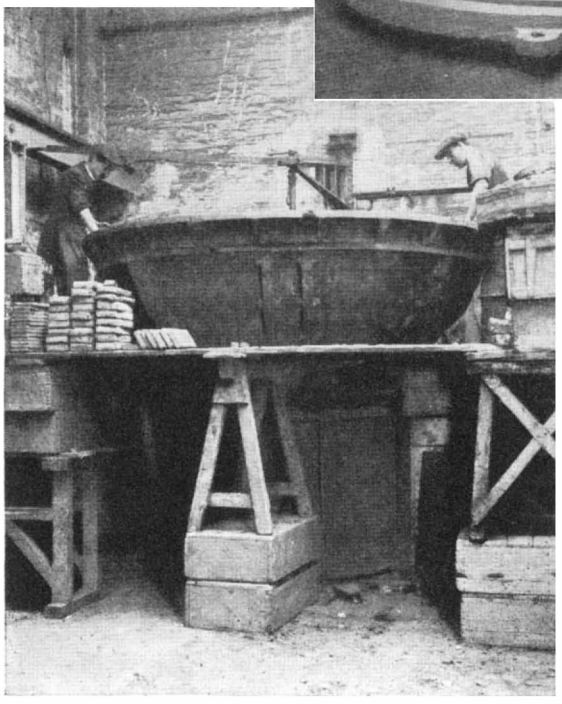
In the case of a large bell the core is placed in a deep pit in the foundry floor and the case is carefully lowered over it. The space between the core and the case is a perfect bell of air which will be displaced in a short time by the molten metal.

The case is securely bolted down to the cast-iron plate on which the core is formed, as the hydrostatic pressure of the molten metal, which is very great in the case of some of the mammoth bells, would otherwise float the case and allow the metal to escape.



The molding floor of the foundry is where the core is built up and the outer mold is formed in an iron case. The metal between core and case forms the bell





Above: **A bell-shaped sand core is built up on a brick center.** ***Left:*** **An iron case or outer mold is lined with damp sand**

"Casting day" is always interesting to visitors at the foundry. A number of bells are usually cast on the same day. The casting of a ten-ton bell can be accomplished in about ten minutes. The composition of the alloy varies somewhat, but great care is always taken to insure that only the purest metals are melted together. Expert supervision is given to the processes of preparation, melting, and casting.

In preparation for pouring, a cast-iron box is fitted to the top of the case and in this there is formed a chamber to provide a "head" of metal, with a circular opening leading down to the bell. A cone-shaped plug is arranged so that it can be raised or lowered to control the flow of metal as required during pouring.

THE bell metal, pure copper and tin, which has previously been heated for several hours in a reverberatory furnace, is now tapped into an iron ladle, and the scum, which floats on the surface, is raked off. The foreman in charge takes the wheel of the tilting gearing of the ladle and turns it over till the metal begins to run out into the "head," an assistant holding the lever which controls the plug. When a good amount of metal has been poured into the head the plug is lifted, and while the metal is running in, the plug is kept in such a position that the clean metal from the bottom of the head never runs into the mould faster than the metal is poured from the ladle, thus keeping all the scum and dross on the surface of the metal in the head. In 24 hours for a small bell and perhaps two weeks for a large bell, the metal is cool enough for the case to be lifted off, exposing for the first time the finished bell, which, after still further cooling, is lifted off the core plate, laid on its side, and the core broken away from the inside. While in this position any inscription or ornamentation is cleaned

Lowering the case onto the core in the pit before casting

up with a sharp chisel to remove the hard burned sand sticking between the letters, and the fins of metal at the joints of the moulds are "fettled" off.

The bell, on its way through the machine shop, is stopped to have drilled in the top the holes which will be used for hoisting and suspending. It then goes to a shed, where all dirt on the surface is cut away by a powerful sandblast, leaving the metal smooth and clean. From there it goes to the tuning shop. Here it is placed mouth upward on the revolving table of a large boring mill, to which it is firmly secured by bolts and clamps, and the metal is cut away from the inside until not only is the strike note in tune with all the other bells in the carillon, but also various harmonics and octave overtones are in accord. This, as may be imagined, is the work of highly skilled experts, involving much time and great care and patience.

THE bell is then brought into the main erecting shop to join its brothers or sisters, or to await their arrival, and, in the case of a large bell or "bourdon" a massive steel headstock is fitted, with trunnions working in roller bearings. It is then lifted into its steel swinging frame, steel wheels are added, and the wrought-iron clapper fitted inside. This clapper plan is one of the three methods of striking this particular bell and is used when it is swung for church services, or possibly for tolling on special occasions; it rings "half up," that is until the tip of the bell is vertical, and the two wheels are driven by electric motors and automatic gearing. It can also be sounded by a hammer that falls on the sound bow, or, for carillon action, by a counter-balanced clapper which is pulled rapidly against the outside of the bell.

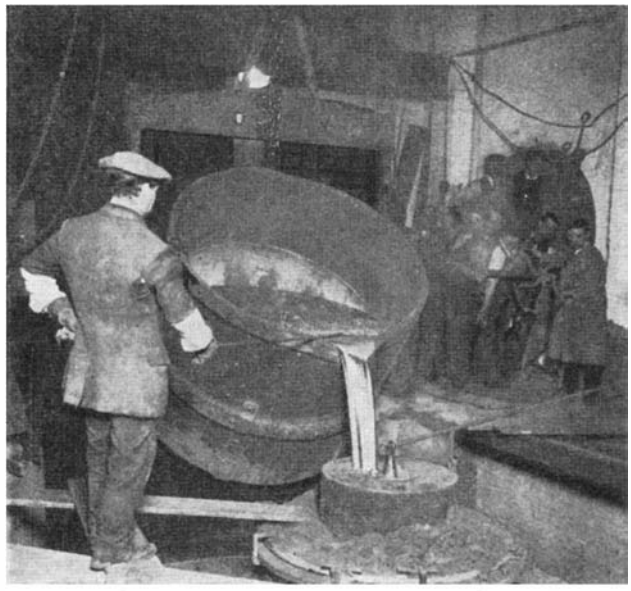
If the bell is not one of those which swings, it is suspended from the steel beams with a suitable insulating material between the bell and the steel, and is struck at the sound bow by an internal clapper, the strokes being given by hand pressure on one of the claviers operated by the carillonneur. The bells which are stationary can also be struck by means of outside hammers operated by gravity to give the "quarter chimes."

The foundry is often required to correct defects in bells. When it is possible to correct to a reasonable extent the harmonies of each bell in an old group, while putting the group into tune as a whole, this is done with the utmost care. In each case where it is found that the harmonies of an individual bell are too false for appreciable correction, it is recast, using the same metal, unless there are historical or sentimental reasons against such a procedure. On the other hand, a bell that is really bad, but worthy of retention in its present form owing to antiquity, is usually preserved in the church while a new one takes its place in the belfry.

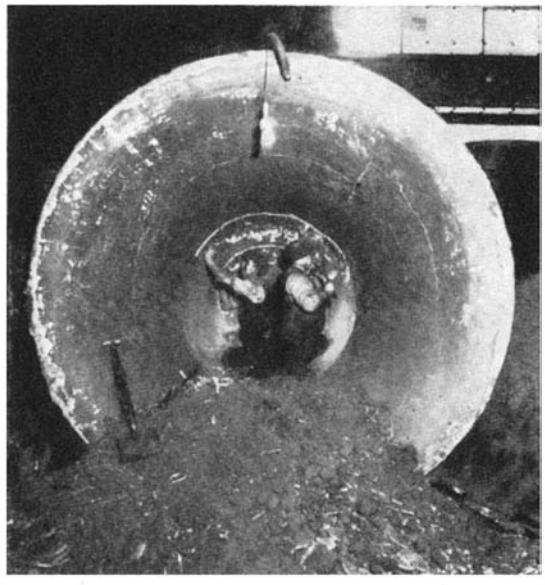
The belfry of the Riverside Church, which is located in the 392 foot tower, is 40 feet wide and 63 feet high. The bells are disposed in three tiers or stories within this huge cavity and the carillonneur, Mr. Kamiel Lefevere, sits (at present) within the operating chamber in the middle section at the console. He has complete control over the 72 bells which run in weight from the "bourdon" weighing 40,880 pounds, to a six-inch. 10-pound bell tuned to "C."

AT present these bells are operated by four different methods: 1. By the carillonneur's console, giving delicacy of touch and expression; 2. Five of the heavy bells are swung by automatic electric mechanism as a call to services, or on special occasions; 3. By electro-pneumatic mechanism and long-distance control from the church or chapel organ consoles; 4. By automatic hour striking and quarter chiming mechanism. The hours are struck on the "bourdon" by a clock-controlled mechanism, and the quarters are chimed on any number of bells up to four octaves by means of a revolving barrel five feet diameter studded with electric contacts which can be changed for varying the music of the chimes as often as desired.

There are also pedals like those of the organ to actuate some of the bells. The small bells play easily by the hand levers free from mechanical help, but in the case of the



Pouring the bell metal. A large bell can be cast in the mold in ten minutes



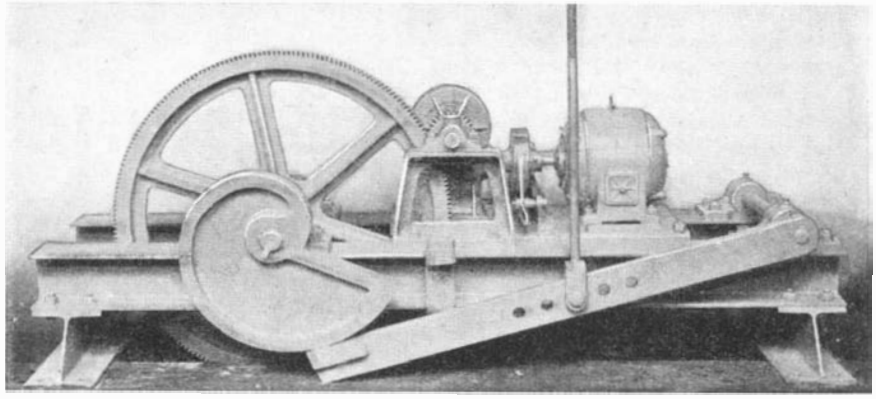
After the casting is cold the core is broken down leaving the bell ready for the finishing

larger bells electrical contacts bring an electro-pneumatic system into play. Even with this powerful aid expression is not lost sight of and the carillonneur has three gradations of power to use, giving soft, medium, or loud blows.

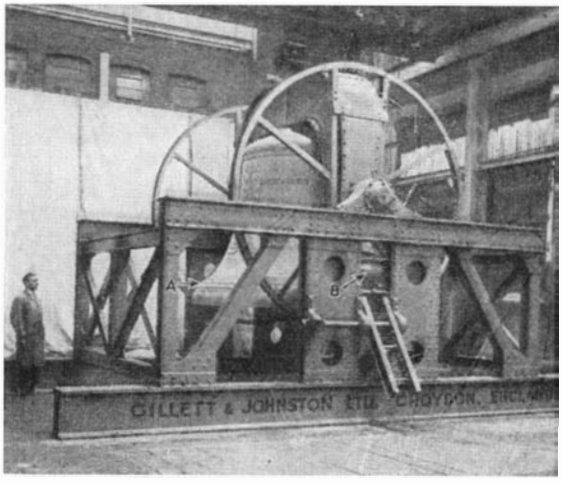
IN a small room several floors below the belfry is the clock proper, a compact and neat piece of delicate mechanism the duty of which is to keep accurate time and at the right moment send an electrical impulse to start the hour striking and quarter chiming mechanism. Both of these units stop themselves when they have struck the correct number of blows on the bell. A program wheel has an adjustment for silencing both the hours and the quarters during the night. Each hour the clock automatically winds up the 20-pound weight that keeps it going. The clock has no dials as the church is Gothic and the dials would not be in accordance with this style of architecture.

The total weight of the bells is over 100 tons and the steel work weighs 140 tons. The clapper for the "bourdon" weighs 4000 pounds and the clock hammer 1000 pounds.

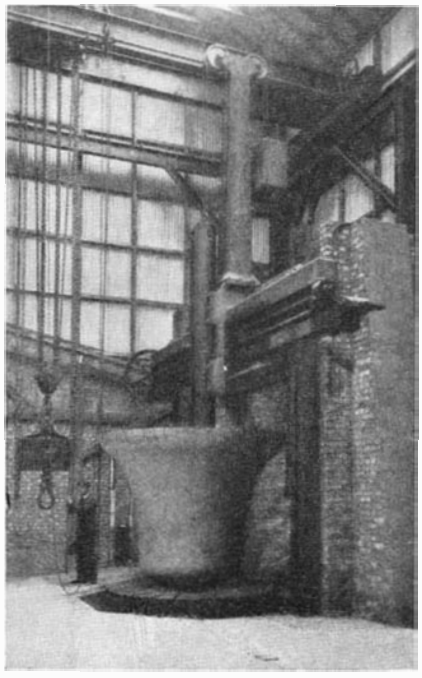
As may be imagined, a careful lay-out of the switch-gear and wiring has been necessary, for on no account must the external hammers or clappers strike the bells while they are swinging, and it must be impossible for two operators to play the bells from different places, the carillonneur's console and the organ console, at the same time. A control panel is placed beside the carillonneur; when he wishes to play he presses one button only, labeled "start" and this starts up the power plant, cuts out the quarter chiming gear, and cuts off all controls from the organ consoles. After playing, the button "stop" is pressed and this stops the power plant, releases the quarter chimes, and connects the organ controls again. In both cases telltale lamps light up to show how the controls are set. The pressure of either button starts motors which switch over 157 wires from one system to another.



The motor-driven, clock-controlled mechanism for striking the hours on the "bourdon." The outside hammer is attached to the end of the upright rod at the right



The largest bell is swung by motors and is also struck by power-actuated hammers at *A* and *B*



Tuning is done by removing metal from inside bell by a boring mill

The new bells for the Riverside Church. The "bourdon" weighs 20½ tons and is swung and struck at different times. The larger bells are placed below the console

On March 3rd 1928 two thousand four hundred ringers from all parts of England gathered at Croydon to witness the casting of the great 20½ ton "bourdon" for the Riverside Church. Among the visitors were 41 ringing clergymen and 71 lady ringers. The Archbishop of Canterbury made an address and a great "bell concert" followed, which included hand bell ringing items by famous ringers.

We are indebted to Mr. R. F. A. Housman, M. I. Mech. E., General Manager of Gillett and Johnston, Ltd., for the interesting series of pictures and for much help in explaining the action of this beautiful carillon in its lofty belfry.

SALT DOMES*

By M. F. KNOY

Efficiency Engineer, Gulf States Utilities Company, Lake Charles, Louisiana

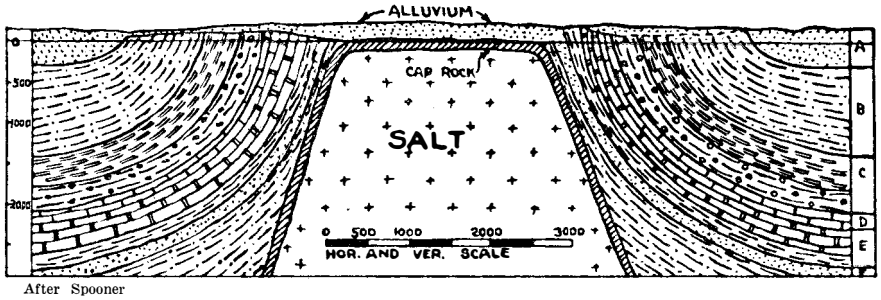
TO THE casual observer the Gulf Coast region of Texas and Louisiana offers no spectacular topographic features such as are met with in other sections of the country. Its pine forests, densely wooded swamps, broad prairies, and extensive marsh lands, while possessing a certain scenic charm, offer no natural wonders to the traveler's eye.

One must not conclude from this, however, that the region is devoid of any interesting feature. On the contrary it is one of the most famous localities in the world from a geological standpoint, owing to the numerous subterranean salt domes that occur here. Salt domes occur in other parts of the world, notably in Germany and Roumania, but nowhere have they proved of more scientific interest or of greater economic value than here on our own Gulf Coast.

As the name indicates, the typical salt dome is a more or less imperfect cone of rock salt, rising from several thousand feet below to within a few hundred feet of the surface. A good idea of the form and extent of such a dome may be gained from a study of Figure 1. The body of salt in the various domes will of course vary as to size and shape and in other details, but the general plan is the same.

Space does not permit of a discussion of the various theories of salt-dome origin that have been offered in the past. Suffice it to say that many eminent geologists have made a study of the subject, and at present they are agreed in a general way as to the manner in which these peculiar structures were formed. They know that vast deposits of sodium chloride, or common salt, exist at a depth of several thousand feet below the surface in various parts of the earth. They also know that any rock will flow if subjected to sufficient pressure, and that rock salt will flow more readily than any of the more common rocks of the earth's crust. Hence, the theory is that during past ages uneven pressure, due to gentle folding of the crustal rocks, has caused the salt to flow upward through weak points in the overlying strata.

As would be supposed, these overlying strata have been highly compressed, bulged upward, and in many cases broken entirely. Much of the rock directly above the salt has been thrust to the surface and carried away by erosion. Figure 1 illustrates this condition of affairs. Of course the process should not be thought of as something in the nature of a sudden catastrophe, but rather as a slow upward movement requiring for its total rise of several thousand feet a period of tens of thousands of years. In many cases erosion of the uplifted rock has kept pace with its elevation, so that to the untrained eye the surface may offer little evidence of the dome beneath. Usually, however, the site of the dome is marked by a surface prominence or a mound of varying height and several hundred feet in diameter.

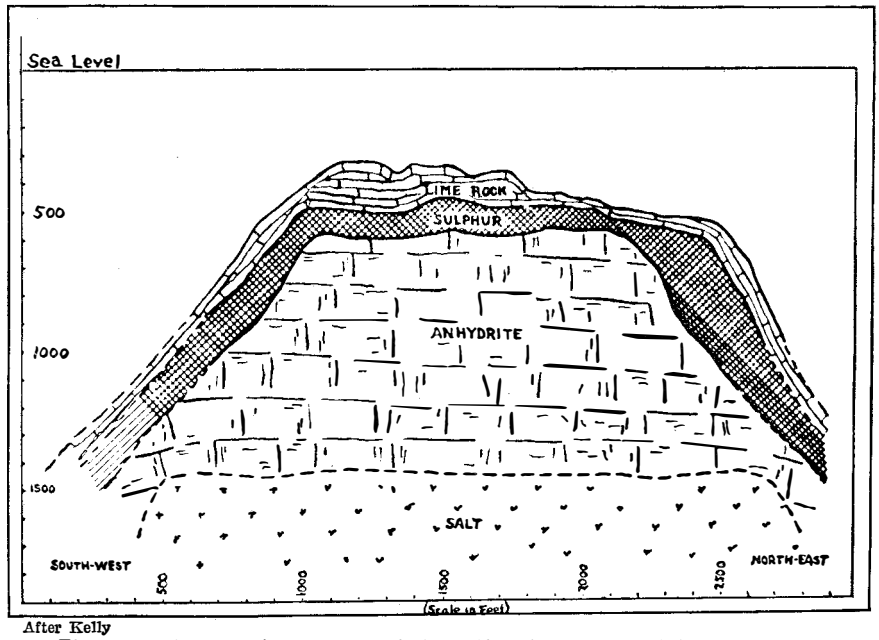


After Spooner

Figure 1: **Cross-section of a typical salt dome in the Gulf Coast section**

SOMEWHAT over 40 salt domes have been located in the coastal plain of Texas and Louisiana, and several more are known farther inland in each state. The existence of salt springs on the site of certain of these domes was known to the earliest white settlers and even to the aborigines. In the case of Avery Island, a dome near New Iberia, Louisiana, the white men found a surface deposit of ashes and potsherds five acres in extent and reaching a depth of three feet in places. These ashes were presumably from the fires of prehistoric red men who evaporated the brine over open fires and reclaimed the salt. The enormous extent of the ash deposit would indicate an accumulation of hundreds of years, and no doubt the place was the scene of a thriving salt industry in the days of our savage precursors. But the existence of the salt springs was unknown to the Indians found in the region by the white men.

A number of domes have been worked for salt at various times and in



After Kelly

Figure 2: **Showing the position of the sulfur deposit at Sulphur, Louisiana**

*Reprinted by kind permission from the *Stone and Webster Journal.*

various ways. In some cases water is pumped into the salt formation and withdrawn again, carrying the salt in solution. The brine is then evaporated and the salt reclaimed. In other cases shafts have been sunk into the salt. Here the lump substance is loosened by light blasting, loaded on small flat cars and hoisted to the surface. It is then crushed, sized, and prepared for distribution.

Huge quantities of salt are produced by the latter method in the three famous salt mines, Jefferson Island, Avery Island, and Weeks Island, near New Iberia, Louisiana. The product from these mines is of unusual purity, often testing over 99 percent pure sodium chloride.

Salt was discovered on Jefferson Island about 1895, but was not worked commercially until 1923. Since that time, however, production has been on a large scale. Large scale production was begun at Weeks Island in 1902. By 1924 a total of more than 2,000,000 tons had been produced, and at that time the annual production was more than 200,000 tons.

AVERY ISLAND was used as a source of salt by prehistoric Indians as mentioned above. The salt springs here were discovered by a white hunter in 1791, and when during the war of 1812 England stopped the shipment of salt from Liverpool to the States, a shaft was sunk and production started on Avery Island. After the war, however, the competition of imported salt caused production to be discontinued in 1817. Again during the Civil War, when salt became scarce in the South, production was resumed at Avery Island. It is estimated that some 10,000 tons were supplied the needy Confederacy before a Union army, under General Banks, destroyed the works in 1863.

After the Civil War several unsuccessful attempts to operate the mine were made. In 1899, production was put on a paying basis, and continues so at present. Up to 1924 a total of 2,500,000 tons had been produced, and the annual production at that time was 100,000 tons.

Despite the huge quantities of salt that have already been removed from each of these mines, scarcely a sign has been made on the known deposits which in each case still contain hundreds of millions of tons of high grade salt.

Some of the Gulf Coast salt domes have a cap of sulfur-bearing rock. The origin of this sulfur is not definitely known, but is usually regarded as the result of the reduction of calcium sulfate, or anhydrite, by oil and natural gas in the porous strata surrounding the dome. Some salt domes have little or no anhydrite on them and hence no sulfur. Other domes seem to have brought up from below a cap of anhydrite which in some cases is several hundred feet in thickness. In these a heavy deposit

An airplane view of Spindletop, a famous salt-dome oil field near the city of Beaumont, Texas. Compare the distribution of the wells with the typical figure placed below it

of sulfur is often found at the top of the anhydrite. Figure 2 shows the position of the sulfur deposit in the dome at Sulphur, Louisiana, one of the most famous sulfur producers.

Sulfur was discovered here about the time of the Civil War, but was not profitably exploited until about 1903, after the noted chemical engineer, Herman Frasch, had perfected a practicable method of production. By this method wells are drilled through the sulfur-bearing rock. Water at about 300° F. is pumped into the porous rock to melt the sulfur, and the molten product is brought to the surface by means of an air lift. It is then run into enormous vats where it cools and solidifies. The walls of the vats are then pulled down and the material is ready to be broken up for shipment. A stranger to the region is sometimes astonished to see at a distance of several miles a huge, golden lump of pure sulfur, containing several hundred thousand tons, glistening in the sunlight.

From 1903 to 1924 some 9,000,000 tons of sulfur were produced from the Sulphur dome. Since that time the sulfur mining has been abandoned and the flanks of the dome explored for oil. Today it is an active and valuable oil field.

The Frasch system of production, which was perfected at Sulphur, is now in use on other similar deposits, notably the one at Gulf, Texas. Though there is commercial production at only a few points, it is on such a huge scale that since 1917 the Gulf Coast mines have supplied most of the world's sulfur. And, when we consider the enormity of

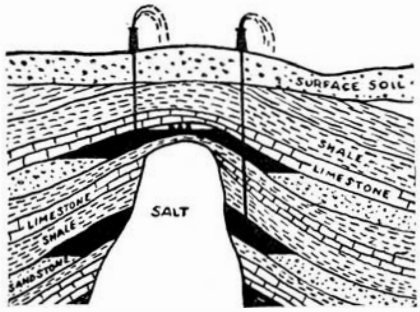


Figure 3: **Ideal conditions for oil**

the known deposits and the economical recovery made possible by the Frasch system, it is likely that they will continue to do so for many years to come.

The Gulf Coast region is underlain by several oil-bearing strata. Though these strata may be encountered almost anywhere, oil in paying quantities is found only where they have been faulted, ridged, or domed. The accumulation of oil at such points is due to the fact that these strata are permeated by both oil and water. Since oil is the lighter of the two liquids, it is floated by the water to the highest accessible point. Thus the ideal oil pool is found where there is an elevated point in oil-bearing strata, and where the underlying and the overlying strata are of dense formation that will prevent the escape of oil. Figure 3 shows diagrammatically how a salt dome may bring about these conditions.

Today there are 18 producing oil fields in the Beaumont district of Texas and Louisiana, with development under way on several others. Most of these fields are on proved salt domes. Salt domes have made this region an important factor in the nation's oil production. It has likewise become a great refining and export center, with a refinery capacity of 100,000,000 barrels

per year. This means that approximately one tenth of the entire refinery capacity of the nation is located at Beaumont and Port Arthur, Texas.

The following abstract of a paper by D. C. Barton and R. B. Paxson on the Spindletop field at Beaumont will give an idea of the importance of salt domes to the oil industry: "The Spindletop oil field was the first and one of the most brilliant of the Gulf Coast oil fields. Spindletop is a characteristic Gulf Coast salt dome and is composed of a steep-sided, relatively flat-topped, circular salt core with a diameter of about one mile, and with a limestone, anhydrite, gypsum cap surmounting the salt. Most of the oil was produced from the porous, cavernous limestone at the top of the cap. The early gushers have never been equalled in the United States for the size of their daily flush production. Few fields in the United States of like size (265 acres) have had as big a production. This totaled 30,000,000 barrels in the first three years and over 50,000,000 barrels to 1924."

In 1925 a deeper pay sand was discovered in this field, and since that time an additional 50,000,000 barrels have been produced, bringing the total production to over 100,000,000 barrels to date. The present production is at the rate of about 900,000 barrels per month.

Since the occurrence of oil on the Gulf Coast is so frequently in connection with a salt dome, the first step in the search for new oil fields is the discovery of other salt domes. A novel and interesting method has been devised for the purpose, and several of the major oil companies keep crews in the field with this object in view.

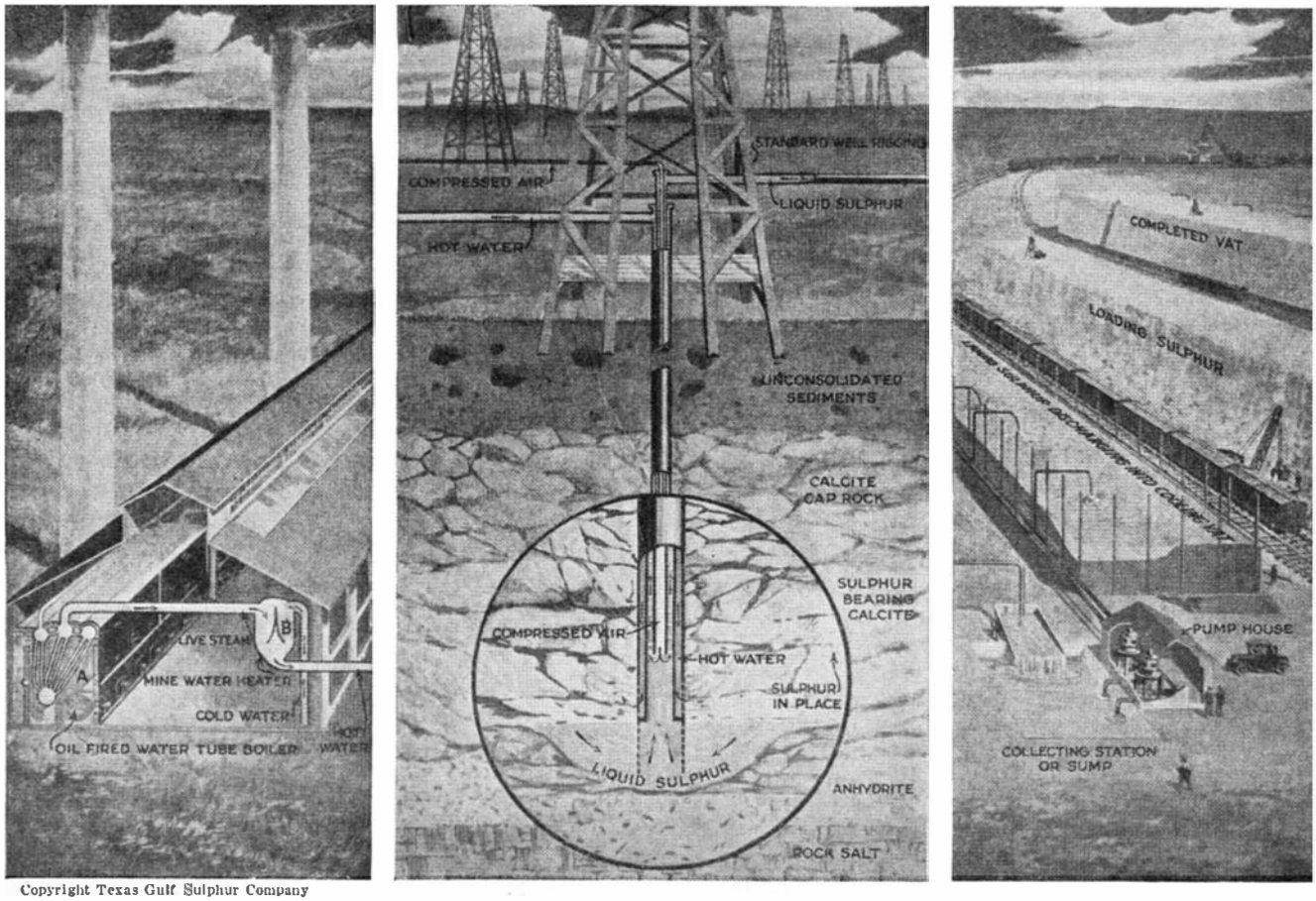
THE instrument employed is the seismograph, a delicate apparatus first used to record faint earthquakes. Three of these instruments are set up about a mile apart, each in turn being about a mile from a heavy charge of explosive, usually consisting of 250 pounds or more of dynamite. A man is stationed with the seismograph and another attends to setting off the explosive. When all is ready radio signals are exchanged, instruments are accurately timed, and the charge is fired. The blast is of terrific intensity, sufficient to rattle window panes for miles around and to set up distinct vibrations in the earth. If these vibrations reach all of the instruments in the same length of time the test is blank, no salt dome being indicated. But if there is a marked difference in the time shown by the various instruments it is a favorable indication and the vicinity will be closely explored.

It has been found that the ordinary rocks of the Gulf Coast transmit sound waves at the rate of about 5000 feet per second, whereas, rock salt transmits sound waves at the rate of about 15,000 feet per second. Thus when the shock reaches one of the instruments much more quickly than it does the others the presence of a salt dome is indicated between this instrument and the explosive. This method is very reliable when used by skilled operators. It has been used to locate several salt domes whose presence could not have been ascertained from surface indications alone.

The Gulf Coast salt domes are truly of great scientific interest. And when we remember that during the past 30 years they have yielded millions of tons each of salt, sulfur, and petroleum, and that they have been the direct source of wealth and employment in more than a score of communities, we realize that they are also of tremendous economic importance.

●

This is the first of three articles dealing with minerals recovered in connection with salt domes. The second will deal mainly with sulfur; the third with geophysical methods in the search for salt domes with reference to the discovery of oil.—The Editor.



The Frasch hot water process of mining sulfur. Hot water from plant at left passes down within outer, six-inch well tubing (note arrow marked "hot water," within central circle), passes out into rock through perforations, melts sulfur. This rises within smaller, three-inch pipe, and is helped to surface by air bubbles from central one-inch piping

WHICH RACES ARE BEST?

Why Science Can Not Admit Racial Differences in Intelligence

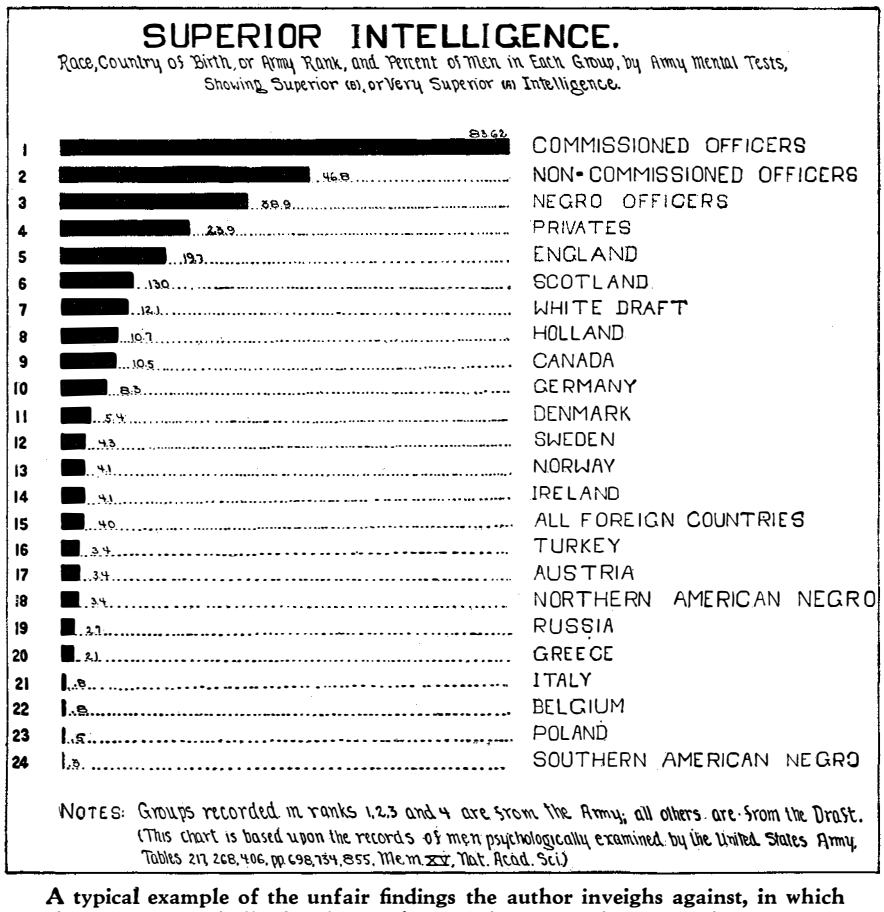
By G. H. ESTABROOKS
Assistant Professor of Psychology, Colgate University

WE hear a great deal about the superiority of the Nordic. Apparently he is some kind of direct descendant from the ancient gods of the Greeks and Romans. Before him all other races pale into utter insignificance and leave—or at least should leave—to him a monopoly of brains, brawn, and virtue. If, however, you will review the numerous works which have placed this fair-haired, blue-eyed giant on his pinnacle of perfection you will find they are all written by authors who have no especial training which fits them for their position as judges of human destiny.

Actually the problem of racial superiority is one which must be solved by the expert. When you have a problem in chemistry you go to the chemist—not to some layman who is merely interested in chemistry as a side line. You would never think of having anyone but a trained engineer build a modern factory, nor anyone but a competent physician treat you for smallpox. Similarly there are certain branches of science which are especially entitled to pass judgment on the problem of Nordic superiority. The anthropologist and the psychologist must solve this question between them—and their solution is in sharp contrast with those of many of our popular writers.

Science has not as yet demonstrated the existence of racial differences in intelligence. The reason for this is fairly obvious. First, let us consider what the anthropologist would have to say on the subject. He studies the past history of all races. His interests are largely of an historical nature. Just where did such and such a race come from? Why did the long-headed peoples in Europe give way before the round heads about 10,000 years ago? Who first domesticated animals and who is responsible for the wonderful civilizations which once flourished in Egypt and in Central America? These and such questions as these are the ones in which he is interested.

"Now," he says, "you wish to talk on racial intelligence. An excellent idea, but let us start by finding out just what you mean. Just what do you mean by a race?" Here we receive our first jolt, for the anthropologist defines "race" in terms of physical or bodily characteristics. Thus the people of the North European race are fair-haired, blue-eyed, tall individuals with long, high heads and thin noses. The term "Nordic" can be properly applied only when we speak of people having these characteristics. Then there are two other races in Europe, according to the generally accepted classification. One of these is the Alpine race which chiefly inhabits the center of Europe but which has pushed out into all corners of the continent. The third is the Mediterranean race. The Alpines are short, thick-set people with brown hair, brown eyes, and a round head. The Mediterraneans are short, slender, with black hair, brown eyes, and a long, low head.



A typical example of the unfair findings the author inveighs against, in which the alien, not wholly familiar with English, is pitted against the American

IF we are going to talk about *racial* intelligence within the white race we must confine ourselves to this classification or to some other similar division of races based on strictly physical data. Thus the English are not a race; they are a nation. It would be of no use talking about the inferiority of the Italian race—if it were inferior—because there is no such thing. The Italian nation comprises a mixture of all three races, and the Nordic who throws stones in that direction is very likely to raise a lump on the head of a member of his own group.

Similarly the Jews are not a race. There are tall Jews and short Jews, blue-eyed and brown-eyed, fair-haired and dark-haired, long-headed and round-headed. One might prove the Jew either superior or inferior, to one's heart's content, but it would have absolutely no bearing on the racial question. Indeed, even when the Negro "race" and Indian "race" in the United States are considered, one is almost as badly off, since both are largely mixed with whites and with each other.

So the first criticism of the anthropologist would be that almost all the work done on so-called racial intelligence had, with a very few exceptions, been

done instead on national intelligence.

The second argument which the anthropologist would advance is the historical one. We tend to look at things as they are, not as they may have been in the very near past. For example, the foundations of our culture go back to Egypt, Babylon, and Greece. From such countries as these came our real higher civilization, while such things as the domestication of animals and the cultivation of our great food plants go back even farther. The anthropologist would point out that the Nordic had nothing whatsoever to do with these beginnings of our cultural life. The Mediterranean seems to have made the real contribution, while many of our most useful food plants came from the American Indian.

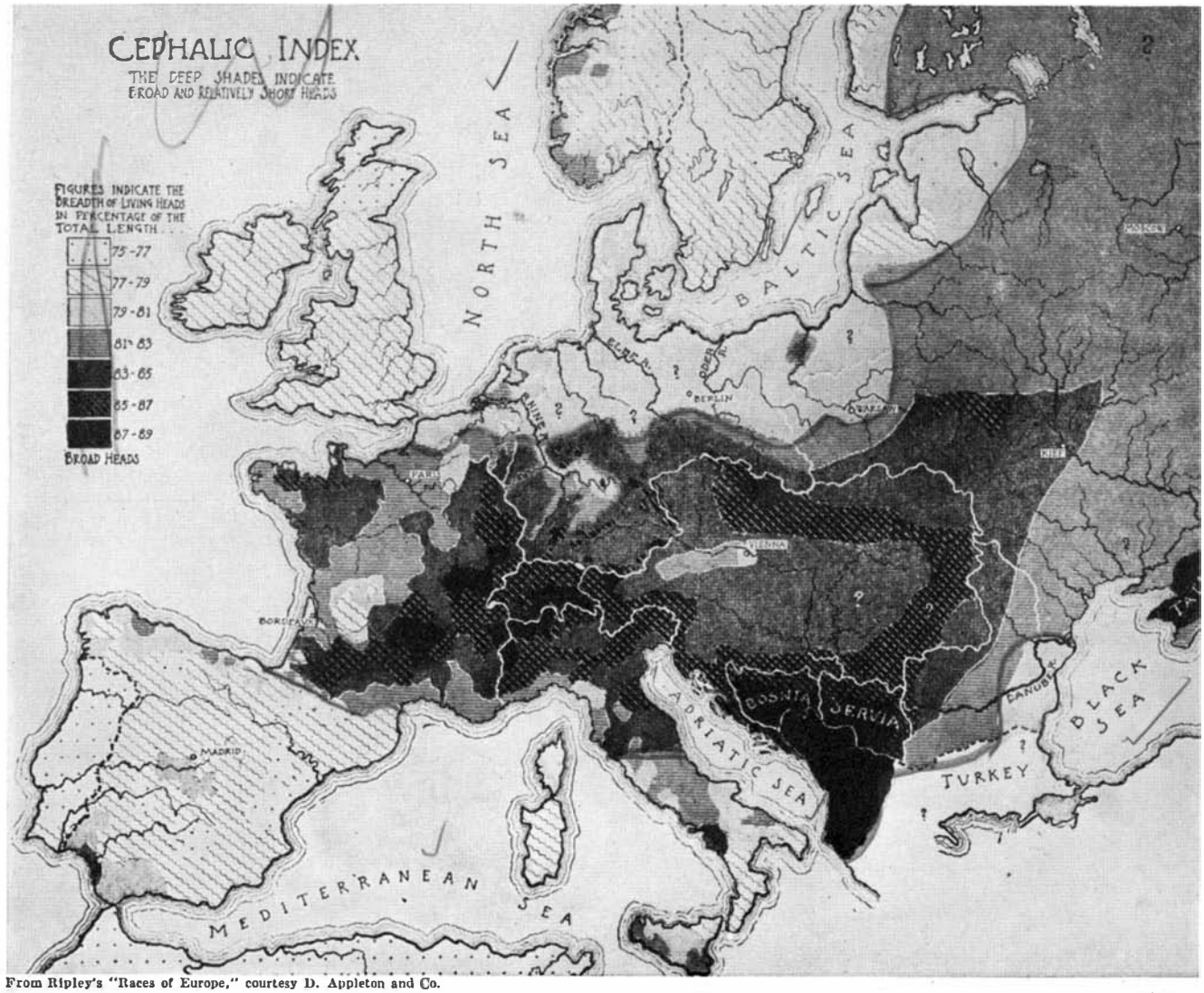
Even as late as the 15th Century A.D. the Nordics were savages, compared with the people living in southern Europe. The anthropologist realizes this fact. He realizes that the despised Indian of Central America had a very high civilization in 500 A.D., when the Saxons were heathen pirates whose sole interest was plunder and destruction; that the Chinese built the Great Wall at a time when the crude Nordic was just learning to use iron; and that the Egyptians and Babylonians had a written language and a high culture when the inhabitants of northern Europe were just learning to tame certain wild animals and plant certain grains.

In other words the Nordic is very much in the place of the *nouveau riche*. Just at present he happens to be doing very nicely but his history is very short indeed compared with that of certain other races.

WHEN we turn to psychology, the other branch of science which is interested in our problem, we find that the psychologist is very suspicious about this whole business. He tries to measure intelligence with the so-called "intelligence test" and does a very good job with school children when they have had the same type of environment. He is worried, however, when others try to apply his results to different races and nations.

For example, there is the language handicap. I have no right to test an Italian child with an intelligence test written in English, when that child has not a thorough knowledge of the English language. The best piece of work of this kind has been completed in the Philippine Islands. The results were very interesting. About 32,000 children were given several intelligence tests. Now, these children could not speak English very well. It was found that when they were given an intelligence test which was written in English they were far inferior to American children of the same age. But when they were given what we call a non-language test, a test which is designed in such a manner that it does not matter what language the subject speaks, then there were no differences whatsoever between their intelligence and that of American children.

The psychologist will not even allow us to sidestep this question by pointing to the negro, who is certainly familiar with English. Intelligence as measured by the intelligence test depends very largely on how and where you were



From Ripley's "Races of Europe," courtesy D. Appleton and Co.

Over three decades ago William Z. Ripley, ignoring the relatively recent accidents of history which have made nations, measured many thousands of heads in Europe and discovered Europe's three racial stocks: the Nordic long-heads on the north, the Alpine broad-heads in central Europe (the great dark wedge on the map), and the Mediterranean long-heads

brought up. To be sure, the negro does generally fall below the white on these tests, but no one who is familiar with conditions in the south can claim that the negro has as good a chance to be educated as his white neighbor. We hear a great deal about negro inferiority but there are one or two facts which are often overlooked by the advocate of white supremacy.

For example, the northern negro as seen in such places as New York City is actually superior in intelligence to the southern white, if we are to believe the results of army tests. Home conditions have a very great influence on these intelligence tests, as do also the amount of schooling and similar factors. The psychologist realizes these facts and is careful about making sweeping statements on such evidence. Unfortunately many popular writers get hold of these test results and promptly jump to the most unwarranted conclusions.

FINALLY, there is another point in the argument which is advanced by the biologist. We say, for example, that the Indians or the inhabitants of the South Sea Islands are inferior because they are rapidly vanishing before the advances of the white man—they can not withstand his civilization, therefore they must be of inferior intelligence.

This, however, is by no means the case. What actually is wrong is that these peoples simply can not withstand the white man's diseases. For instance, when Cortez first attacked Mexico City he received a disastrous repulse. The Spaniards under his leadership were the first white people whom the ancient Mexicans, the Aztecs, had ever seen. Despite the fact that the invaders were armed with powder and steel, the Indians fought bravely. But the Spaniards brought another ally even more terrible than superior weapons. This was smallpox. Between the first and second attacks on the city one half of the male population had died from this scourge. It was then a much more easy task for Cortez to reduce the survivors to submission.

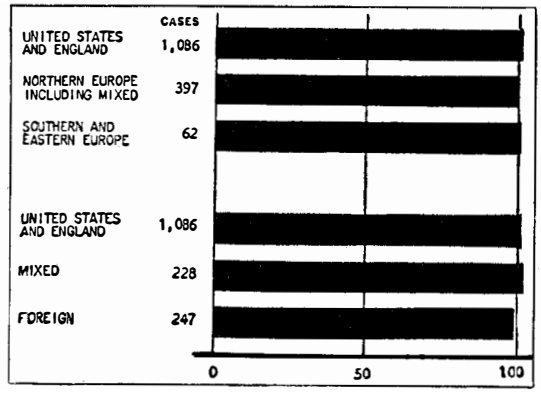
Similarly, everyone who comes in contact with the Eskimo is greatly impressed with his intelligence. But the Eskimo is doomed. He has little resistance to the diseases of the white man. Tuberculosis and smallpox wipe out whole tribes. The South Sea Islanders are in no better situation than the Eskimos and are rapidly dying out because of this hopeless fight against disease.

The white man naturally feels that such peoples are very inferior. They can not resist sickness as well as himself; therefore he very often looks down on them in all respects, intelligence included. But intelligence has nothing whatsoever to do with it. Indeed, recent research suggests that even the European may rapidly degenerate if placed under the living conditions of some primitive races. We find, for example, that certain animals, such as the white rat, will give birth to defective offspring if forced to live on a diet containing alcohol, or if they have their thyroid gland injured.

This branch of experimentation is new but it contains the suggestion that anything which weakens the body, such as alcohol, insufficient food, or disease, may lead to defective children and so to race degeneration. If this is true we can well see how a new disease, such as malaria, might easily lead to a mighty race becoming a very weak one.

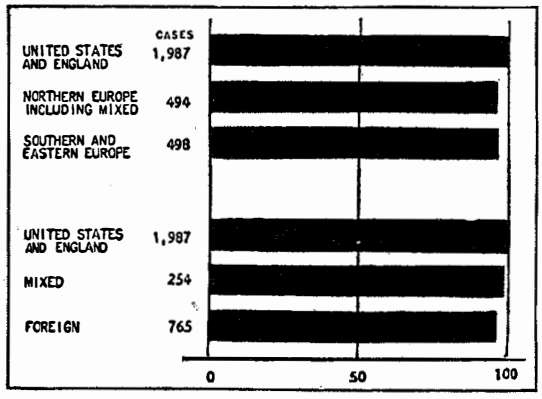
When we sum up the evidence we find that science is unwilling to give any race the crown of intellectual superiority. Results have been wholly inconclusive, and even the rabid exponent of intelligence tests is becoming more and more moderate in his claims. Ten years ago he looked over the results from the famous Army Tests and neatly catalogued all races on this earth as to the order of their mental ability. Today he attacks the problem far more cautiously with much better tests, and frankly admits that he is badly puzzled over the whole thing.

Can we definitely solve this problem of racial intelligence? Possibly, but it is one of the most difficult which science has ever faced. First, we must test races, not nations. We have talked a great deal about Nordics, but no one has ever, to my knowledge, taken a group of true Nordics—that is, people with fair hair and blue eyes, tall, with long, high heads and thin noses—and compared them with a group of typical Mediterraneans—short people with black hair and brown eyes, long low heads and medium noses. Thus no one has yet taken the trouble of even attempting a first step. This statement may be harsh, for certain investigators, such as Garth, have done excellent work comparing Indians and other races with the white race. Even Garth himself would probably admit that his research was far from accurate as regards an exact determination with reference to the purity of his groups.



Illustrations on this page from Edmund de S. Brunner, "Immigrant Farmers and their Children," courtesy the Institute of Social and Religious Research

Intelligence tests on American-born children of Nordic and non-Nordic stock, with language disability eliminated, show practical equality



Arithmetic scores of children by racial parentage again show essentially equal intelligence

FROM this point on, however, the problem becomes extremely difficult. If we are to measure intelligence we must use intelligence tests. So suppose a research worker chooses a Nordic and a Mediterranean group. In the first place, since the language handicap is a serious difficulty, he must either have these two groups speak the same language or give them a "non-language" test. Even then he must be able to guarantee that their cultural background is the same, or that this cultural background has absolutely no effect on the test he is using. This is hopeless at present. The mere fact of using a "non-language" test does not eliminate the possibility of other factors in the cultural background having a very definite effect.

Granted, however, that we shall have reached this far distant goal and shall have finally proved the Nordic superior to the Mediterranean, what next? Science would point out that this was merely a *present day* finding. Where now are the people who built the pyramids or who founded the wonderful culture of ancient Greece? They were then the great leaders in culture. The north European was an uncouth savage.

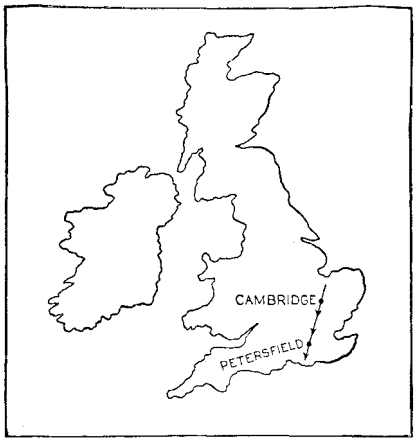
The despised Nordic has mounted the throne, but there are other peoples anxious and possibly able to hurl him from it in the near future. Such is the teaching of history. We must be more charitable in our views toward others, for some day they may have occasion to exercise charity toward us.

MORE ABOUT THE GREAT SIBERIAN METEORITE[1]

By J. G. CROWTHER

Author of "Science for You"; "Short Stories in Science"; "Science in Soviet Russia." Scientific Correspondent to *The Manchester Guardian*

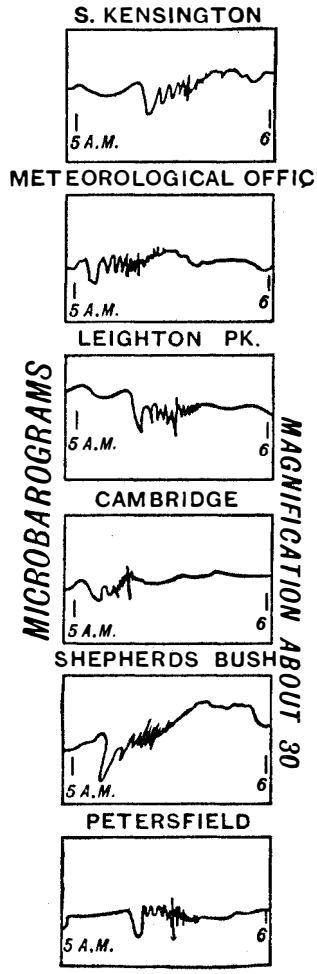
THOSE readers of the SCIENTIFIC AMERICAN who live in the United States, Canada, and Japan and keep diaries may be able to provide some special information of value to meteorologists. It concerns the atmospheric and sunset effects of the great meteorite which fell in Siberia in 1908 and devastated over a thousand square miles of forest. That the fall actually took place became generally known only in 1928 and since then some remarkable new information has been discovered.



Line of travel of air waves across England from the Siberian locality

The subject of one of the discussions at the Dublin meeting of the British Association for the Advancement of Science in 1908 was wave-motion. Dr. W. N. Shaw (now Sir Napier Shaw) contributed an example of a curious atmospheric wave-motion recorded on the self-recording micro-barograph invented by himself and Mr. W. H. Dines in 1903. This instrument automatically records sudden small changes in atmospheric pressure such as those due to air-waves (that is, sound waves when audible) but not slow changes due to ordinary rising or falling of the barometer. It registers the frill, as it were, on the continuous but slowly varying line which represents the record of the pressure of the air.

On June 30th, 1908, six of these instruments in England, respectively at South Kensington, Meteorological Office, Leighton Park, Cambridge, Shepherds Bush, and Petersfield, recorded a series of air waves arriving during a period of about 20 minutes, with about four fairly plain maxima, as if there had been four disturbances or explosions somewhere in the earth's atmosphere during that period. After the discussion this record was more or less forgotten



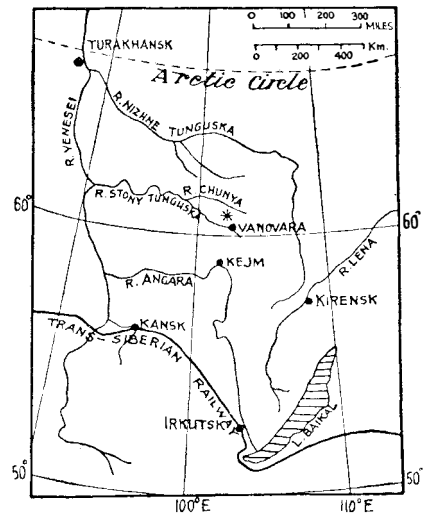
Oscillations at several points in England, June 30, 1908—until recently these were unexplained

and became one of the unexplained curiosities of meteorological science.

Since 1928 fragments of news from Russia have conveyed the information that a great meteorite had fallen in Siberia on June 30th, 1908, and expeditions had been made to discover the place of fall. In 1930 the eminent English meteorologist Mr. C. J. P. Cave suddenly remembered that the date of the Shaw micro-barograms corresponded with this date of the meteoric fall. Were the English micro-barograms due to the air waves caused by the great meteorite said to have fallen in Siberia? This discovery greatly stimulated interest in the reports of the Russian explorers. The expeditions were led in Siberia by the geologist Professor Kulik. I met him in Leningrad last autumn and heard something of his experiences directly, and also had as a kind gift from him several photographs (the ones reproduced—*Ed.*) taken in the area devastated by the meteorite as it fell.

IN Russia in 1908 there were rumors that a meteorite had fallen near Kansk in the Yenesei region of Siberia. The earthquake observatory at Irkutsk had recorded a small shock on the morning of June 30th. At Kirensk the sounds of the explosions were heard and various stories of terrific events having occurred in the north were noticed in the newspapers. Apparently these records were ignored by Russian scientists at the time, and no investigation of them was made until 1921, 13 years later. Russia was then stricken with poverty and famine after the

Illustrations at left and below, from the *Quarterly Journal of the Royal Meteorological Society*



Where the Siberian Meteorite fell —indicated by star near center

[1]See "The Great Siberian Meteorite", *Scientific American* July, 1928—a preliminary account by Professor Charles P. Olivier. Further discussion appeared in the *Literary Digest*, March 16, 1929—*Ed.*

struggles of the revolution. Nevertheless Kulik, Oldenburg, and Wernatsky of the Academy of Sciences approached Lunacharsky, the Commisar of Public Instruction, for funds to finance a preliminary expedition of inquiry in the Kansk district to discover whether the old rumors were worth further investigation. The funds were given and Kulik led the inquiry in Kansk, returning to Leningrad definitely convinced that something extraordinary had happened on June 30th, 1908, in that region of Siberia, and that a thorough exploration of the district was necessary.

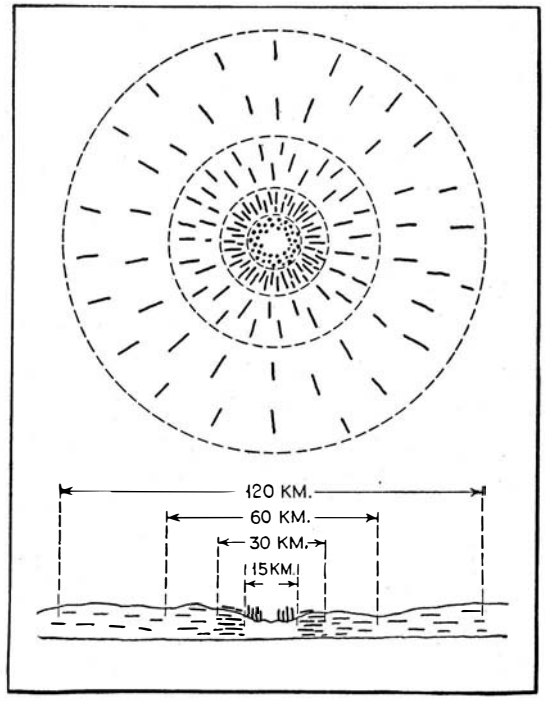
IN March, 1927 he led a second expedition from Kansk to the Yenesei district. They marched through blizzards with temperatures of –40 degrees Centigrade to reach Keshma on the River Angara. There they formed a caravan for Wanawara on the River Tunguska. They engaged a Tungus guide to lead them into the crater region. The Tungus had a family of four and ten reindeer. He would not start in the morning without deep potations of tea and then not earlier than 10 A.M. In the afternoon he refused to move after 4:30 P.M. and on halting commenced more endless drinking of tea. They could proceed only from one patch of vegetation to another in order to get fodder for the reindeer, so with these handicaps and the difficulty of the country they could not cover more than four or five miles a day.

Finally the explorers reached the craters. These proved to be from 30 to 150 feet in diameter and about 12 feet deep. The bottom was covered with swamp moss. Around the craters the earth was crinkled in a direction at right angles to the southwest and northeast line. Round about the craters the ground had been entirely blasted and at the time the meteorite fell every living thing must have been quite consumed.

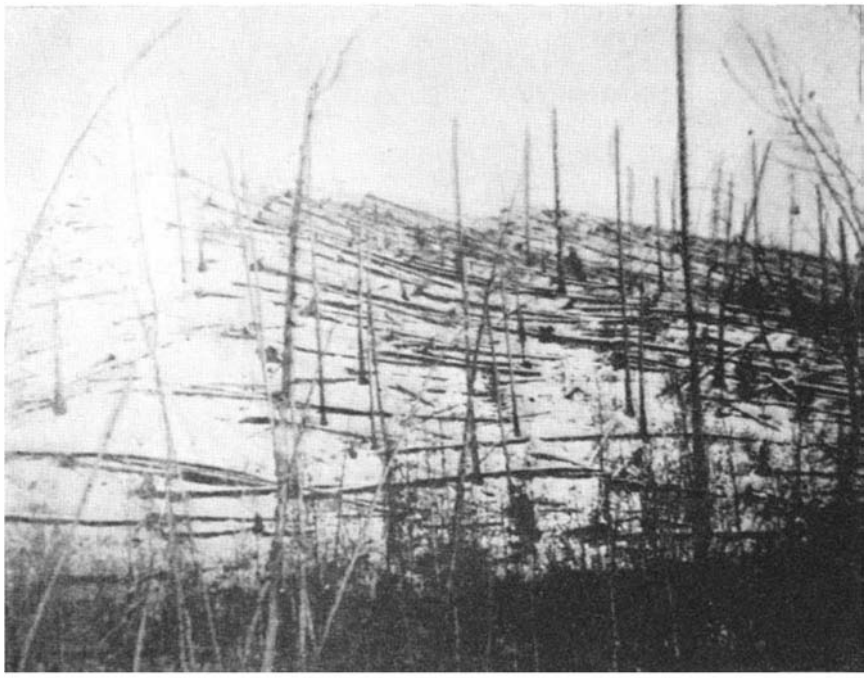
Professor Kulik told me of one remarkable feature: within the central blasted area was a ring of upright trees. The trunks are seen to be stripped or singed of foliage. The fact that they remained upright while all vegetation inside and for some distance outside the ring was destroyed seems to suggest that they mark some kind of node or region of rest due to interference of air waves coming from the craters. Some of these trees are shown in one of the photographs. From a pencil diagram Professor Kulik drew for me, one sees that the central area which was devastated except for the ring of upright trees, was about fifteen to twenty kilometers (roughly, 10 or 15 miles) in diameter. Beyond this circle was a ring of felled trees extending up to a diameter of 30 or 40 kilometers, as shown in the diagram. The next zone extended to about 60 kilometers diameter and contained a considerable number of felled trees, while occasional trees were found felled within a diameter of 120 kilometers or about 75 miles. Throughout the circle the trees were felled radially from the craters.

In the devastated parts the living vegetation was less than 20 years old. For example, in one of the photographs, a young tree less than 20 years old is seen standing among dozens of felled tree trunks.

Professor Kulik believes a great outrush of hot air produced by the change of kinetic into heat energy when the meteorite crashed into the earth blew the forest trees down and singed rather than tore off their branches and foliage. He said that he and his party had dug 30 feet into the crater bottoms but had not found the meteorites. The boring is difficult because the soil is eternally frozen below half a yard and considerable equipment is required. He is not sure whether the meteorites are sunk in the earth or whether the craters are the marks of a ricochet where the meteorites struck the earth a glancing blow and then flew off into space again, or perhaps vaporised on the spot. He is not yet certain whether the meteorites approached from the north or the south. If they came from the north he believes they may have been connected with the comet Pons-Winnecke, or indeed they may have been the comet itself.



Sketch showing the effects of the meteoric fall. Redrawn from a sketch by Professor Kulik



In the distance-zone roughly between 30 and 60 kilometers—say, 20 to 35 miles—from the center a part of the trees remained standing. Compare with the drawing

In 1929 Professor Kulik led a third expedition to the region, taking with him Chudnovsky, the famous Russian arctic airman and rescuer of Nobile. They intended to make an aerial survey but the weather was adverse and it could not be made. The difficulties of the country were great. They must explore while the land is not too deeply covered with snow, yet they must also leave before the thaw sets in. The thaw is very rapid and the rivers such as the Angara and the Tunguska rise several feet in a few hours, flooding

Typical Siberian country, heavily forested as in the corresponding forest belt of Canada but never glaciated. Reproduced from a photograph by Professor Kulik

the country and making it impassable. Then a terrible plague of mosquitoes arises and this apparently is one of the worst of the obstacles. Professor Kulik's expeditions have left a mark on him. He is a tall, wiry, bronzed man of Scots figure, lean and a little tired. Perhaps a rest will soon entirely refresh him.

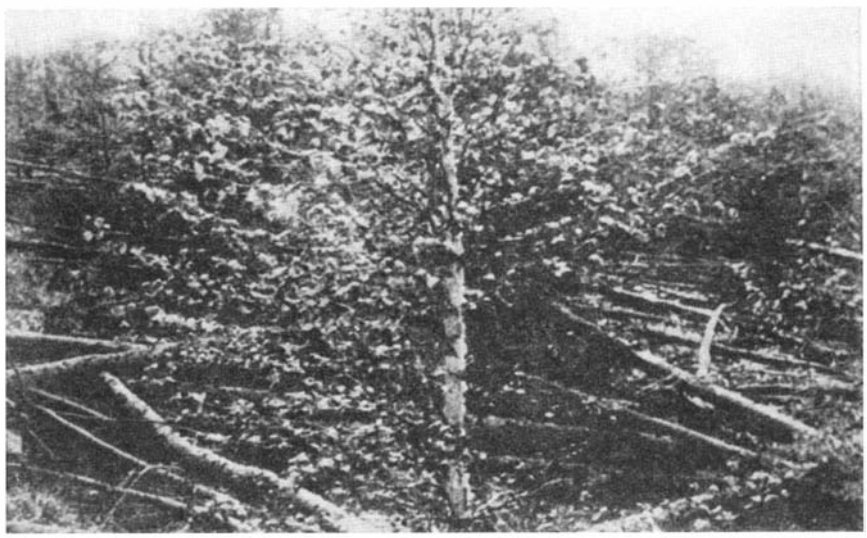
The Kulik expeditions have stimulated much remembrance of atmospheric disturbances on June 30th, 1908, and the succeeding days. The reports of inhabitants who were interrogated by Kulik and his colleagues are interesting. I. I. Illinski, now a stationmaster, was at the Lialka Siding at Kansk. "Suddenly I felt what seemed to be a violent vibration of the air and heard a loud noise. I was terrified. The engine driver of train Number 92 was so scared that he stopped the train, fearing it might be derailed, and when he reached us at the siding asked us to examine the train to see whether some of the goods might have exploded." An observer near the Arctic Circle heard three or four (compare with the Shaw micro-barograms) dull thuds in succession. Professor Kulik told me that the explosion was heard at points within a circle 2000 miles in diameter; south of Lake Baikal, in Mongolia, for example.

S. B. SIMIANOFF of Wanawara said that after "the flame disappeared there was an explosion which threw me off my feet a distance of seven feet or more. The glass and frames of the house broke and clods of earth were spit up from the square in front of my hut." Kosolapoff said that the door of the Russian stove flew out and into a hammock on the far side of his room. The glass from the windows burst inward. Afterward there was a sound like the roar of thunder from the north. Dr. Whipple remarks that this evidence indicates that there was a pressure wave which broke windows inward and was followed by a suction wave which sucked clods out of the ground and hurled the stove door across a room.

A Tungus called Ilia Potapovich said that his brother was living on the Chambe River when a terrible explosion occurred. For miles along both banks of the river the trees were uprooted. His brother's tent was hurled down, the wind carried away the top, deafened his brother, and dispersed his reindeer, many of which he was unable to collect when he had regained his senses. These events affected him so that he was ill for a long time. In the part of the forest which was uprooted a big hole appeared. The Tungus road formerly passed this place but now it is avoided as the Tunguses are terrified of the locality. The informant Kartashoff who gave this information of the Potapoviches said he did not believe it was true. Here is an example of the type of incredulity which caused the Siberian meteorite to remain uninvestigated so long.

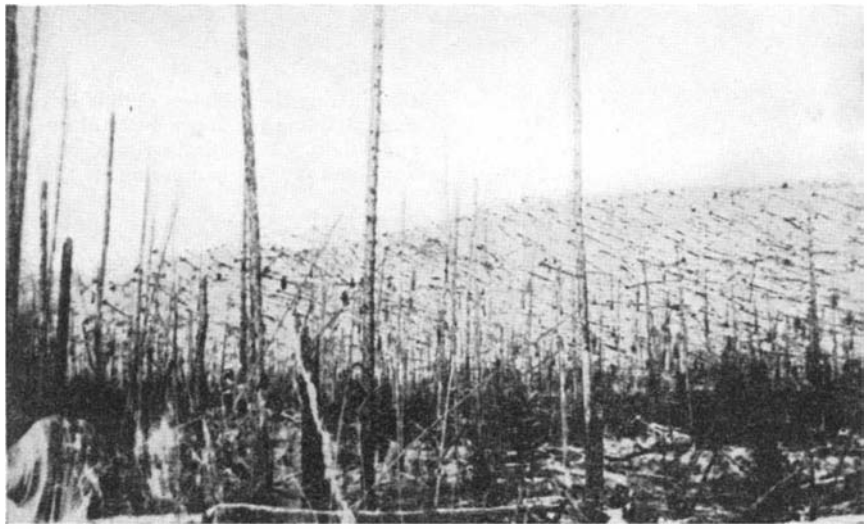
Many other reports referred to the devastation of the forest and the felling of the trees in uniform directions—one to the destruction of several Tungus families and one to a forest fire. The Tungus's terror of the district will be understood when I report that Professor Kulik told me the occurrence had caused the evolution of a new tribal religion. They regarded the arrival of the meteorite as a visitation from a God named Agdy (meaning Fire) to punish the wicked. The place is believed to be accursed. The destruction of vegetation removed the sources of food for animals, so that the subsequent scarcity of living things made the place seem sinister. The development of a myth whose circumstances and date of birth are exactly known possesses considerable interest for comparative anthropology. (Similarly the Navajo have a superstition regarding the descent of one of their gods at Meteor Crater in Arizona. SCIENTIFIC AMERICAN, September 1927, page 246.—*Ed.*)

THE *Bulletin* of the Russian earthquake observatories had three references to the occurrence in 1908. In the town of Kansk the first shock caused doors, windows, and a votive lamp to shake. There were subterranean rumblings and a second shock came five to seven minutes later. A minute later there was another shock. At the Kuriske-Popovich village a severe earthquake was felt. Afterward there were two loud bursts like the firing of cannon. Earthquake shocks were also registered at Tashkent and Tiflis, but their connection with the Kansk phenomenon was not recognized. Since then an earthquake record for the appropriate time has been found at Jena in Germany. The Director of Irkutsk Observatory ascertained that the meteorite had fallen near the River Tunguska about 400 miles from Kansk, but nothing more was done about it.



A young tree less than 20 years old, which appears to be a birch, growing among the decaying trunks of the forest laid low in 1908 by the meteorite's air blast

Since the significance of the Shaw micro-barograms of 1908 became understood the records of the atmospheric and earthquake effects of the meteorite have been very interestingly discussed by Dr. F. J. W. Whipple, the Superintendent of Kew Observatory, London. As the Tunguska district, Cambridge and Petersfield in England lie approximately in a line (see a globe—*Ed.*), the time of travel of the atmospheric disturbance from Cambridge to Petersfield, at each of which it was recorded, will give its speed. This proves to be about the velocity of sound, according to expectations. By comparing the hour of the disturbance in Siberia with the hour of the arrival of its air waves near London, the time of travel is found to be five hours and ten minutes, which is about right for a journey of 3550 miles, the distance from London to the place of fall.



Local effects of topography. The trees on the exposed hillside were entirely felled while part of the slightly protected trees on the level in part escaped

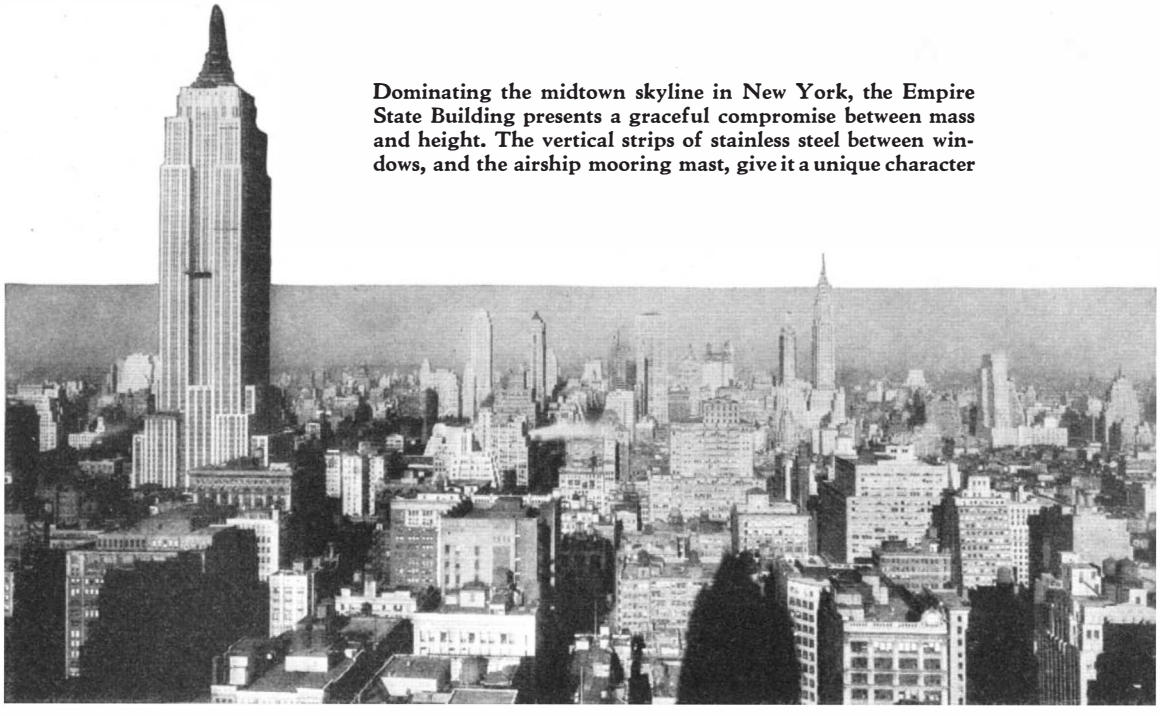
THE sound of the meteoric explosion in Siberia was heard in London by instrumental means, if not by human ears. The English micro-barograms furnish data which permit estimates of the energy of the disturbance. According to formulas derived by Professor G. I. Taylor, Dr. Whipple calculates that the meteorite must have had energy at least equal to that of a body weighing 12 tons traveling at seventy-two kilometers (45 miles) a second. Professor Kulik estimated the meteorite to weigh 130 tons. One may assume that only a fraction of the energy would pass into air waves, so the two estimates agree quite well.

Beside causing earthquake records at Irkutsk (589 miles distant), Tashkent (1890 miles), Tiflis (2727 miles), and Jena (3240 miles), and no less than six detailed air-wave records in England at an average distance of 3550 miles, the meteorite caused immense sunset effects in many parts of Europe at least, as scores of weather diarists are now proving. During the night of June 30th, 1908 "a strong orange-yellow light became visible in the north and northeast, causing an undue prolongation of twilight lasting to daybreak on July 1st, when the eastern sky was an intense green to yellow-gold hue. The entire northern sky on these two nights, from the horizon to an altitude of 40°, was of a suffused red hue varying from pink to an intense crimson. There was a complete absence of scintillation or flickering, and no tendency for the formation of streamers, or a luminous arch, characteristic of auroral phenomena. Twilight on both of these nights was prolonged to daybreak and there was no real darkness. At 1 A.M. on July 2nd small print could be read without the aid of artificial light. The phenomenon was reported from various places in Britain and on the Continent, from Copenhagen, Königsberg, Berlin and Vienna." So writes Mr. Spencer Russell in an article just recently published in the *Quarterly Journal of Meteorology*.

A member of the staff of Greenwich Observatory took an excellent photograph of the Royal Naval College shortly before midnight with an exposure of about one minute. The famous astronomer Wolf of Heidelberg found he could not take star photographs owing to the fogging of the plates due to the unwonted luminosity of the sky. He considered that the effects must have been due to dust which developed in the highest parts of the atmosphere on June 30th and gradually settled during the following days. At 7 P.M. on June 30th de Veer of Haarlem, Holland, saw something to the northwest which he described as an undulating mass. It was not cloud, for the blue sky itself seemed to undulate. Presumably it was due to dust from the meteor and had taken 18 hours to cover 97° of longitude, giving a speed of 300 kilometers or about 185 miles per hour. On the morning of July 2nd Wolf noticed a peculiar wisp of cloud moving apparently at 220 miles an hour. Unfortunately the dust cloud could not travel entirely around the globe in 24 hours at that speed and meteorologists want to know whether Wolf was observing the object seen by de Veer on the previous night, after having passed right around the globe and arrived back again. The evidence of observers in the United States, Canada, Japan, and countries south of the line from England to the Crimea, whether they noticed this object on its journey round the globe in the upper atmosphere, would be valuable.

Part of the ring of trees whose trunks were not knocked down, probably because of a nodal or interference effect. Tungus guides and horses in foreground

HOW strange that a cataclysm leaving traces in many parts of the earth should pass almost unrecognised for 20 years, and then require geologists, seismologists, meteorologists, even airmen and anthropologists for its elucidation.



Dominating the midtown skyline in New York, the Empire State Building presents a graceful compromise between mass and height. The vertical strips of stainless steel between windows, and the airship mooring mast, give it a unique character

THE ULTIMATE IN SKYSCRAPERS?

By ANDREW J. EKEN

Vice-President and Chief Engineer, Starrett Bros. & Eken, Inc.

THE battle for the possession of the world's highest structure goes on apace in New York. Billions of dollars have been spent, millions of tons of steel and stone have been reared from Manhattan's rocky base in the struggle to come nearest to a literal interpretation of "skyscraper."

Nearly a quarter of a mile into the air, the Empire State Building now towers 102 stories above Fifth Avenue and 34th Street on the famous old site, first of the farmlands of the Astor family and later of the Waldorf Astoria Hotel. Construction beyond this height, while far from impossible, is uneconomical. Space becomes too expensive to bring adequate return. New York land is too expensive to assemble easily a plot large enough to support a building topping the Empire State.

It has taken just 19 months to demolish the Waldorf Astoria Hotel and erect in its place the greatest structure ever conceived by man. It is topped with a mooring mast designed to be the terminus of transatlantic dirigible services of the future and will be populated with 20,000 busy workers who are visited each day by an estimated 40,000 floating population.

"Just for the record," as former Governor Alfred E. Smith, President of Empire State, Inc., which owns the building, would say—this structure is 1248 feet from sidewalk to tip of the mooring mast and contains 85 stories of tenantable office space. This compares with the Chrysler Building's 1046 feet from ground to the tip of its spire with 71 floors of office space; with the Eiffel Tower, useless for any purpose more practical than sightseeing, but 995 feet high; and with the Bank of Manhattan Building, 927 feet high with 76 stories of tenantable space. Naturally the erection of such a structure brought peculiar engineering problems to the planners and builders of Empire State.

WHILE the removal of the Waldorf was under way, Shreve, Lamb & Harmon, architects, struggled mightily with the Empire State plans. Fifteen times the building was created on paper and 15 times rejected for some economic or technical fault. Finally came the sixteenth plan, which is Empire State as it stands today.

Demolishing the Waldorf was no easy job. It is customary for wreckers either to pay for the privilege of removing a New York City building or to do it free of charge for the value of the materials they can salvage, but the Waldorf Astoria proved too staunchly built and before the last broken fragments of its walls had been removed 900,000 dollars had been spent in cutting the still sound steel columns to pieces with flaming torches and in carting the remains far out to sea to be dumped from barges. The Waldorf now lies beneath the Atlantic Ocean 15 miles beyond Sandy Hook.

Even before the wreckage was cleared from the great hole in the ground, the Empire State foundation—giant blocks of concrete built to support the largest steel columns ever fabricated, weighing over 12 tons to the foot—were being placed.

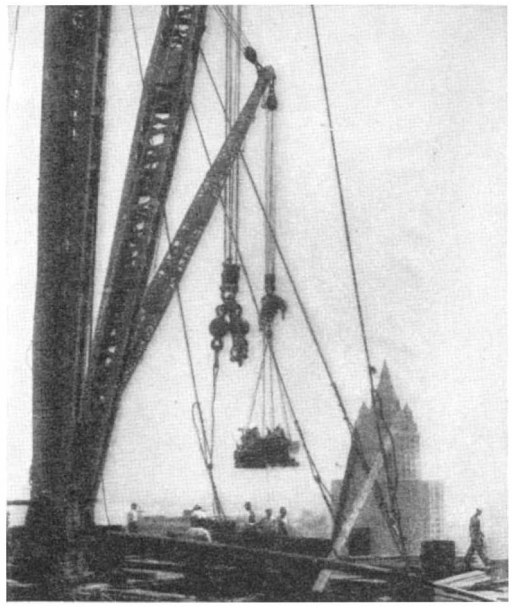
Rapidly the work progressed until only five months after the first steel was set, the American flag was raised on the 86th floor to signalize the completion of the framework. Already the exterior masonry had been raised to within a few floors of this steel work. Then came the building of the 200-foot mooring mast towering above the 86th floor sightseer's observatory. The basketlike steel framework was built by daredevil steel workers casually placing rivets and swinging girders higher than man had ever reached before, until the giant revolving cap of the mast was placed a quarter of a mile above the street. This mast is enclosed with glass and with ribbons of the same shining stainless steel and aluminum which distinguish the exterior of the entire building in shining straight lines from the sixth to 85th floors.

An elaborate system of wind bracing protects this tall structure against the

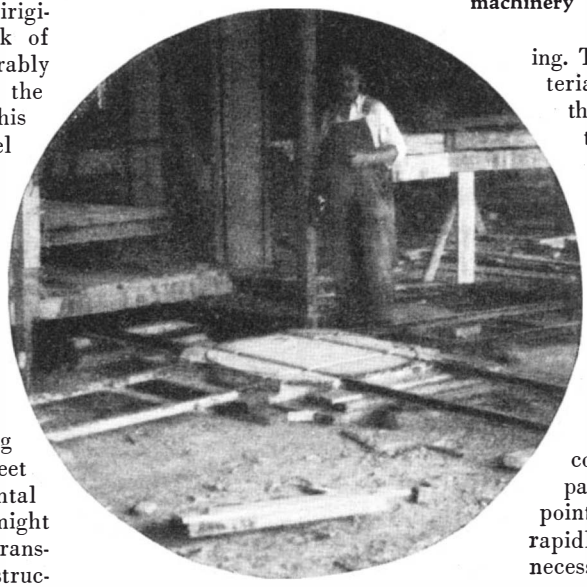
stress of any gale which may blow through New York's canyons. This problem of wind bracing has given much concern to civil engineers. Professor C. R. Young of the University of Toronto has estimated that the pressure of a normal wind on the Empire State Building amounts to 4,340,000 pounds; therefore the building must count on a wind pressure of 20 pounds per square foot for the first 500 feet of height, increasing at the rate of two pounds for each successive 100 feet. A wind of 186 miles per hour, the highest velocity recorded in this country, would therefore produce a pressure of 102 pounds per square foot on a building such as Empire State. Walls and partitions were found by the engineers to be of little if any assistance in wind bracing; therefore systems of bracing the actual steel framework to bear this terrific load were evolved by Mr. H. G. Balcom, consulting engineer on steel erection. This bracing is even more necessary in the tall dirigible mooring mast, the framework of which must necessarily be considerably lighter than that of the rest of the building. At the very peak of this mooring mast a Gothic form of steel arch is placed, the apex meeting at a central point to which the mooring ring of a dirigible tying up to this mast would be fastened.

A red neon light warns aircraft of the towering tip of this mast and an elaborate system of lights outlines its shining column. The four principal columns which compose this mooring mast are carried down through the building all the way to the bedrock, 33 feet below the surface so that the horizontal pull which a moored dirigible might exert upon the mast will not be transmitted to the higher parts of the structure but to the massive concrete foundations instead.

Fifty-eight thousand tons of fabricated structural steel were placed in the Empire State Building, the largest single order ever given for work of this kind and so great an order that no single mill could produce the quantity desired in the time specified. The load on the four central columns is in excess of 10,000,000 pounds, more than 5000 tons to each. Because of the necessity of moving daily such quantities of material into the building, an elaborate and ingenious way of scheduling the arrival and even the manufacturing of the materials needed was devised by the contractors, Starrett Bros. & Eken. An individual railway system was constructed to cover every floor of the Empire State Building. Trucks bearing steel and other materials, instead of being unloaded in the street, where they would obstruct traffic and deface the neighborhood, were taken directly into the ground floor of the building and their loads placed upon small cars running on the steel tracks and turntables of this construction railroad.

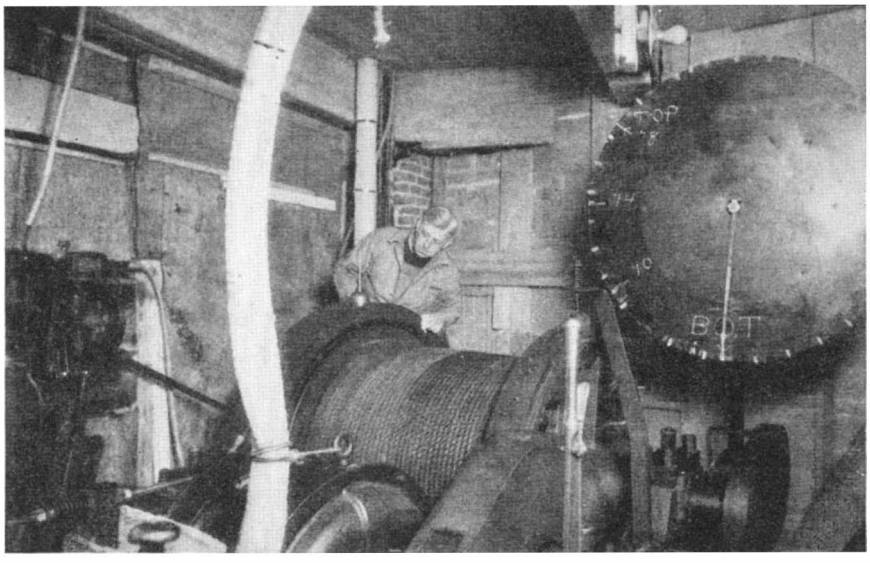


Giant derricks lift part of the hoisting machinery to be used by the constructors



A portion of the builder's railroad in the building, meeting an elevator

The daily work of each of the many derricks and hoists for materials was so scheduled that engineers in charge knew exactly what any conveyance would be carrying at any given hour. Each consignment of materials was dispatched to the nearest hoist to the point at which it was needed and so rapidly lifted upwards that it was never necessary to use any large amount of storage space or to delay the steady flow of trucking to the building. Eighty hours after steel was fabricated in the Pittsburgh Rolling Mills and loaded upon flat cars it reached the Empire State Building, each piece marked carefully with symbols indicating the exact position it was to occupy in the framework and even the number of the derrick which was to lift it to its place. More than 50,000 individual pieces of steel reached the building in this manner and were placed according to schedule without delay.



The operating mechanism and cable drum of a work elevator. At the right is a large dial which shows the movement of the elevator from floor to floor

THE exterior of the building is of Indiana limestone and granite with vertical strips of the now well-known stainless steel, creating an entirely new architectural effect in their straight narrow lines which shine in the sun. Windows were designed to be set flush with the outer walls, doing away with window reveals and creating in the aggregate thousands of additional square feet of usable space in the interior of

Oxy-acetylene torch used to cut notches in beams for inserting concrete floor reinforcing

the building. Radiators, likewise, are recessed into the walls, also increasing available space.

Sixty-two express, signal-controlled elevators have been installed in the Empire State Building by the Otis Elevator Company. These are of the self-leveling type, automatically stopped and started by the pressing of buttons within the car numbered for each floor. A special device developed for use for the first time in the Empire State Building was installed by the Otis Company to take the place of human dispatchers. This electrical device prevents any two elevator cars from stopping to answer a given call and wasting the time of one of the cars. It likewise dispatches cars from the ground floor on their trips through the building at carefully spaced intervals to give smooth continuous service to incoming cars. These elevators will travel at a speed of 1200 feet a minute, the limit allowed by the New York building law. This law previously made provision for an elevator speed of only 700 feet a minute and was only recently changed.

EXPERIMENTS conducted by the Otis Elevator Company have determined that 1200 feet a minute is approximately the limit which the human body can stand, although it is possible technically to produce elevator cars capable of traveling nearly 2000 feet a minute. Empire State express cars will travel from the first to the 80th floor in slightly over a minute. At the 80th floor, passengers desiring to travel to the 86th floor observatory or to the mooring mast will change for a tower car which will lift them the rest of the way. A single elevator will travel through the center of the mooring mast to a room at the top large enough to accommodate 50 people. The weight of elevator cables makes it impossible to make the journey from the ground to the 86th floor in one lift.

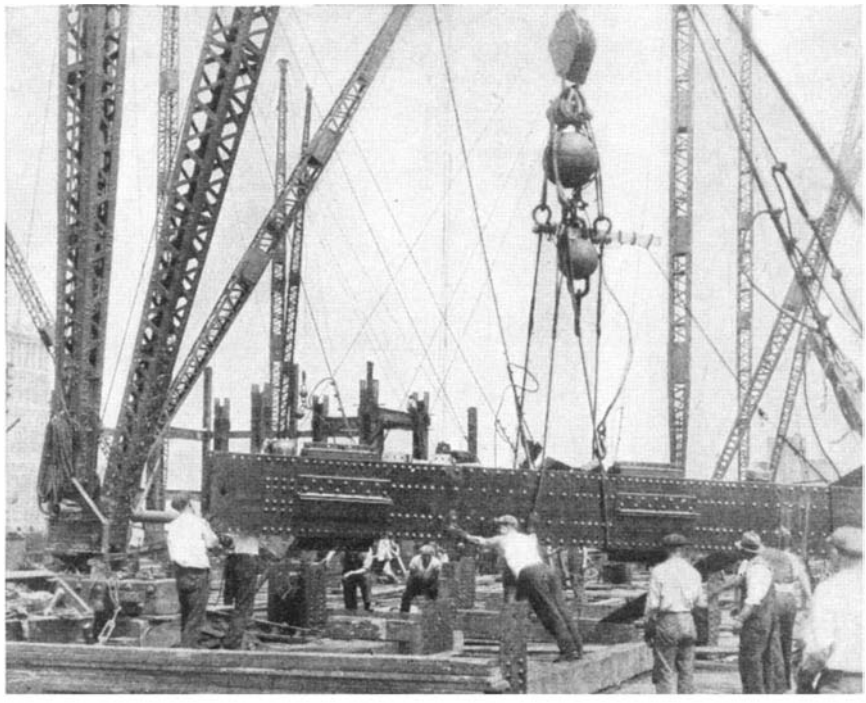
During construction exceptional safety precautions were taken. At all portions of the building where exterior masonry or other work was being done, secondary scaffolding and nets were erected to prevent any materials or tools from falling into the street. All elevator shafts were carefully fenced off from portions of the building where workmen were employed and doorways arranged so it was almost impossible for anyone to enter the shaft to a position where he might be struck by a moving car. Telephone systems connecting various portions of these shafts were used to synchronize the movement of materials and to prevent confusion.

Empire State stands on a plot of 197.5 feet by 424.95 feet. The area of this site is 83,860 square feet and the rentable floor space within the building is 2,158,000 square feet, making it the largest office structure in the world. An average of 2500 men was employed daily in the construction work, while the total sometimes reached as high as 4000. To care for this army of workers and to dispatch them in and out of the building, a stagger system of hours for beginning and quitting work was established and four portable cafeterias were erected and moved about as the work progressed, to save the men the time otherwise necessary for going outside the building for lunch. Fifty miles of temporary water piping were installed for the convenience of these workmen and a complete hospital, with doctors and nurses always in attendance, was established.

Empire State statistics are staggering in their magnitude and it will be interesting to read some of them. For instance, 3500 kilowatts of electricity will be consumed when the Empire State is fully tenanted. This is enough to light a city the size of Albany, New York.

THE steel contained in Empire State framework could be rolled into a double track railroad reaching from Montreal to New York. Four and one-half stories of steel work were erected every week. There are more than 2,000,000 feet of electrical cable in the Empire State and adding this to telephone and telegraph wire placed in service, the total would stretch nearly twice around the earth. There are 6400 windows, 10,000,000 bricks, 200,000 cubic feet of stone, 400 tons of exterior chrome-nickel (stainless) steel, seven miles of elevator shafts, and enough floor space to shelter a city of 80,000.

Shreve, Lamb & Harmon were responsible for the design of the building and H. G. Balcom was consultant on steel erection. Meyer, Strong & Jones, Inc., were engineers for the installation of utilities and Post & McCord, Inc. erected the steel framework for Starrett Brothers & Eken, Inc., the general contractors. The company owning the building is headed by Alfred E. Smith and includes in its directorate Pierre S. DuPont, Louis G. Kaufman, August Heckscher, Ellis P. Earle, John J. Raskob, and Michael Friedsam.

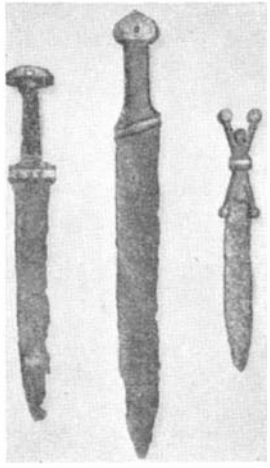


Erecting the steel on one of the lower floors. Some of the steel columns used here were the largest that have ever been fabricated for a building or other structure

FROM THE ARCHEOLOGIST'S NOTE BOOK

"Scramasaxes"

ARMS and armor of the period around 600 A.D. are quite rare, so the Metropolitan Museum of Art is very fortunate in receiving a gift of the three pieces shown. The meaning of the word "scramasaxe" is uncertain but it denotes a knife. The three are representative works of so-called barbaric art—the makers were admittedly skilled craftsmen even if they were barbarians.



Frankish and Gallic daggers, "Scramasaxes," were emblems of power

The earliest piece to the right is of the late iron age, 100 B.C. to 100 A.D., and is Gallic. The other two pieces are Frankish of about the 6th Century. All three daggers were undoubtedly found in graves where they were placed with the supposition that their owners would need them in the here-after.

A Stolen Relief

THERE is a beautiful Greek marble relief of Pentelic marble in the Metropolitan Museum of Art that probably dates from the 5th Century B.C. A battle scene is represented. A little detective work makes it possible to trace in it also the hand of Rome. It will be noticed that the back of the slab is smooth except for a ridge about 3⅞ inches from the bottom. This suggests that the relief was cut with a saw as far as the ridge and then broken; as was customary in Roman times and still is today. The sawing evidently took place in antiquity—presumably by the

***Right:* A Greek marble relief which was broken from a marble block to save weight. *Left:* Back of relief showing marks of saw before being broken**

Roman plunderers who carried the relief from Greece to Rome—in order to lighten its weight. Lord Elgin did the same to the slabs of the Parthenon frieze. This accounts for the unusual thinness of the slab.

A Scythian Work of Art

A BEAUTIFUL Greek sword-sheath covering, made from a thin plate of gold for a Scythian king who dwelt in southern Russia, depicts a contest of Greeks and barbarians and dates from the end of the 5th Century B.C. The gold was beaten out over a die and the details chased afterwards. The metallic

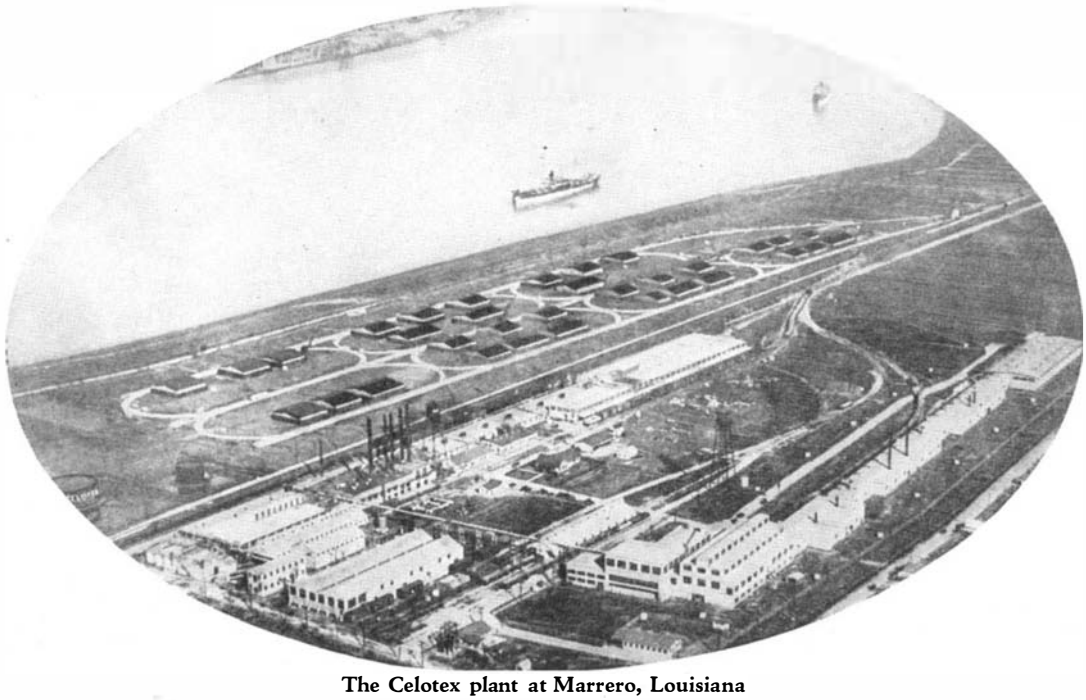
***Below:* Greek sword sheath for Scythian. *Right:* Detail of combat**

sheath cover was made for a sword 22 inches long, and has the characteristic projection for fastening it to the belt. The sheath proper, presumably of leather, has disappeared. The Museum is fortunate to possess such a piece, made when Greek art was at its height.

Iranian Bronzes

NINETEEN bronzes found in Luristan, a mountainous and inaccessible region of western Persia, have just been acquired by the Metropolitan Museum of Art. They consist of pole tops, figures of animals, horse trappings, pins, and bracelets of unusual design and shape. Most of the pieces come from graves. The small figure of a deer belongs to the Bronze Age. The bronzes may be assigned to a period from the 6th to the 4th Century B.C. The elaborate pole tops with heraldic animals are of most interest. The specimens represent the art of a hitherto unknown branch of Iranian nomads.

Iranian bronzes from western Persia. Most of the pieces come from graves. The art of nomads of a hitherto unknown branch



The Celotex plant at Marrero, Louisiana

AN INDUSTRY THAT WAS MADE-TO-ORDER

By A. E. BUCHANAN

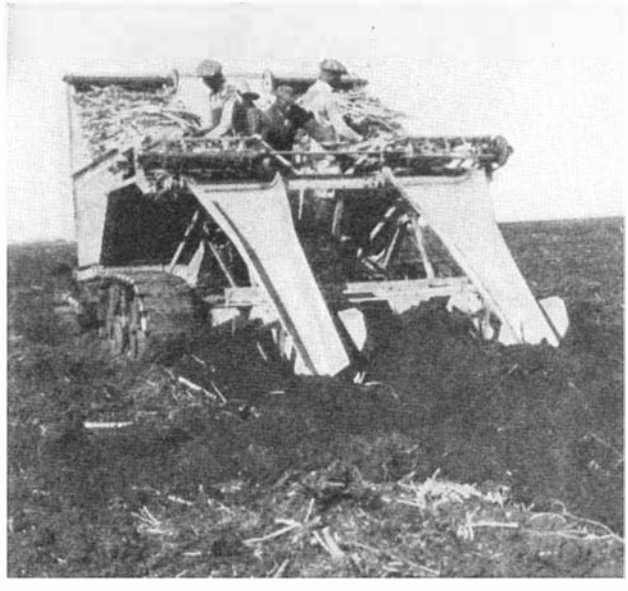
"GREAT oaks from little acorns grow." In the colorful history of American business, the old proverb has been applied to the little machine shop that became an automobile factory and to the newsboy who became a captain of industry. But this is the tale of a new kind of a business romance in which an industry was literally built to order in a single decade. It is the story of a group of men armed with the tools of science, who, disregarding the acorn, visioned the mighty oak and methodically proceeded to build substance into their dream.

It has been long recognized that the average home, artificially heated in cold weather, is an excellent radiator to warm up "the whole outdoors." Until about ten years ago, however, only the wealthy could afford to build heat-insulated houses, using the flax, animal hair, or wood fiber materials then available. To our little group of industry builders, with the engineer's inherent distaste for wasted energy, it seemed but elementary common sense that any building for human occupancy should be designed to retain heat in winter and exclude it in summer. Accordingly they set out to create a new structural material that would bring insulating properties within the reach of every home-builder.

The first requirement for the new industry was a fiber which would be available annually in large quantities. This fiber must be low-priced and hence must be a vegetable waste without food value or other economic worth. Cornstalks, flax, cereal straws, hemp, and wood fiber were considered. From the chemical standpoint, some of them seemed suitable, but there were economic objections to their use. Some of them had value as cattle feed; some had already found industrial uses and most of them would involve an expensive collection system because they are produced by many scattered farmers.

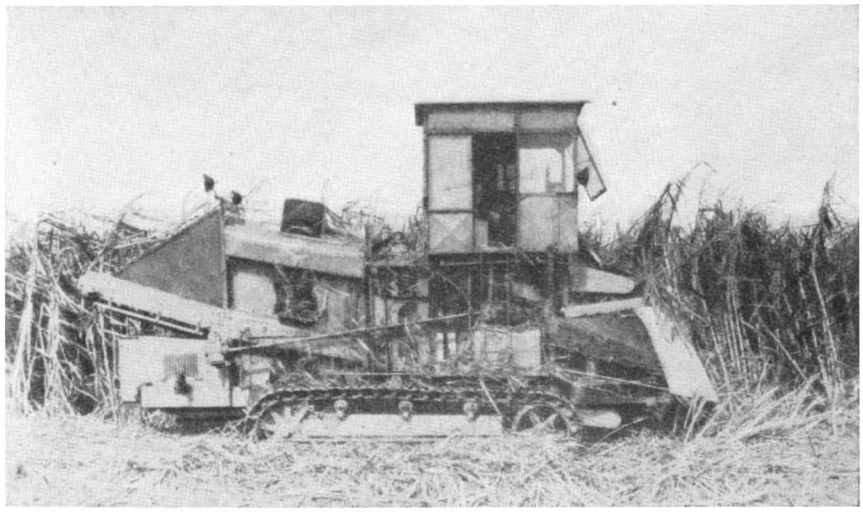
Finally the investigators came to bagasse, the fibrous refuse that remains after the juice is extracted from sugar cane. Sugar cane is grown in large, concentrated areas throughout the world. The juice is extracted by crushing the cane between rollers. The residual fiber is light and bulky and would form a tremendous pile of refuse at the sugar mill unless some means were devised to dispose of it. Because of the tough, spiny character of its fibers, bagasse cannot be used for cattle feed. It is so resistant to decay that it cannot be plowed back into the soil to form humus. The only way to get rid of it was to burn it and this was the general practice at sugar mills. Although its combustion produced a portion of their steam requirements, the sugar millers knew it to be a very inefficient fuel.

Having determined that bagasse offered the ideal raw



Veteran sugar-cane growers said that a machine could not be used to plant cane. Here is one that has been developed and that can plant 400 acres of cane a day

material for their new industry, our industrial pioneers, after much persuasion, made an arrangement with a sugar plantation at Houma, Louisiana. Under its terms, they converted the furnaces in the mill to burn natural gas, which was conveniently available, and agreed to pay the fuel value of the bagasse, plus a profit, for the entire output of the mill. Part of the agreement provided that bagasse must be removed from the mill as produced in order that it might not interfere with the crushing operation during the busiest season of the year. The first crushing season, that of 1920, witnessed a daily battle to get away from the mill 300 tons of bagasse every day. Not only was the battle won, however, but so decisively was the feasibility of the whole project demonstrated that today the sugar cane industry of Louisiana owes a large part of its prosperity to the utilization of a by-product; the bagasse that was formerly burned is now converted annually into approximately five hundred million square feet of insulating board, trademarked Celotex.

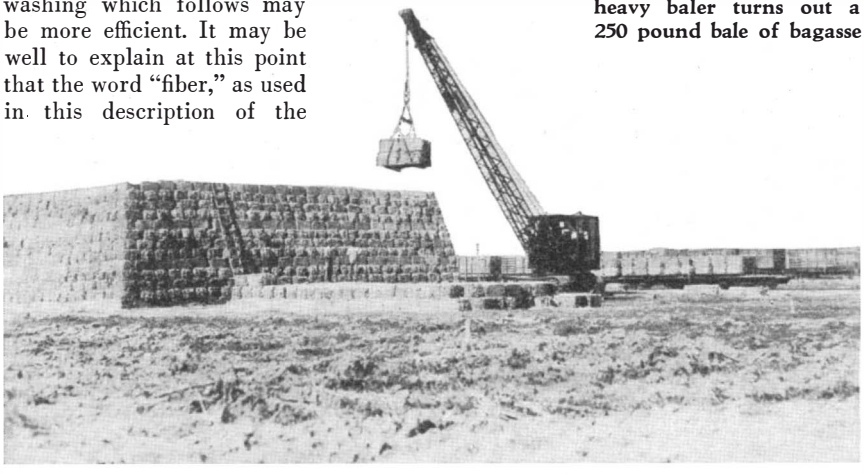


Harvesting sugar cane in the Florida Everglades. The refuse left after extracting the juice is the material on which has been built a vast made-to-order industry

The mills of The Celotex Company are located at Marrero, just across the Mississippi River from New Orleans. In the illustration at the top of the opposite page may be seen the huge piles of bagasse bales, stored to await processing. Bales of bagasse are delivered as needed to the mill where they are broken open and conveyed on an endless belt to the cooker room, where the bagasse is dumped into great rotary digesters, 14 feet in diameter. Here it is cooked under pressure, in order to make the fiber more flexible, to sterilize it, and to remove soluble organic matter.

After cooking, the fiber is pumped through shredding machines in order to break up the large shreds so that the washing which follows may be more efficient. It may be well to explain at this point that the word "fiber," as used in this description of the manufacturing process, refers to a suspension of fiber in water. By keeping the bagasse fiber at a 2 to 3 percent consistency, it can be pumped and otherwise handled as though it were liquid.

A specially designed extra heavy baler turns out a 250 pound bale of bagasse

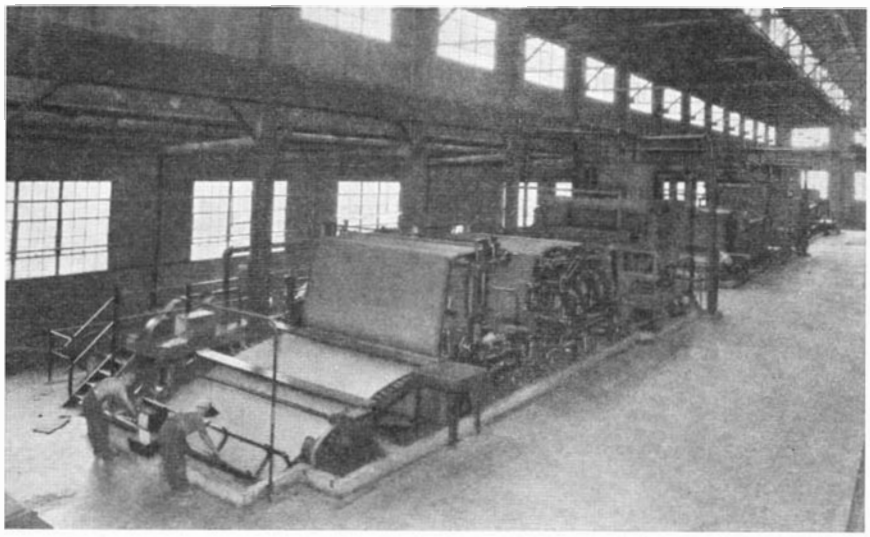


Since the raw material for a year's manufacture of Celotex is produced during a cane-crushing season of about three months, large storage space is essential

From the shredders the fiber is discharged into rotary washers where the dirt, soluble organic and mineral compounds, and a certain amount of pith are washed out. From the washers the fiber passes to stock chests which are large wooden vats, fitted with powerful rotating agitators to prevent settling. In these stock chests the sizing agents, mainly rosin and alum, are added. The next step is the refining of the fiber in order to produce uniform shreds of the proper length and width.

AFTER passing through a series of beating and rendering operations, the fiber is ready for the manufacture of Celotex and the "stuff" is pumped to the board-forming machines. Here the pulp is changed from a liquid suspension into a damp board of uniform thickness. This operation is accomplished on specially designed machines composed of two distinct parts, the mold rolls and the presses. On each machine there are two mold rolls, 6 feet in diameter and 13 feet long, covered with wire mesh and together forming the front end of a vat into which the thin pulp is admitted. The rolls rotate toward each other, acting like filters. The water drains out through the wire and a thick layer of pulp builds up on the wire surfaces. This layer of pulp is then carried over the rolls, between heavy belts of felt, which conduct it through presses where the excess water is squeezed out and from which the matted pulp emerges with a moisture content of 50 to 55 percent. The wet board now passes to the dryers which are 1000 feet long and large enough to accommodate two or three sheets of board each 12½ feet wide. The dryers are steam and oil heated, being provided with coils supplied with high-pressure steam and fans which carry off the moisture as it is driven from the board by the heat.

The board comes from the dryer in



A board machine in a Celotex plant. At the high end the water is drained and the cane fiber (bagasse) is formed into a continuous sheet which passes through pressure rolls and on down, through the floor, to the drying chambers beneath

practically a bone dry condition and will take up about 8 percent moisture when stored under ordinary atmospheric conditions. In order to season the board, therefore, it is sprayed with clean water as it emerges from the dryer. This seasoning is very important because it prevents buckling when the sheet is used for construction purposes. After the board is sprinkled, it is automatically cut into desired length and width by revolving knives. The knives run at slow speed and have emery wheels attached to keep them sharp.

Celotex has found a wide variety of applications, not only in building construction but also in the industries. In the former field it is used as sheathing, as a base for plaster walls, for roof insulation, as an interior finish, and for sound insulation of offices, auditoriums, and so on. Industrially, it is used in railroad refrigerator cars, for domestic refrigerators, in ice cream, bottle dispensary and similar cabinets, as radio loudspeaker baffle-boards, as a base for linoleum, in aircraft and hangars, for expansion joints in concrete, for sign boards, and for special packaging. It has even been used for making tennis court surfaces, pipe gaskets, archery targets, oil filters, table pads, automobile radiator shields, and art screens.

AN interesting special form of this product is known as Acousti-Celotex. As its name implies, it is designed to utilize the sound-absorbing properties of the material. It is made in the form of tiles, each tile composed of two or three laminations of insulating board, and drilled almost through with 441 holes per square foot, thus increasing the sound-absorbing power of the material.

Perhaps the most interesting phase of this romance of a made-to-order industry is the startling economic development that has followed in its wake. At the time when the first experiments were being conducted, the cane-sugar industry in the section of Louisiana known as the Sugar Bowl was facing extinction. The yield of cane from the once productive lands was falling to an unprofitable minimum. Government experts advised the planters that the continuous planting of Louisiana cane had so weakened the strain that it could no longer withstand the rigors of weather, insects, and parasites. The United States Department of Agriculture recommended planting certain varieties of cane produced in Java by scientific cross-breeding. But the Louisiana planters were skeptical, discouraged, and financially crippled.

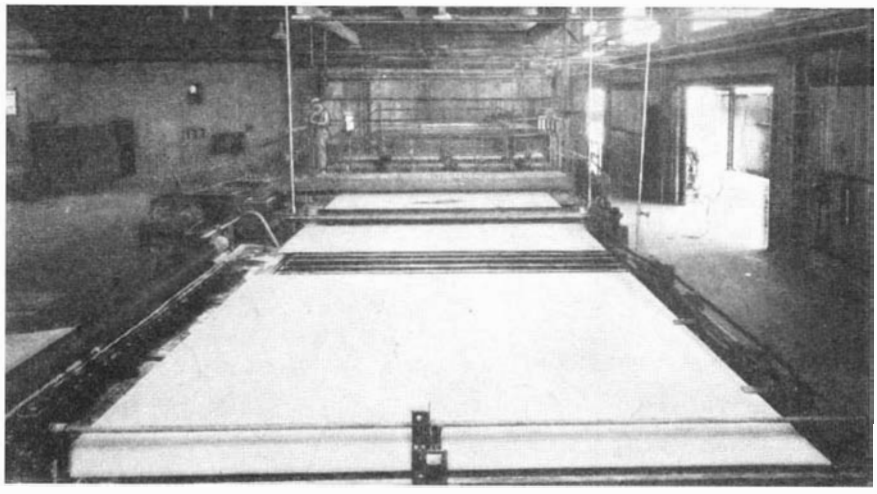
It was at this time, in 1926, that The Celotex Company, because of its need for the bagasse that had formerly been an almost useless by-product, injected itself into the raising of sugar cane. New capital was raised for a thorough trial of the theories advanced by the government experts. The new variety of cane thrived. The yield per acre jumped back to a profitable figure and the Louisiana Sugar Bowl was saved from bankruptcy. Not only did the new cane produce more sugar, but appropriately enough, it yielded a better grade of bagasse than the older variety.

As a result of this experience, the Celotex interests organized subsidiary companies which developed land in the Florida Everglades for sugar cane raising. This work involved an engineering achievement of no mean proportions for it was necessary to construct a huge system of dykes and ditches to control the water that had brought grief to all former attempts to cultivate this swampy area. Also, the land in its natural state was not suitable for cane culture. But it was found that the addition of 75 pounds of copper sulfate per acre of land brought the drained soil to fertility within six months.

But these industrial pioneers have done more than this. They have demonstrated an entirely new principle in agricultural economics by completely industrializing the age-old business of raising sugar cane. In the words of E. C. Lathrop*, Director of Research of the Celotex Company, "The securing of fiber and sugar is being thought of, not in terms of agriculture, sugar milling, fiber manufacturing, but as a continuous inter-related and inter-locking industrial problem, beginning with the drainage and character of the soil and ending with the finished fabricated article in the hands of the customer."

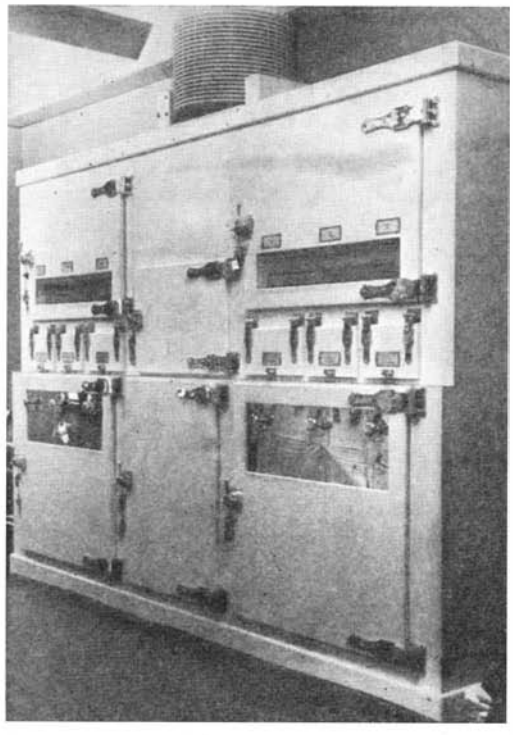
IT is not unreasonable to envision a time when other branches of agriculture may join forces with the chemical engineer to elevate lowly by-products to a dignity equal to that of the crop itself, thereby creating new industries and solving the economic problems of agriculture by industrializing the farm.

*The author wishes to acknowledge his indebtedness to Dr. Lathrop, who supplied both the data and the photographs for this article.



As the pressed sheets of insulating board emerge from the driers onto this conveyor, they are cut by revolving knives into smaller sheets of the required size

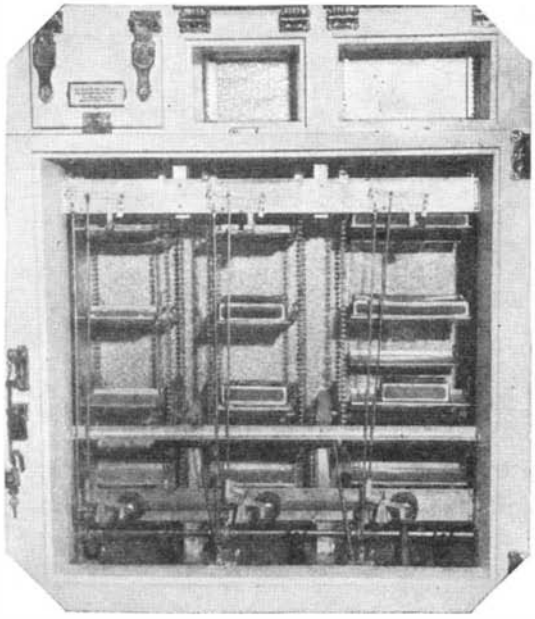
The customer is buying a packaged steak from a refrigerated unit. Another steak will take its place, being lowered by endless chains



The refrigerated unit contains the full automatic coin control

A TWENTY-FOUR HOUR AUTOMATIC MARKET

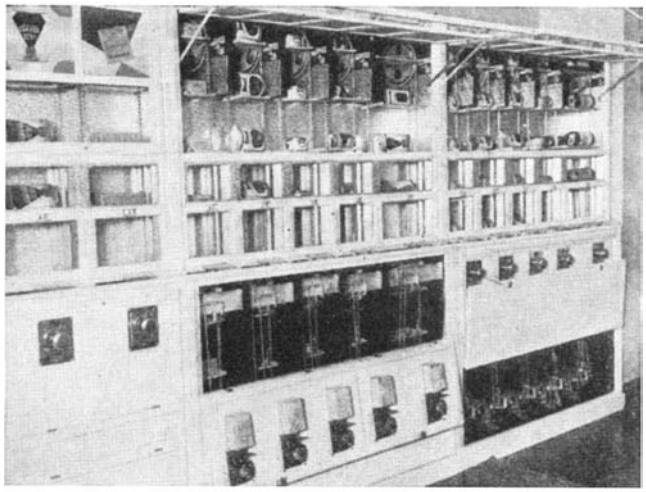
WE recently had the privilege of inspecting the first of the "Delamats" or automatic markets where meat and groceries are sold. The idea is to dispense either refrigerated or unrefrigerated food from coin controlled containers. The first installation has been made in a room on the ground floor in a large apartment house in West 44th Street, New York. In the daytime a girl makes change and sees that the machines are supplied with their merchandise. When she leaves she empties all the coin containers and the outfit carries on, until the next day, without human aid. The units are of two kinds; one is built into a large



Right: Detail of unit showing chains, descending trays carrying merchandise, and clutches

General Electric refrigerator and the others are adapted to handle merchandise at room temperatures. When the cost of the article is less than the coin or coins to be inserted, change is returned automatically. The goods are well displayed and the insertion of a coin or coins and a turn of a knob starts the motor and delivers the goods to the customer. The machine then brings down the next article on a tray attached to endless chains. A small motor actuates the entire mechanism. The systems employed are the inventions of Mr. N. Robert Harvey who has spent several years in their design and development for commercial use.

Mr. Harvey explaining his system. Note the visibility of the goods and also the opportunity for advertising wares

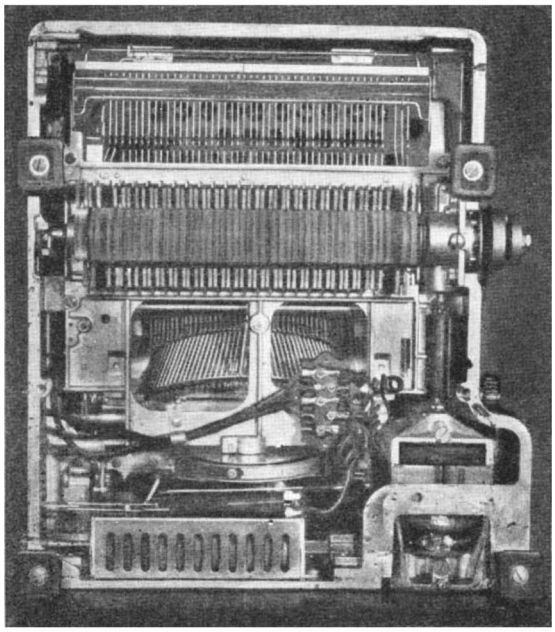


The mechanism is operated by an electric motor by means of a shaft, clutches, and endless chains carrying trays

ELECTRICITY RUNS THIS TYPEWRITER

The simplified typewriter in which every movement is performed by the aid of electric power

THERE is a certain amount of sentiment connected with the invention of the typewriter illustrated and described here. It is the result of a carefully considered engineering investigation into the problem of the motorized typewriter carried on by Mr. Russell G. Thompson who enjoyed the distinction of reaping the benefits of the Orson Desaix Munn Fellowship in electrical engineering at Princeton University. This Fellowship was established by the son and grandson of the late Orson D. Munn, one of the founders of the SCIENTIFIC AMERICAN. Mr. Thompson could have spent two years on this Fellowship but he finished his work in one year and in 1915 obtained not only his degree of Electrical Engineer but also secured the Charles Ira Young medal for engineering research. The Franklin Institute subsequently gave his company (with special mention of Mr. Thompson) the John Price Whetherill medal for the power drive for typewriters.



Bottom view of typewriter showing frame, motor, power roller, cams, and the type "basket"

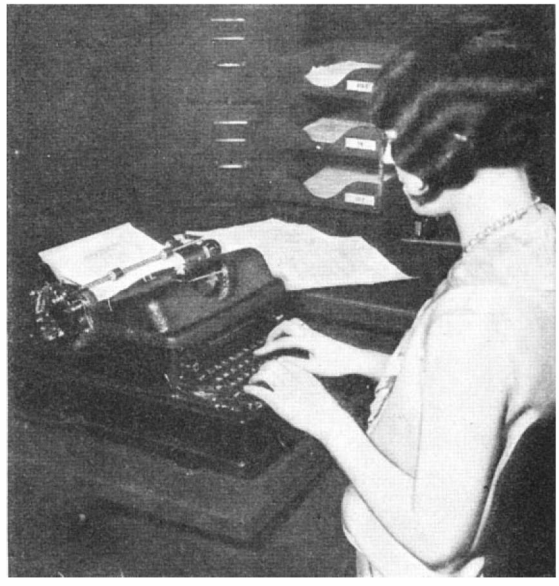
Electric typewriter experiments go back as far as 1900. With the present machine the system was built into over one hundred typewriters of different makes. The idea underlying this machine was to design a typewriter in which every movement would be performed by electric power, thus increasing the speed in writing and reducing the physical work required of the typist. Another object was to create a design that would permit, not alone the highest speed an expert typist can attain, but a much higher speed obtainable only when a supplementary mechanism for automatic operation is added to the standard machine. There are really three machines: the typewriter proper, the perforator, and the duplicating typewriter operated from a perforated roll.

The usual typewriter mechanism, being designed primarily for manual operation, was found to be much more complicated than necessary when power was used; consequently, an entirely new typewriter was developed and built, the typewriter mechanism itself being simplified for the Electromatic mechanism. Numerous parts were omitted and the simplest and most direct designs incorporated in the new machine. The result was an entirely new machine that is a quicker, simpler, and smaller electric typewriter, comparable as regards size, weight, and total number of parts to the ordinary manual typewriters.

Aside from its front cover, this typewriter consists of three major assemblies; the main frame, the sub-frame, and the carriage. Four die-castings, held together by screws and positioned by dowels, form the four sides of the main frame. In this assembly are included the motor, switch, rheostat, and all other electrical parts, the rubber-covered power roller which transmits motor power to the mechanism, the worm gearing which serves as the speed reduction between the motor and the power roller with its die-cast housing, the carriage ways, escapement and back-spacing mechanism, and a few other minor parts.

A motor of special design and construction is employed. All these motors have the inherent characteristic of constant speed, regardless of the load employed in their normal operation. By setting a small rheostat slide, the voltage applied to the motor, and its corresponding speed, can be varied. The higher the speed the harder the type blow and the greater the number of carbon copies that can be made.

Fitting into the main frame is the sub-frame, which supports all the keys and operating cams, the "basket" containing all the letter and figure characters, the ribbon mechanism, and various other parts. This sub-assembly is held into the main frame by two hinge dowel pins and four screws. A feature of this assembly is the mounting of the basket, which is raised and lowered for each capital letter. In each extreme position it is locked securely and automatically by a toggle linkage, assuring perfect

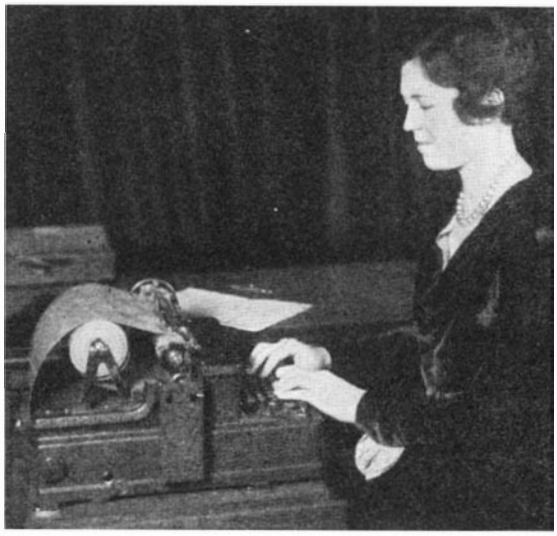


The slightest touch actuates the mechanism; everything is moved by the motor-driven roller

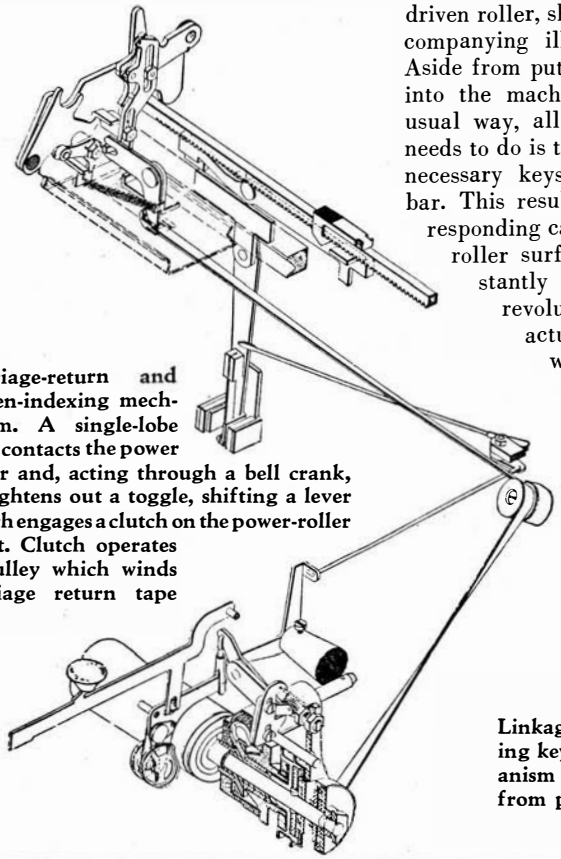
alignment. The basket is attached to the sub-frame by four flat springs held to the respective members by screws through each end. These springs give a parallel motion somewhat on the order of a pantograph, but without any sliding or pivoted joints to wear and give play. Moreover, the springs assure positive alignment from side to side in their own planes.

Although the carriage departs less from conventional design than the other assemblies mentioned, it is not without original features. The platen is quickly removable, and a system for fractional spacing is provided. Line spacing is performed automatically as the carriage is returned.

As already noted, the power for performing the various functions of writing, carriage return, backspacing, line spacing, shifting for capitals, and tabulating is applied by the rubber-faced motor-driven roller, shown in accompanying illustrations. Aside from putting paper into the machine in the usual way, all the typist needs to do is to press the necessary keys or space bar. This results in bringing the corresponding cams into contact with the roller surface. The cams then instantly turn through one half revolution, and in so doing, actuate type bars which write characters, or perform some other function corresponding to the key pressed.

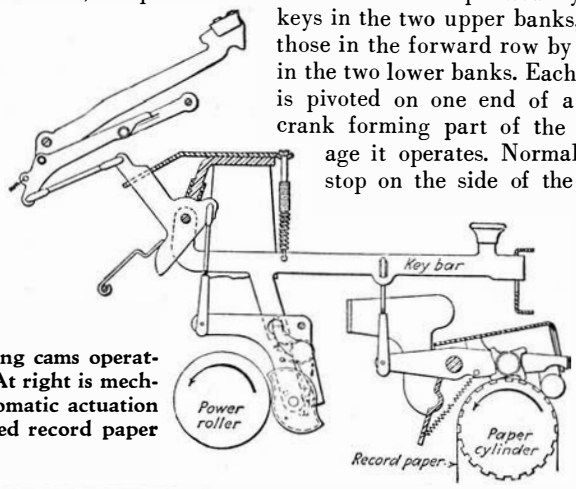


The perforator prepares the duplicating paper roll at about the same speed as in letter writing



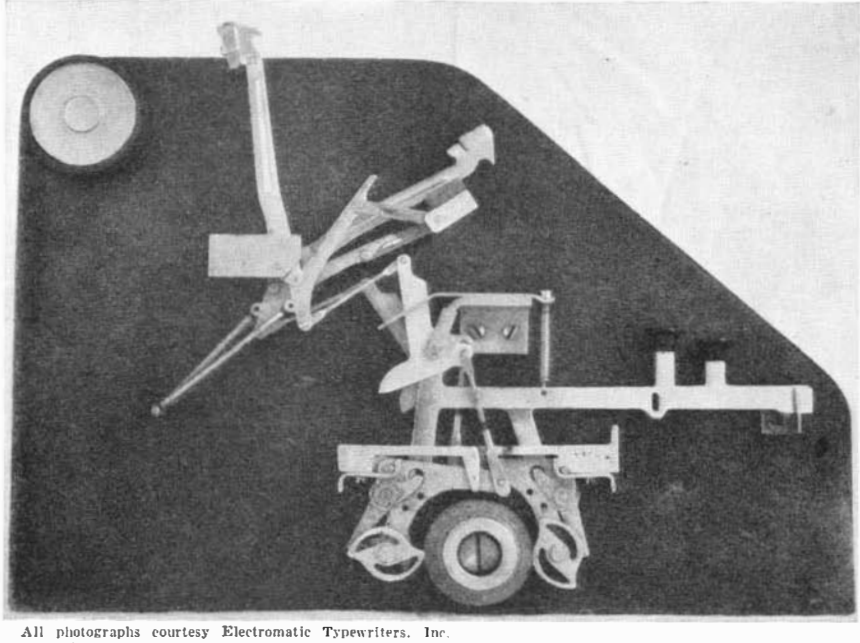
Carriage-return and platen-indexing mechanism. A single-lobe cam contacts the power roller and, acting through a bell crank, straightens out a toggle, shifting a lever which engages a clutch on the power-roller shaft. Clutch operates a pulley which winds carriage return tape

The cams are arranged in two rows. The rearward row is operated by the keys in the two upper banks, and those in the forward row by keys in the two lower banks. Each cam is pivoted on one end of a bell crank forming part of the linkage it operates. Normally, a stop on the side of the cam holds each cam a few thousandths of an inch out of contact with the roller surface, but when the key corresponding to a given cam is pressed, a spring forces the serrated surface of the cam against the soft rubber surface of the roller and the two rotate together without slippage. In so doing, the cam pivot and the link to which it is attached are forced outward, away from the roller, because of the increasing radius of the cam. It is this motion, for which the motor supplies the power, that actuates the type bar.



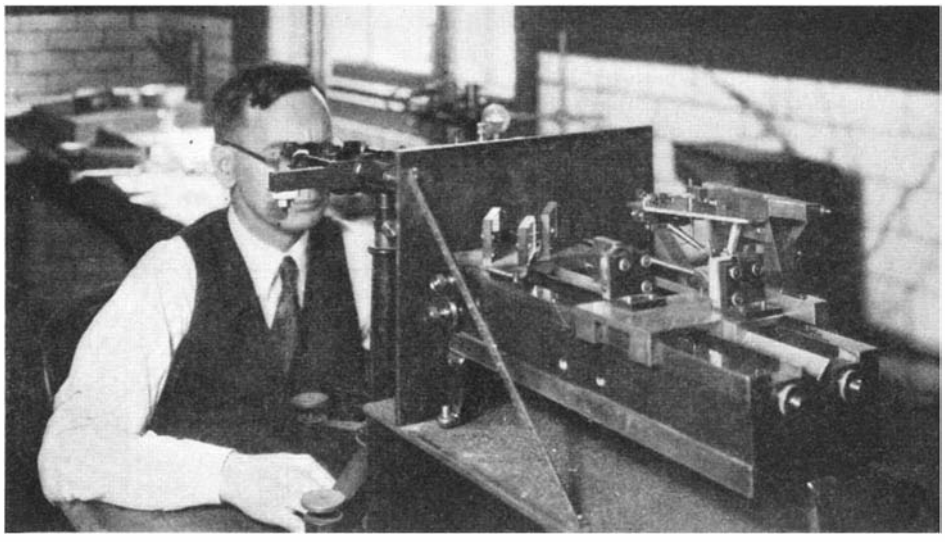
Linkage showing cams operating key bars. At right is mechanism for automatic actuation from perforated record paper

A simple supplementary device can be built in, which will enable it to write letters automatically. The typist in this case need only fill in the address, an operation which can be done while the letter is still in the machine. The automatic device does not interfere with writing individual letters. A power operated perforator makes the master copy on a roll which is placed over a cylinder in the typewriter.



All photographs courtesy Electromatic Typewriters, Inc.

A fore-and-aft section through the machine giving relation of power roller, cams, and bars. Two key bars and two type bars are shown, with mechanism



Ruling a decimeter standard at the Bureau of Standards by interference fringes

HOW BIG IS A QUANTUM?*

By PAUL R. HEYL
Physicist, National Bureau of Standards

THE inspiration for this article came from a letter recently received, which read in part as follows:

"I am usually willing to accept statements made by scientific men without open question, but I sometimes wonder privately how they have arrived at their conclusions. Of course I realize that usually the evidence is of a highly involved and technical character, but I nevertheless have a feeling that in some cases I could and would follow with interest the broad and general lines of the argument. In particular, you stated recently in the SCIENTIFIC AMERICAN[1] that a quantum of star light might be as big as a barrel. It seems very strange to me that an atom of energy should be so large while an atom of matter is so small. I think I understand pretty well what a quantum is, but as to its size —how do you know?"

A perfectly fair question, but let us broaden it a little. How do we know anything about light at all?

To this there are two answers: first, that we really know very little, and second, that all we do know (or think we know) we have learned from the behavior of light itself.

What is there about the behavior and properties of light that will give us any indication of the size of a quantum?

The line of reasoning in this case was first set forth by the Dutch physicist Lorentz,[2] who died a few years ago. The experimental basis for the argument is found in the phenomenon of interference.

If you have never seen interference fringes it is not a very difficult matter to obtain them. They may frequently be seen in the vicinity of a filling station where a drop of oil has been spilled on a pool of water on the pavement, and has spread out into a very thin film on the surface of the water. Light reflected from this surface exhibits a pattern of irregular rings, outlined in all the colors of the rainbow.

FIND or make for yourself a patch of color of this nature. Get a pane of colored glass—the ruby glass used in photographic work serves well. Hold the pane of glass close to the surface of the water so that nothing but red light reaches the film of oil. The rainbow colors will disappear, and in their place will be the same pattern in red and black. The black parts are what we call interference fringes. They are caused by two rays of red light mutually extinguishing each other. The red portions, on the other hand, result from mutual intensification.

Now if two rays of light sometimes neutralize and sometimes reinforce each other, each ray must be in part the opposite and in part the same as the other. Where opposite phases come together they cancel each other, like paired votes, and interference results. Where similar states coincide we have mutual intensification.

We can think of several kinds of such opposite conditions: alternate condensation and rarefaction such as constitute waves of sound; motion up and down; positive and negative electric charges; north and south magnetic poles. When speaking of light it is usual to adopt the conventional idea of a wave made up of crests and troughs. When two rays of light simultaneously enter the eye the resulting effect will depend upon whether the rays are in or out of step; that is, in the language of the wave theory, on whether two crests come together or whether a crest of one wave coincides with a trough of the other. (Figure 1.) In the first case the two rays will reinforce each other; in the second, they will neutralize one another and produce darkness. In the case of the film of oil the necessary lag between the two interfering rays is produced by reflection from the upper and lower surfaces respectively of the thin layer of oil.

The modern quantum theory of light does not regard such waves as continuous all along the light ray, but as broken up somewhat like a dotted line. (Figure 2.) Trains of light energy alternate with dark spaces, but so rapidly do the successive wave packets, or quanta as they are called, reach the eye that the effect produced is one of continuous illumination.

Due to persistence of vision in the retina the eye will perceive as appar-

*Publication Approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

[1]Heyl: *Scientific American*, December, 1930: "What is a Quantum?"

[2]Lorentz: *Nature*, April 26, 1924, page 611.

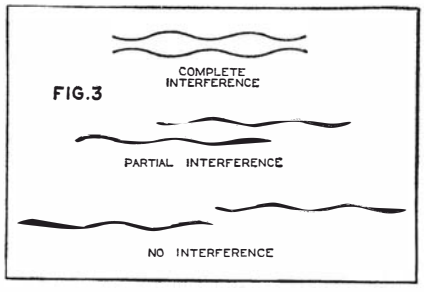
ently continuous a set of flashes occurring as rapidly as perhaps 20 per second. Now the speed of light is something like 190,000 miles per second, and at this speed light quanta arriving at the rate of 20 per second need be no closer together than 9500 miles to produce the sensation of continuity.

By instrumental methods it is possible to separate flashes occurring much more rapidly than 20 per second, but even if the successive quanta should reach the eye with a frequency beyond instrumental separation, say a million a second, the average distance between them would still be about one fifth of a mile.

CONSIDERATIONS of this nature led to the suggestion that a light quantum might be a train of waves of finite length, called by some writers a "dart." Just how long such a dart might be was rather uncertain, but experiments on interference led to the conclusion that in some cases it might be as long as two feet.

It is a remarkable fact that in order that two light rays may be made to interfere they must have started at the same time from the same source of light, and even from the same point of the source. Light rays emanating from different points of the source are emitted by different atoms, and it is the atom that is really the ultimate source of light. It is highly improbable that two atoms should be vibrating exactly in step with one another. Light rays coming from two different atoms in the same body might as well come from atoms on two different bodies. But if we take a single ray of light and divide it into parts it is a matter of no great difficulty to produce interference between these parts. All that is necessary is that the two rays shall be brought to the eye by paths which differ slightly in length.

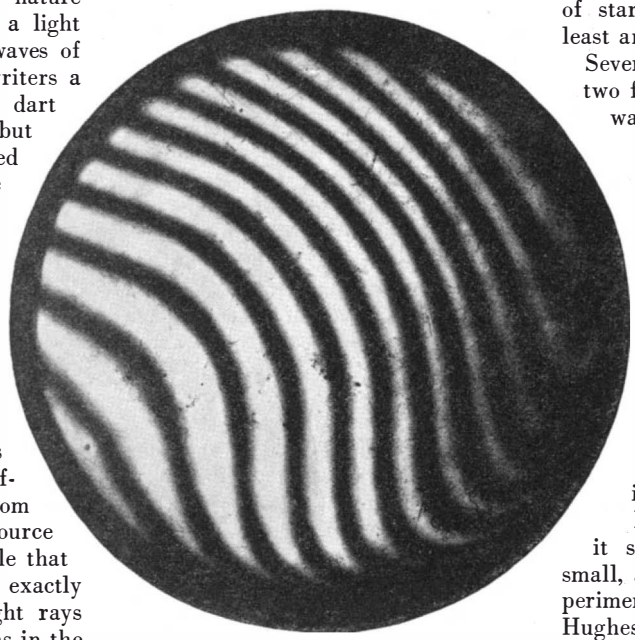
It appears then that two rays of light, to be capable of interfering must originally have been one, and so strictly one as to have been emitted at the same time from the same atom. As Lorentz states it, interference can occur only between parts of the same quantum.



Suggesting how the least length of a quantum of light is deduced

Now imagine such a divided quantum reaching the eye in the form of two darts, one lagging behind the other. (Figure 3.) As long as the two overlap interference will be possible to a greater or less degree, but if the lag, or difference of path, is greater than the length of a dart no interference can take place.

One of the conditions for good interference is that the light shall be of one color. It is for this reason that the use of the pane of red glass was recommended above. Lorentz states that experiments carried out with very pure monochromatic light have given interference with a difference of path of



A photograph of the interference fringes between two glass plates

about 50 centimeters (nearly two feet). A quantum must therefore be at least sometimes of that length.

What may be the cross section of a quantum?

Lorentz, proceeding further with his argument, considers a large beam of light brought to a focus by a lens, such as the objective of a large telescope. The definition of a star image at the focus of such a lens improves with the size of the objective. This gain in sharpness is due to the beneficial effect of interference. By placing a diaphragm over the objective the star broadens and becomes less sharply defined around its edges. By removing the diaphragm the light rays coming through the outer portions of the lens interfere with those producing the fuzzy edge of the image, and greater sharpness results.

It thus appears that the light rays from the outer portions of a lens may interfere with those coming through the center. But, as mentioned above, light rays can not interfere unless they form

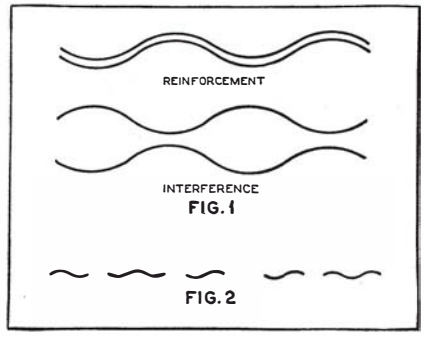


Figure 2, bottom, gives an idea of the "chunks" of light called quanta

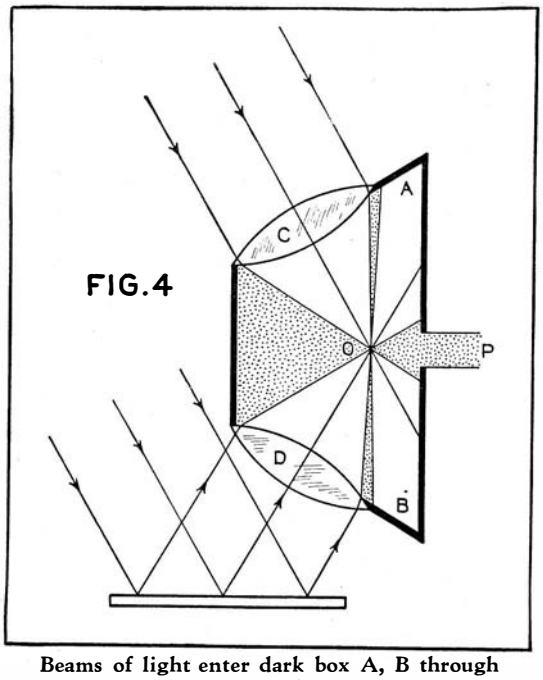
parts of the same quantum. Now astronomical lenses are frequently several feet in diameter, and a quantum of star light must therefore have at least an equal cross-section.

Several feet in diameter and nearly two feet long! The simile of a barrel was not such a bad one.

But Lorentz pointed out that the argument did not stop here. He reminded us of the fact that in Michelson's work on star diameters interference was obtained with light rays that were as much as 18 feet apart. From this viewpoint a quantum might be as large as a section of one of the big trees of California. How much larger it may be, and whether there is any limit to the size to which it may expand, no one knows. But a quantum of light energy, it seems, may sometimes be very small, as indicated by some recent experiments carried out by Professors Hughes and Jauncey[3] of Washington University, St. Louis. These experimenters caused two beams of light as intense as could be conveniently obtained to cross each other at a narrow junction, and looked for evidence of collisions in the form of scattered light. For this experiment they employed broad beams of sunlight 24 centimeters or about nine inches in diameter, concentrated by large lenses so that at the place of crossing the diameter of each beam was about 0.4 centimeters or 3/16 inch. This produced an intensification of the light about 3600-fold (Figure 4.) But even with this density of traffic the successive quanta passed the intersection with no evidence of collisions. As a consequence, it was estimated by the experimenters that the cross section of a quantum at the intersection may have been something like 3×10^{-20} cm^2. (About one 200,000,000,000,000,000,000th of a square inch.—Editor.)

A QUANTUM of light energy, it seems, must be rather an elastic and compressible affair, quite different in this respect from an atom of matter.

[3] Hughes and Jauncey, *Physical Review*, August 15, 1930.



Beams of light enter dark box A, B through lenses C, D and cross at focus O. Eye is at P

But the absence of scattering in the experiments of Hughes and Jauncey is capable of another interpretation. Light as we recognize it today has a dual aspect. In some ways its quanta act like corpuscles and in other ways as waves. In the theory underlying their interpretation of their results Hughes and Jauncey emphasized the corpuscular side of the quantum to the neglect of its wave aspect. Now wave trains, as is well known, can ordinarily cross each other without difficulty. This may be seen in the case of ripples in still water. If emphasis be laid on the wave aspect of light it would seem that no scattering at crossing is to be expected.

BUT when the amplitude or intensity of the wave reaches a certain point the wave form, at least in water, becomes unstable and breaks up. This may be seen at the seashore where the incoming rollers increase in height until they finally break in a shower of spray. And it might have been possible that the two beams of light employed by Hughes and Jauncey could have been each so intense that their sum would have surpassed the limit of stability. As it appears, this did not happen.

A quantum of energy, it seems, has no definite size such as characterizes an atom of matter. A quantum may be originally contained in a single atom of a star. Leaving this abode, it may travel outward into space, continuously expanding without limit, for all we know to the contrary. By means of lenses or mirrors it may again be compressed to a very small size, again apparently without limit. And it appears that sometimes a quantum will contract of itself to a size so small that it can be totally absorbed by an atom, or even by the still smaller electron. This is believed to take place in what is called photo-electric action.

When light of the proper color falls upon certain substances electrons are emitted, copiously if the light is bright, more sparsely if the light is faint, but no matter how feeble the light the emission of electrons starts immediately when the light falls upon the sensitive substance.

Sodium, for example, will respond in this way when exposed to light of any color between the yellowish green and the violet of the spectrum, but light at the other end of the spectrum, between yellowish green and red, will not excite this action no matter how intense or long continued it may be.

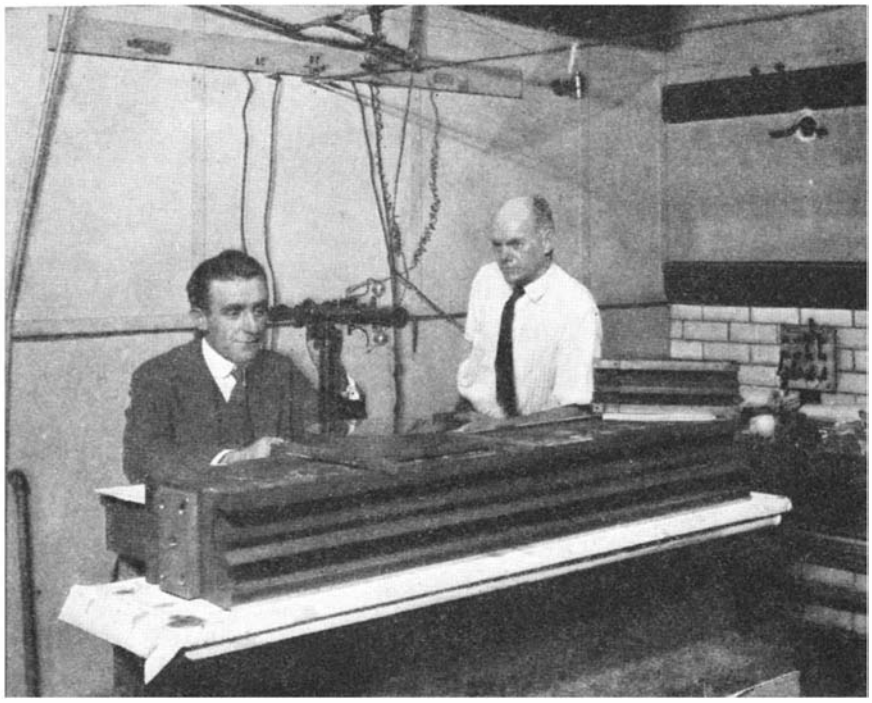
What is the mechanism of this process? Where does the energy of the emitted electron come from?

These questions might be easy enough to answer if we neglected quantitative considerations. It might be said that the electron was almost able to break away, and that the light exerted a trigger action of some kind, releasing it from confinement. But there is a curious quantitative relation between the energy of the emitted electron and the energy of the quantum which liberates it. If we wish to obtain electrons of high energy content we must supply light quanta of equally high energy. Quanta of less value will produce electrons of lower energy or perhaps none at all.

To use an illustration which is not new, suppose a plank falls from a ship into the water and sets up a series of waves, which travel onward, continually growing less intense, until they reach another ship at some distance away. Nothing would surprise us more than to see a plank of the same weight detached by the ripples from the second ship and flying up into the air to a height equal to that from which the first plank had fallen.

Something very like this happens in the photo-electric effect, and in the face of this quantitative relation the trigger explanation fails. Here we have a first class mystery. There is not enough energy at any point in the wave front to do the work, and yet somehow or other the work gets done. Does the widely extended quantum, when it encounters a waiting electron, gather itself together and whisk into the electron like the genie into the bottle in the Arabian tale?

MUCH yet remains to be learned about the quantum. We have evidence sufficient to warrant us in believing in its existence; we know a little about the way it behaves; but whether it be wave or particle or both at once we are as yet doubtful. Yet the quantum concept has been the most fruitful of all the new concepts of 20th Century physics, surpassing even the theory of relativity; and while the theory of relativity seems to show signs of reaching a barren stage the quantum theory is still lusty and vigorous.



Ruling a standard meter bar by means of interference fringes. Mr. C. G. Peters of the National Bureau of Standards is at the interferometer in the foreground

CLEMENCEAU AND FOCH

A Biographical Study of Two Fearless Frenchmen

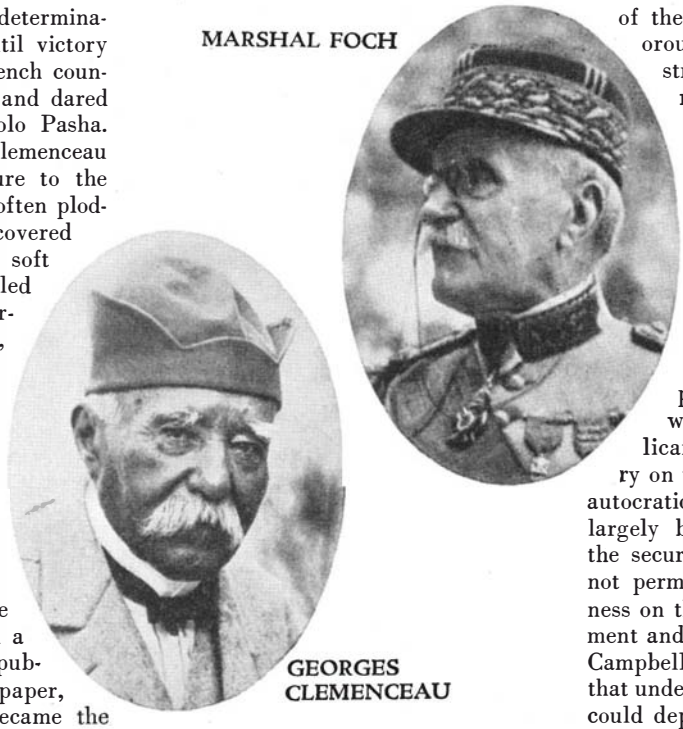
By CAPTAIN W. D. PULESTON
United States Navy

BIOGRAPHIES greatly influence history. It is only by the disclosure of the personal viewpoint and the influences which govern action, that events can be properly judged.

So many biographies of wartime leaders have appeared and they are so voluminous and contradictory, that the average reader is completely confused.

The author of this article is internationally known for his judicial, keen, and searching analysis, and here presents a resumé which we believe will be recognized as historically important.—*The Editor.*

IN the darkest days of the last German offensive on the Western Front in the spring of 1918, when their armies approached nearer to Paris than they had been since September, 1914, it was Georges Clemenceau, French premier, who roused the flagging spirit of that sorely tried nation for the last struggle with the invaders. Alternating unceasingly between the French trenches and the rostrum of the Chamber of Deputies in Paris, he imbued the French troops with his own fierce determination to continue to fight until victory was won, drove from the French councils defeatists like Caillaux, and dared to execute the traitorous Bolo Pasha. When he became Premier, Clemenceau was already a familiar figure to the French poilu, for he had so often plodded through the trenches, covered by a dark greatcoat, with soft hat whose narrow brim pulled sharply down over his weather-beaten face, that his stocky, rather stout silhouette gradually assumed a remarkable resemblance to the well known outline of the French private with his trench hat and field coat.



MARSHAL FOCH

GEORGES CLEMENCEAU

Clemenceau entered French public life as a member of the Chamber of Deputies in 1876, an extreme radical, an anti-clerical, and a devoted adherent to the Republic. In 1880, he founded a paper, *La Justice*, that speedily became the organ of the Paris radicals. In the Chamber and through his paper he became conspicuous as the overturner of cabinets; he steadily refused to enter the government until 1906, and for 30 years France thought he was more of a destructive critic than a constructive statesman. On one occasion he overthrew Poincare's ministry which drew upon him that statesman's persistent hostility and during three years of war President Poincare would not call Clemenceau to the cabinet.

Clemenceau's extreme republicanism led him to oppose the French alliance with Russia and his fear of Germany led him to oppose a vigorous French colonial policy, for he remembered that in 1866 Maximilian's adventure in Mexico detained French troops abroad that were needed in Europe. At first a supporter of General Boulanger, Clemenceau turned against him when he realized that Boulangerism was dangerous to the existence of the Republic. His experience in the War of 1870 convinced him of Germany's enduring hostility, his native shrewdness and an almost chauvinistic patriotism prevented his accepting too literally the Socialist's creed of the brotherhood of man.

His hostility towards the Russian alliance and his indirect (but innocent) connection with a leading actor in the Panama Canal scandals cost him his seat in the Deputies in 1893, and for nine years thereafter he confined his activities to journalism. In 1902 he was elected to the Senate as a Socialist Radical, and in 1903 undertook the direction of the journal *L'Aurore*, which he founded after severing his connection with *La Justice*; both in the Senate and in his paper, he supported the Dreyfusards and actively advocated the separation of Church and State. From 1876 to 1906, a full 30 years, Clemenceau proved his abilities and courage in opposition; finally in March, 1906, he took office as Minister of the Interior, and to confound his critics, he showed ability and courage in defense of the government's powers by vigorously suppressing a miners' strike with the Army. He definitely broke with the Socialists in a celebrated speech answering an attack upon his procedure by Jaures, the leader of French socialism.

In the summer of 1906 Clemenceau became head of the Government, as President of the Council, and remained in power until the summer of 1909. During this period the entente with England was fostered and the old Republican found it much easier to carry on with democratic England than autocratic Russia, whom he tolerated largely because she was necessary to the security of France; still he would not permit any unnecessary indefiniteness on the part of the British Government and insisted upon Prime Minister Campbell-Bannerman giving assurance that under certain conditions the French could depend upon British military assistance on the Continent.

In 1907 Lord Bertie, British Ambassador, reported to his Government that the French were far from bellicose and were anxious to preserve peace with Germany. In 1908 Clemenceau summarized to Bertie the French view of Germany as follows: "France had suffered a crushing defeat in 1870-71 because she was entirely unprepared. The French Army was very different now from what it was then. The French desired peace in order to solve their pressing internal problems, but the French had confidence in themselves and Germany must not 'tread on French toes'."

In the Casablanca incident in 1908,

(*Please turn to page* 351)

Dispatcher operating control machine by means of which he flashes the signals and throws the switches that regulate the movement of trains over a 40-mile section of railroad. This efficient system makes possible the abolition of train orders

SIGNALS REPLACE TRAIN ORDERS

By R. D. MOORE
Signal Engineer, Southern Pacific Company

AN interesting innovation in train dispatching, by which telegraph offices are discontinued and the use of train orders entirely abolished, has been made by the Southern Pacific Company on its Stockton Division in California. This dispatching system is in operation between El Pinal and Brighton, a distance of 40 miles, and all train movements are electrically controlled by the dispatcher, including the setting of switches.

The section of country served by the railroad between the two points named, is a highly productive agricultural area, and the movement of perishable freight presents an unusual problem, in that the railroad is confronted with irregular peaks in the flow of traffic. At certain seasons of the year there is little or no movement. Later, the shipments increase steadily until October, when the year's peak is reached for a short time. During this heavy shipping season, each day's movement achieves a peak of a few hours, during which the problem of handling the movement expeditiously is a serious one.

The line over most of this stretch is single track, and the laying of a second track, which would have solved the problem, meant the expenditure of 2,500,000 dollars for a roadway that for a certain period of the year would not be required sufficiently to justify the expenditure. The system installed, which is known as the centralized traffic control system, obviated this expenditure and has increased the efficiency of the existing line to the point where the handling of a 30 percent increase in traffic is possible.

The control, or dispatching machine, located in the dispatcher's office, is provided with a chart of the track controlled. This chart is a diagram of the district and is equipped with small lights connected with the switch signals along the line, which automatically light up as trains pass over the various sections of track. By a glance at the chart, the dispatcher can see just what portions of the track are in use.

THERE are 11 sidings in the control, and these, with the two end switches, are provided with 24 electric switch machines. Suitable signals for governing train movements at switches, and a track circuit including the complete fouling limits of the switches and leads make up a group known as a "field station."

Each field station is reproduced on the control board in the dispatcher's office. Each panel of this board consists of a section of the track diagram representing one switch, a two-position switch lever, a three-position signal lever, a starting button, and a pen on an automatic graph, arranged in that order from top to bottom. Each panel also includes a luminous track indicator to repeat the condition of occupancy of the track circuit, and similar indicators to repeat the position of the switch and the signals.

The control of traffic, with all necessary information for governing train movements, is thus centralized at this board, and any switch or signal can be operated by the dispatcher at any time.

The location and progress of trains are indicated visually by the track diagram indicators and are also permanently recorded automatically on a train graph which is located in a compartment below the level of the desk at the bottom of the control panels. It is a roll of specially-ruled paper, operated by a clock mechanism at three inches per hour, on which rest 24 recording pens, one for each switch point. When the train enters a track circuit the corresponding pen moves a short distance to the right, returning when the train leaves. The glass cover may be slid aside to permit the dispatcher to make any desired notations. The train-chart paper is in a continuous roll and it is the practice to tear it off daily at the mid-

night line and file it in lieu of the usual dispatchers' train sheets.

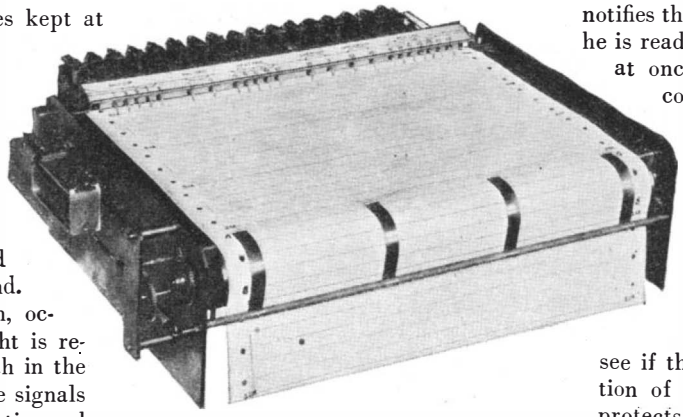
To change the position of a track switch or signal, the corresponding control levers are moved to a desired position and the push button is operated, causing the generation of a code in the line circuit, consisting of a series of circuit interruptions therein. When the field station units have responded completely, a code of similar nature is transmitted from the field station to the control panel, and causes the lights to indicate the new positions. If the levers are not moved, the pressing of the starting button enables the dispatcher to verify the indications without operating the field station units. Each code requires about six seconds to complete, so that several starting buttons may be operated in rapid succession and the codes will be sent out consecutively.

THE switches at ends of passing tracks are connected with, and operated by, electric motors. Power is furnished by storage batteries kept at a constant state of high efficiency by a trickle charge from a 110-volt power circuit.

All the switches are arranged for dual operation, so that, in case it becomes necessary, the electric control may be discontinued and the switch operated by hand. This, under normal operation, occurs only when a local freight is required to move back and forth in the process of switching cars. The signals between sidings are automatic and guide the trains much as they do elsewhere on the railroad. That is, should an engineer find a signal against him, he may proceed under standard automatic block signal rules to the next signal. The signals at the ends of the sidings are known as "absolute" signals. When an engineer finds one of these absolute signals in "stop" position, he must bring his train to a stop and telephone the dispatcher for instructions before proceeding. For this purpose, a telephone is placed near each absolute signal. The absolute signals govern the movement of trains into and out of sidings, and from one siding to the next. They are arranged to indicate whether the train should proceed on the main track or siding, and a clear absolute signal is all the authority required for a train to run to the next signal of this same classification.

When it becomes necessary to move a switch by hand, the conductor must first secure authority from the dispatcher, which is done by using the telephone located at each dual-control switch. Before the dispatcher gives such permission, he places the signals at each end of the block in the stop position, to protect the train. He then notifies the conductor the limits within which he may operate and the time he is allowed to do the work. When the switch is placed in the hand-throw position, it automatically lights a signal in the dispatcher's board, giving him visual evidence that the switch is in use. The work completed, the conductor notifies the dispatcher by telephone that he is ready to proceed, and operation is at once restored to normal. If the conductor should find that he is unable to complete the switching in the allotted time, he must secure from the dispatcher an extension of time.

When necessary to communicate with the dispatcher, the telephone in the little house is used



Device on dispatching machine which records train movement over the section

Thus, when authority is requested of the dispatcher to do hand switching, he first looks at his board to see if there are any trains in the section of track in question. If not, he protects each end of the section of track by placing signals in the stop position, and then gives the conductor authority to proceed.

THE advantages gained under the new system are manifold. In the matter of operating costs, a considerable saving is effected by reducing delays and greatly decreasing the number of stops.

Delays are reduced by the elimination of stops or slow speed for the delivery of train orders. A reduction of time consumed in meeting and passing trains is now possible, due to the great flexibility of the system. Under the old system, three stops were required when a train took a siding: one to open the switch, a second after the train had entered the siding, and a third to close the switch after the train was again out on the main line. Under the new system, two of these stops are eliminated, as the dispatcher opens and closes the switches. Frequently, the dispatcher is able to arrange such close meets that the third stop is also eliminated. More trains may also be operated by reason of the increased elasticity of movement with which traffic is handled.

Dual-control switch leading from the main line to a siding, and the switch mechanism which is operated by electric motor or, when necessary, by hand

Thousands of acres of water-covered land such as this in the United States and Canada are covered with wild rice, a valuable food grain indigenous to North America. These Indians are harvesting it in the primitive manner that is still used

WANTED: A WILD RICE HARVESTER

By LAWRENCE W. PEDROSE

LONG before the advent of the white explorers and the resultant civilization which introduced cereals in printed packages and bags, the Chippewa Indians of the central west harvested wild rice on the prairies, and made cakes and breads which have never been excelled by modern millers and bake shops, and which are in these modern times considered equal to foods made from the finest domestic grains. Singularly, the aborigines' method of harvesting wild rice has never been improved upon, and the colorful industry is carried on by a picturesque people in the same manner their forefathers conducted it, except that now it has a commercial aspect in that the grain is widely used in dietetics and for purposes of propagation. The growing demand for wild rice in recent years has resulted in experiments being made to increase the supply, and attempts at domestic cultivation on a comparatively small scale are proving successful.

Wild rice, also known as Canada rice, is indigenous to the North American continent. It is native to prairie marshes and is found in vast areas from the Great Lakes to the Rocky Mountains and in Northern Canada and Alaska. It is to the wild rice marshes that the migrating waterfowl common to North America go when they fly north in the spring. There they breed and rear their young, remaining until the approach of winter has sealed the lakes with ice and cut off their food supply.

WILD rice has qualities said to be found combined in no other grain. High caloric content and the principal vitamins are claimed for it. It is easily digested and valued for its medicinal properties. Hospitals use it extensively in the treatment of dyspeptic disorders, and it also is popular as a companion dish with almost any kind of wild game. But despite the fact that the demand exceeds the supply, and the cost has risen to a dollar or more a pound, the character of the rice fields is such that it discourages improvement on the primitive and more or less efficient harvesting methods of the Indians. However, a fruitful field for experimentation is here, and it offers possibilities of establishing a domestic industry of great economic value.

When the early fur traders extended their activities northward through the then little-known Louisiana Territory and entered the Sioux, the Chippewa, and the Cree nations, they found the Indians using wild rice in much the same manner as the coastal and southern Indians used maize. The rice fields were merely shallow lakes and seemed almost limitless in extent. Harvesting was simple. A light canoe was poled through the fields, a squaw seated in the stern with a birch bark basket in front of her. In her hands she held two short clubs. As the canoe made a lane through the rice, she hooked sheaves of

rice-stalks with one club and bent the heads over the basket while with the other she struck the grain from the heads with a quick, sharp blow. The method, while painstakingly slow, was productive, and a deft worker could harvest several hundred pounds in a day.

The next step was to place the grain in a wooden bowl and bruise it with the ends of poles to remove the hulls. Relieved of chaff, the grain could then be stored in any convenient container and kept indefinitely if stored in a dry place. Today practically the same method of gathering the wild rice is used.

THE harvest season is short. The field is a lake varying from one to five feet in depth. New rice shoots appear as grass on the bottom of the lake as soon as the ice thaws in the spring. As summer draws near, the lake shrinks, and the rice sprouts reach up to the surface. By August the stems have risen several feet above the water and the head begins to form. The grain ripens in a fortnight to three weeks, and nature protects it by causing it to fall while still green so that it will sink to the lake bottom and become seed. After the grain falls, the stalks wither and sink to provide nourishment for the next crop. It is during the short ripe period that harvesting must be done.

If the grain is very ripe, gathering of the grain is a delicate procedure. If the harvesters procrastinate, they may find that a sharp wind has stripped the field of its grain overnight. Then it can be secured only by the wild waterfowl that dive to the bottom and pluck it from the mud. Ordinarily only the older and more experienced Indians, especially the squaws, do the gathering, and the threshing is left to the young people of the tribe. Production is figured at 12 to 15 bushels per boat a day, and during the harvest season this work is pressed from daybreak to dusk almost without halt—a period of 18 hours or more. To a white man the harvesting of a bushel of grain per hour would be tedious labor, but to the Indian, with his vast patience, time means nothing.

A number of physical obstacles stand in the way of applying science to the wild rice industry. By the Indian method, only a fraction of the grain can be garnered. Could a machine be perfected to take the place of the canoe and hand-beater, production would be increased many fold. But the operation is a very exacting one because of the delicate character of the plant, and because of nature's way of assuring its perpetuation. Successive steps in the harvest, such as separating the grain and the chaff, can be accomplished by mechanical methods of removing the stubborn hulls.

In the last few years hundreds of duck preserves have been established in practically all parts of the country by sportsmen's associations and game conservation clubs. Many of them have successfully propagated wild rice, and the grain, when once started, has been found to be very hardy and adapted to any temperate climate.

Copyright by Asahel Curtis

No machinery is used here. An Indian woman harvesting wild rice as explained in the text

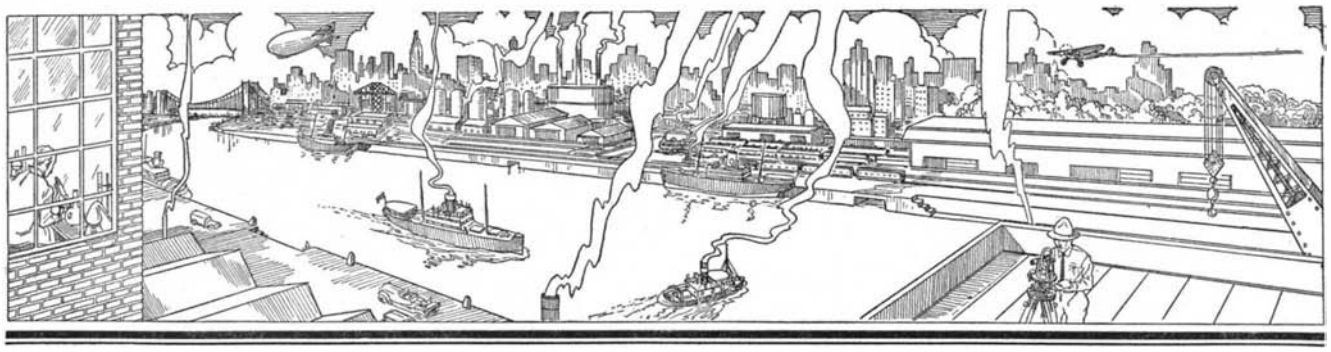
Oriental rice is adaptable only to tropical and semi-tropical climates, but native wild rice, once successfully seeded, grows well in northern climes and propagates itself as luxuriously as weeds. The grain, however, loses its fertility if it has been dried. When it is to be used for purposes of propagation, it must be stored in water immediately after harvesting. When it is shipped, it must be placed in water-absorbing material to protect the germ. When kept moist it retains its fertility until the following spring. Packed in wet moss and sealed in a watertight container, it can be shipped anywhere.

THE Indians use the straw of the wild rice for many purposes, and there is a possibility in developing this by-product. Hundreds of thousands of tons of the straw could be obtained on the central and northern prairies and in Alaska. The Chippewas take the part of the straw between the last joint and the head, and weave it into hats, baskets, mats, and other useful articles. It is said that the straw is comparable to the product imported from South America and Europe, is easily bleached, and is very durable as well as extremely light in weight. In experimental work a high grade of paper has been made from it, equaling the best domestic rice straw papers manufactured in the Orient.

Knowing the facts concerning the excellent dietetic qualities of wild rice and the possibilities of utilizing its straw, one can readily imagine seeing, in the future, great lakes or marshes of the growing grain being harvested by special machinery on chugging motor boats. While the incentive to development of such machinery may be lacking now, man's persistent search for new foods in commercial quantity, for new methods of utilization of the earth's waste spaces, and for valuable by-products may turn wild rice into a valuable commodity.

Copyright by Asahel Curtis

Chippewa Indians threshing the grain by pounding it with the ends of poles to remove the chaff. Quaint birch bark baskets used in the harvesting are shown

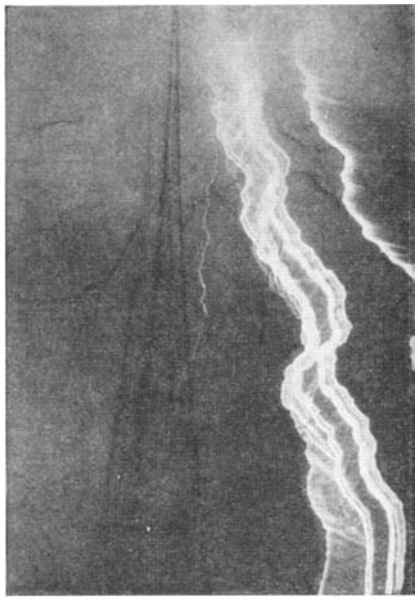


THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Lightning, Benefactor of Mankind

"SCURRY to the cellar and jump into the furnace if you want to be absolutely safe during a severe thunder storm," says K. B. McEachron, research engineer in the lightning arrester engineering department of the General Electric Company at Pittsfield, Massachusetts. "This is, in effect, a solid iron room perfectly grounded,



Bolt of lightning near a large radio tower showing clearly how lightning can be blown by gusts of wind

which would be the ideal safe place for a human being to be. Since this is impossible, however, we should simply carry on, if we are in the house, with the ordinary routine but should remain away from overhead wires, keep away from the radio, not take a bath, be chary about using the telephone, and keep away from metal objects of appreciable size. Then we are in little danger. Some of the old ideas about protection from lightning are really sound after all."

Lightning is one of the greatest benefactors of mankind despite its reputation for being a terrible enemy, Mr. McEachron points out. It produces, free of charge, about 100,000,000 tons of fixed nitrogen yearly over the earth's surface. It acts in this capacity the same as heavy electric discharges do in nitrogen fixation plants. The only difference is that the bolt of lightning coming down through the air, which is approximately four fifths nitrogen and one fifth oxygen, breaks down the chemical constituency of the air and deposits fixed nitrogen on the soil, all at no cost to the farmer. In manufacturing nitrogen, electric sparks of from 15 to 20 feet in length are used. In nature, lightning provides sparks perhaps 2000 or more feet in length, thus producing immense quantities of this absolutely essential chemical in agriculture. Hence it is that we find lightning as a great benefactor, although sometimes it does jump about wild and loose, causing considerable property damage and even loss of human life.

One old idea about protection from lightning is that it is not wise to stand in an open doorway or near an open window during a lightning storm. It has been proved in several different ways, says Mr. McEachron, that lightning can be blown and moved from its path by the wind. For that reason it is not wise to stand in an open doorway or near an open window, for if lightning should strike and be blown by the wind in the direction of the person standing, it might prove fatal. Such instances, however, are rare.

"It is a good idea to keep away from chimneys or open fire-places during an electrical storm," Mr. McEachron continues. "One of the poorest places to be during a lightning storm is in the water. If you are swimming, bathing or enjoying any water sport during a lightning storm, you had better paddle ashore and watch the storm from a safe distance.

"In an automobile one is relatively safe, although not a bit more, and possibly even less so, than when walking on the ground."

New Paint Resists Corrosion

FOR resistance to mineral and organic acids, mild alkalis, alcohol, benzol, gasoline, acetylene, oils, greases, soaps, steam, sunlight, and very high temperatures, a newly developed coating material is being sold under the name of "Rubalt G." This coating, used on metallic or other surfaces, forms a very hard cement-like surface with a rough gray finish. It is adhesive but not elastic, and is air drying. In being applied, it is maintained at the proper thickness by adding a small quantity of water. It is flowed on thickly in two coats, and after the second coat is dry, a coat of hardening compound is applied.—*A. E. B.*

Eruptions from Women's Hats

AGAIN and again skin disturbances are reported which are related to something peculiar about feminine costumes. German observers have reported irritation of the skin of a patient associated with "V" necks in winter. The rolling of stockings brought about unusual appearances of the skin of the knees, and the appearance of varicose veins due to constriction of the circulation. Furs dyed with paraphenylenediamine have produced eruptions on the skin. Now Professor Frei in Germany insists that skin eruptions are occurring on the heads of women because of the present style of hats.

The recent type of eruption is not asso-

Do hogs perhaps point the way to one satisfactory solution of the wheat surplus problem? This fine drove of hogs, raised on the farm of John J. R. Claasen, near Beatrice, Nebraska, was wheat-fed; and, according to Mr. Claasen, yielded a return of $1.15 per bushel of wheat—more than market price

ciated with any special hair tonics or hair dyes. It is more like the form of eruptions which were found on the heads of men due to the artificial leather used in the sweatbands of hats. In the four cases seen by Professor Frei, all the women had worn tight fitting hats now the vogue, and the irritations of the scalp were found at the points on the head against which the hats rubbed. Professor Frei thinks it possible that the women concerned were hypersensitive to dye substances used in making black felt, but attributes their skin eruptions also to the fact that the tightly-fitting hats bring the dangerous substance in close contact with the scalp, rubbing the scalp vigorously and producing heat and perspiration. —*M. F.*

Traffic Snarls Irk Old Algiers; Plan Subway

FINDING that apparently even the lure of mystic Africa loses its glamor in traffic congestion, the old city of Algiers plans a subway for relief.

Claiming that picturesque natives and their camels plodding through the bazaar-lined streets would appeal more to tourists that would a traffic jam too familiar to the visitors at home, a commission recommends that this city, now boasting 350,000 population, should build a three-mile subway. The plan calls for completion within 10 years at an expenditure of 20,000,000 dollars.

Have You Had Your Mercury Today?

Little Willie, from the mirror,
Licked the mercury all off;
Thinking in his childish error
It would cure the whooping cough.
At the funeral, Willie's uncle
Sadly said to Mrs. Brown:
"'Twas a chilly day for Willie
When the mercury went down!"

Whenever the toxic properties of quicksilver are mentioned, this jingle inevitably comes to mind. Yet here comes a German chemist with the announcement that many perfectly good foods contain traces of mercury.

A few years ago, a storm of protest was elicited from dentists by the publication of a report that small, but harmful quantities of mercury are released to the body by the ordinary amalgam tooth fillings. Doctor Borinski, director of the Chemical Institute of the Principal Health Office of the City of Berlin, now maintains in the *Berliner Gesellschaft für Öffentliche Gesundheitspflege* on the basis of many years' investigation of the mercury research position established at the institute, that almost all our foods contain mercury. Mercury was also found in persons who had never had a tooth filling and had never come in contact with mercury, and even in sucklings and the new born. The mercury found in persons having amalgam tooth fillings might not originate in the dental fillings, but from food itself, and this naturally occurring mercury cannot be injurious to the health.—*A. E. B.*

Vanadium in Shatterproof Glass

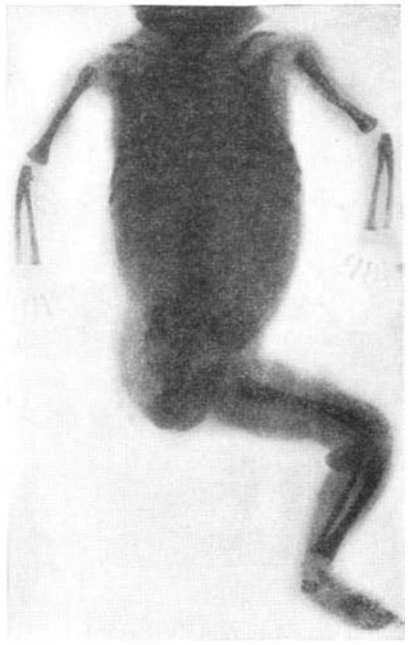
THE physical properties—such as refractivity, absorption of heat rays and ultra-violet rays, transmission of luminous rays, and reduction of glare—imparted by the rare metals to glass are dealt with in an article in a recent issue of the *Vancoram Review*, the organ of the Vanadium Corporation of America.

Most of these metals give decided colors to the glass, but a few, such as cerium and vanadium, under proper conditions, produce colorless glass and, it is predicted, it will be these colorless glasses which will receive added attention in the future. Cerium nitrate is generally used for the addition of cerium to glass mixes and occasionally cerium borate and ceric oxide, the proportion of metal varying from 1.0 to 7.5 percent. Cerium is of value in cutting off the ultra-violet rays; the glasses are very slightly colored, and allow nearly all of the luminous rays to pass. The heat absorption is about 30 percent.

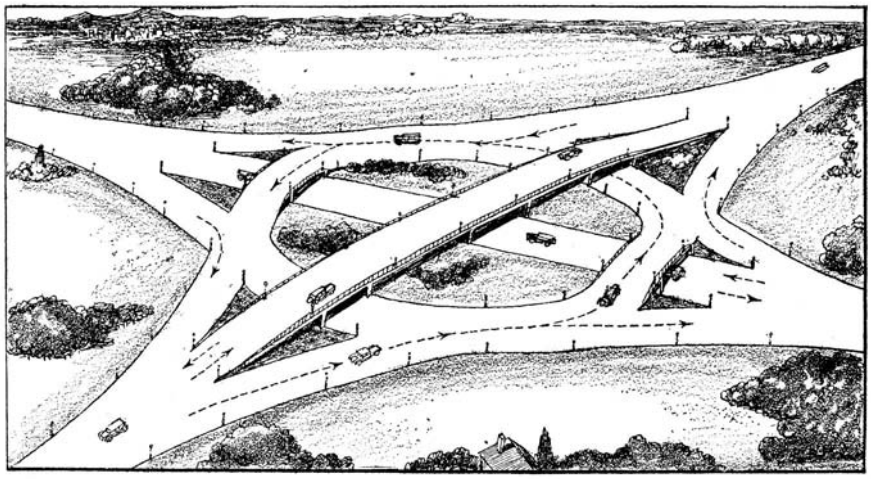
Neodymium and praseodymium, when used in the proper combination, produce a neutral grey. By variation of the proportions, the color varies from a light ruby color to greyish-blue and brown-green. They have a high absorption of the ultra-violet and infra-red rays.

Uranium in glass produces a brown-to-yellow color with a greenish opalescence. The opacity for ultra-violet light increases as the glass is richer in metal.

Vanadium glass has the bright appearance and high transmission properties of ordinary glass but it filters out ultra-violet rays. It is therefore used in the glass used in the manufacture of non-shatterable glass which is made by cementing two glass sheets to an intermediate sheet of celluloid. The ultra-violet rays passing through ordinary glass cause deterioration of the celluloid, which may be quite rapid where the glass is used on ships or automobiles in tropical or very sunny regions.—*A. E. B.*



X ray of a baby who was born with a perfect left leg but no right leg



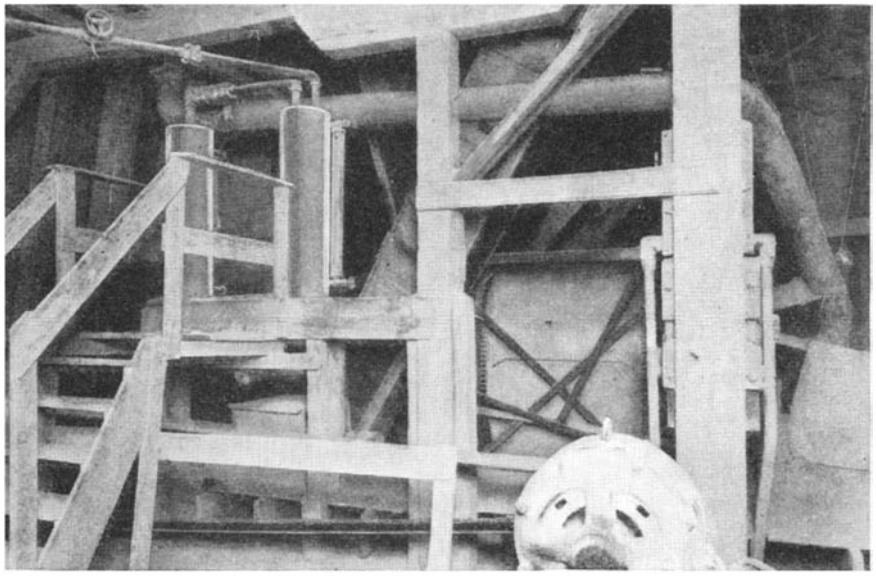
Becoming interested in the clover-leaf design of a highway crossing which was the subject of our cover painting for February, Dr. Wm. T. M. Forbes, of the New York State College of Agriculture at Cornell University, worked out the above design which our artist has sketched. Dr. Forbes said in submitting it: "For a given limited turning radius, it would take up far less space than the clover-leaf model, and would be just as safe since the intersections at grade are of traffic going in practically the same direction." Possibly Dr. Forbes' design will prove practicable in places where space is at a premium. He does not claim, it will be noted, that it would otherwise be superior to the clover-leaf arrangement

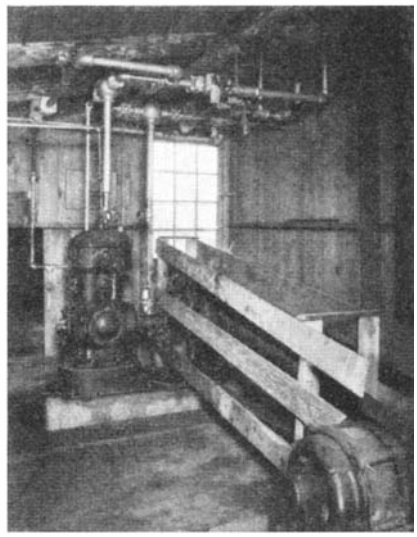
Congenital Absence of the Right Leg

AMONG the saddest of deformities are those cases in which children are born without some of the four limbs which constitute the normal equipment of the average human being. In a case just described by Dr. F. J. Barkman, an infant born to a young mother as her first child had a complete absence of the right leg at birth. Apparently some process occurring about the fifth week of embryonic life had interfered with the development of the right limb, since it was absent completely. A careful search of medical records by Doctor Barkman revealed the fact that there have been only four previously reported cases of this kind, which would indicate the extreme rarity of the condition.—*M. F.*

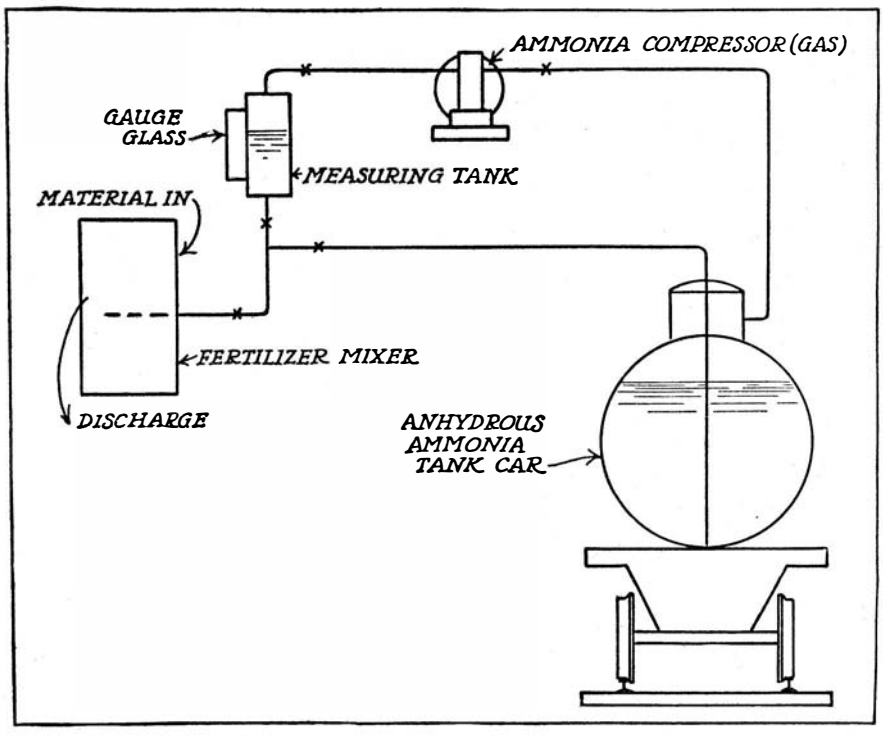
Mucin and the Stomach

WHEN a person chews food vigorously a considerable amount of mucous material is combined with the food. Mucous secreting glands are found all along the gastro-intestinal tract. It occurred to Dr.





Above: **The rotary mixer may be seen beyond the motor. At the top of steps is the measuring tank into which the ammonia is pumped and from which it is discharged into the mixer. Fertilizer from the mixer is ready for bagging.** *At right:* **Ammonia compressor in a fertilizer plant in Indiana.** *Below:* **The simplest method of fertilizer ammoniation—direct from the tank car**



S. J. Fogelson that mucus might be an ideal substance to restrain the acidity of the stomach, particularly in cases of gastric ulcer or ulcer of the intestines. Mucus combines readily with acid. Normally it acts as a protective, soothing, and lubricating substance. So far as is known, the presence of mucus does not bring about any chemical disturbances in the body.

A preparation was made of gastric mucin by treating chemically the lining of a hog's stomach. Tests were then made on the effects of this mucin on animals to determine the manner in which it would affect digestion, and also the extent to which it would control the acidity of the gastric secretions. After the usual preliminary tests on animals the preparation was tested on 12 patients with typical histories of gastric and duodenal ulcers. It was found that gastric mucin has the ability to combine with the acid of the stomach so that two ounces of mucin placed in the stomach of a dog was more than sufficient to combine with the acid secreted in response to the irritation following the injection of histamine. When half an ounce of mucin was mixed with a half pound of meat and fed to the dog, free acid did not appear in the dog's stomach for some five to seven hours.

Several patients who were given the mucin stated that they were freed of their symptoms for varying periods so that it has been determined to carry the investigations further in order to determine the exact value of such a method in human cases. —*M. F.*

Fertilizer Nitrogen from Synthetic Ammonia

FOR over ten years, Congress has been trying to decide what to do with the nitrate plants built during the War, at Muscle Shoals. It has been evident that if the plants were operated, the nitrate so produced would be available for fertilizers to replace the natural sodium nitrate imported from Chile. Fortunately, chemical technology moves more swiftly than Congress and it begins to appear now that by the time a decision is reached on the Muscle Shoals question, sodium nitrate will have been superseded by ammonia as the nitrogen-bearing constituent of artificial fertilizer. This change is due to the recent development of a process for the synthesis of ammonia from the nitrogen of the air, making anhydrous ammonia available at commercial prices.

According to F. J. Keenen in a recent issue of the *DuPont Magazine*, the production of artificial fertilizer in this country last year amounted to eight million tons containing approximately 800,000 tons of phosphate and 300,000 tons each of nitrogen and potash. Natural-occurring Chilean nitrate is being rapidly replaced by nitrogen obtained from the air as ammonia. Anhydrous ammonia is 82 percent nitrogen and is therefore the most concentrated form of fixed nitrogen known, which means low transportation costs.

About half the fertilizer tonnage produced in this country is known as superphosphate, produced by the action of sulfuric acid on phosphate rock. Because of its acid properties, superphosphate absorbs ammonia and combines chemically with it rapidly up to 5 or 6 percent ammonia. The first reaction occurring when ammonia is added to superphosphate is the neutralization of the free acid present. This eliminates the rotting action of the free acid on fertilizer bags, heretofore a nuisance. Also the tendency to cake is to a great extent removed. Ammonia further acts upon the superphosphate to produce dicalcium phosphate, mono-ammonium phosphate, ammonium sulfate and a new form of phosphate which is called "precipitated tricalcium phosphate." The exact chemical composition of this new material is not yet known but it is almost identical in behavior with bone meal phosphate. The fertilizing value of these materials is very high, because all are water soluble and

hence are readily assimilable by plants.

The technique of adding nitrogen to commercial fertilizers in this new convenient form is very simple. Anhydrous ammonia is pumped from a tank-car through a measuring tank and thence into a mixer where the ammonia is thoroughly stirred into the superphosphate. Since the fertilizer manufacturers mix their materials in the same equipment, anyway, the application of ammonia does not necessitate an extra handling of the materials and an improved plant food is thus produced at no extra cost.—*A. E. B.*

Overhauled Bus Motors "Broken In" By City Gas

MOTORS overhauled in the garage of a motor bus operator in Chicago are "broken in" ready for high-speed highway operation by running them on manufactured gas until danger of over-heating and other damage is past.

Little heat, no carbon, no noise, and slow speed are the benefits claimed for gas over gasoline for limbering up new or tight motors.

Retail automobile dealers are watching the process carefully, it is reported, as it offers the possibility of selling cars ready for the road, without the tedium of many miles of slow driving for the new owner.

Bees Travel 40,000 Miles To Make Pound Of Honey

A 16-OUNCE jar of honey, no matter how good, is hardly worth a 40,000-mile journey. Yet that is the total distance traveled by many bees to provide the nectar necessary for just that amount of honey, according to C. B. Gooderham, apiarist of the Dominion Government.

Mr. Gooderham has figured it out mathematically. A honey bee weighs approximately only 1/5000th of a pound, and during the honey flow on each trip she carries approximately half her own weight of nectar. It therefore requires approximately 10,000 flights to gather a pound of nectar. Furthermore, Mr. Gooderham states, nectar loses about half its weight through evaporation.

Taking all this into consideration, as well as the fact that each return flight averages about two miles, it is figured that bees have traveled at least 40,000 miles to provide 16 ounces of honey.

So it is no wonder that the little honey bee unlucky enough to be born in summer lives but a brief six weeks. Bees born after this summer rush have an average life of seven months.—*Science Service.*

An X Ray of a Passenger Airplane

THE Handley Page 42, equipped with four supercharged Bristol engines, has a speed of nearly 130 miles an hour. The stalling speed is 50 miles an hour. It can fly on any three engines at normal power with full load and can climb to 6000 feet under these conditions.

A study of the artist's brilliant drawing is most instructive. One can almost imagine oneself inside this comfortable looking craft.

The pilot's cockpit is at the very bow of the ship, so that vision is uninterrupted in all directions. Immediately behind the pilot is the wireless cabin; beneath the cabin is suspended the wireless antenna. The pilot can keep in constant touch with ground organizations, sending messages as well as receiving them.

The forward cabin looks quite comfortable and is well ahead of all the engines. Windows are not relied upon for ventilation: the drawing shows ventilating pipes, with the suction of the propellers assisting ventilation. A corridor leads past the lavatories into a cocktail bar. The English are, apparently, not at all afraid of smoking on board a plane, and hence we find a smoking cabin.

It will be noted that the tail is of biplane construction which is quite logical for a ship of this size. It will be noted also that the balance for the rudders is in the form of a separate auxiliary surface.

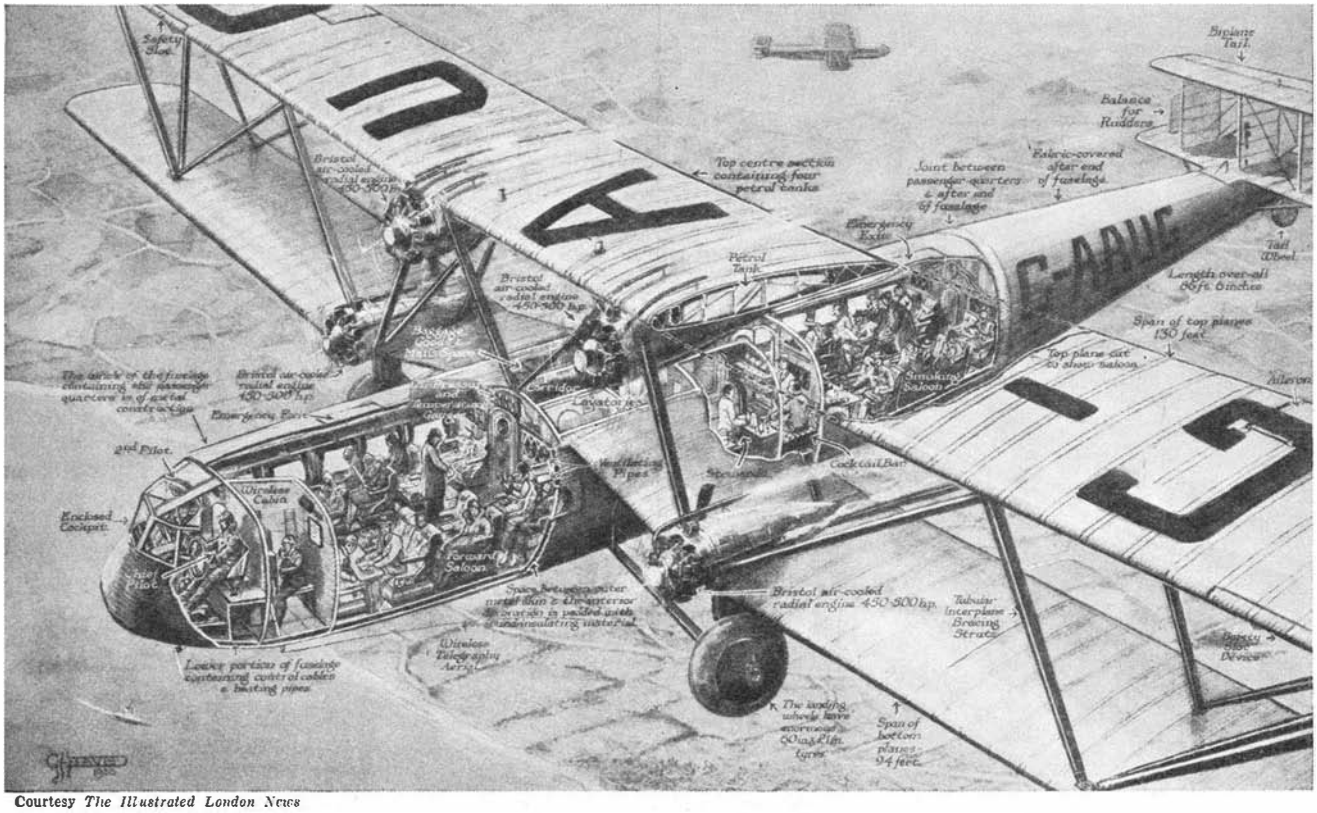
The span of this enormous plane is 130 feet. In spite of the great size of the biplane structure, all wires have been avoided and tubular interplane struts of steel form the trussing of the biplane. While such trussing means a little sacrifice in efficiency and weight, the elimination of wires lessens maintenance troubles.—*A. K.*

Gliding in a High School

WE have always been strong exponents of the argument that gliding was a fit activity for the public school. Now we read in the magazine of the Negaunee, Michigan, High School, a series of articles on gliding, contributed by the Aviation Club of this school. The boys built their own glider, tested it themselves and had a wonderful time.

Here is what the boys write about it:

"The construction of a glider was begun. There were ready-made gliders in the market selling at around 500 dollars. Buying one of these would have enabled us to fly sooner probably but would have deprived us of the experience of building a ship. The construction is very much the same as that of an airplane with the motor left out. Then there is the possibility of mounting a motor in the glider after one has become skillful at handling it. The price of the ready-made gliders made the purchase of one impossible for us anyway, so we went to work in earnest. Every spare minute, every day, and nearly every night the boys plugged away. None of us ever having had any experience, every minor detail had to



Courtesy *The Illustrated London News*

Cut-away, or "X-ray" drawing of the passenger airplane described above

be studied carefully and the best plan decided on.

"I cannot begin to enumerate the difficulties and puzzling questions that arose. In the first place the materials of which an airplane or glider is constructed must be very carefully selected. After it is decided what materials are needed it is not always easy to find where you can purchase them. After they are obtained the problem arises of cutting and fitting the parts into place. One illustration may bring out the magnitude of this last mentioned job. In the wing alone there are over 2000 pieces of wood. Each one of these pieces must be cut to exact size and glued into place. I cannot take time to write about the metal fittings, the wire parts, the cloth, the dope, and the paint entering into the construction of the ailerons, the elevators, the stabilizer, the rudder, the fuselage, and the control stick.

"Not much was done during summer vacation but work began in earnest again upon the opening of school in September. As the Christmas vacation appeared, the glider neared completion. It seemed as if we never would get it finished but on the Saturday night before Christmas about midnight the last work was completed. The seat was placed at that time and our ship was ready to be taken out and assembled. The next morning at daybreak the boys were all on hand and this work began. About three hours were spent assembling it on the High School lawn. Then the glider was lifted over the fence and towed to the Maas Mine aviation field. That afternoon we made our first flights with a great deal of care indeed and by evening were pretty well satisfied that everything was well with our glider.

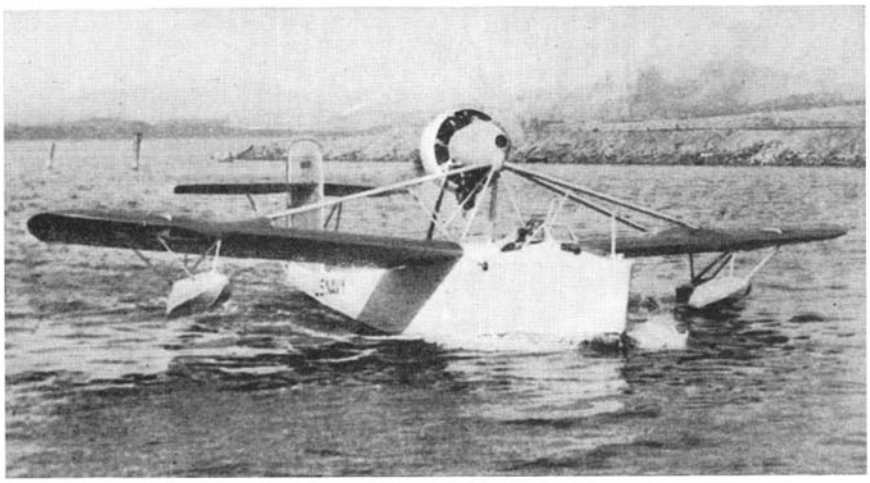
"Every member has gained considerable skill at flying. Rudy has been in the air more than an hour and flown more than 50 miles. Lawrence ('Col. Lindbergh') and Oscar have done almost as well if not just as well. This has been done without a bump or bruise. I truly believe that learning to fly a glider, under proper supervision, is no more dangerous than learning to ride a bicycle. Every one of the boys will agree that he has been fully repaid many times over for all the hard work. Besides this he has the knowledge gained in the construction of the glider. We also have the glider with the heaps of fun and opportunities which it is sure to afford us in the future."

This is the most convincing proof of the possibility of glider activities in the schools that we have seen in a long time.—*A. K.*

The Loening Submarine Plane

MORE than four years back, in the November 1926 issue of the SCIENTIFIC AMERICAN, we described a little biplane with an over-all wing spread of only 20 feet and equipped with a three-cylinder Wright air-cooled engine of only 60 horsepower. This craft was capable of a speed of 80 miles an hour. As a result of very careful design, it could be packed in a few minutes into a tube placed on the deck of a submarine; a few minutes sufficed for disassembly, nine minutes for complete assembly. To make a getaway, the deck of the submarine was kept flush with the level of the sea.

As far as assembly and disassembly and



The Loening flying boat can be assembled or dismantled in three minutes

flying in calm weather were concerned, the little biplane was quite successful. It was too small however, to be perfectly airworthy in the all-weather service required by the Navy.

Now Grover Loening, the well-known aeronautical engineer, has designed a much larger craft which is reported as being entirely satisfactory to the Navy Department. The Assistant Secretary of the Navy for Aeronautics states that the Navy is planning to equip each of its submarines with at least one plane of this type.

While this is much bigger than the small two-seater hydroplane used in 1926, nevertheless the Loening flying boat will still be capable of stowage in a tube, presumably still to be mounted on top of the submarine.

The Loening submarine flying boat is expected to become a valuable plane for naval patrol duty. It will also be able to carry a certain amount of armament. Owing to its larger size, it is really airworthy and its high-prowed metal hull makes for seaworthiness in a choppy sea.

In all its struts, tail surfaces and engine nacelle, bolts and cotter pins are used so as to provide fast assembly or disassembly. The engine is mounted on hinged struts just behind the pilot's seat. Some of the engine nacelle struts extend at an angle midway along the wing. By slipping a few bolts, the whole engine nacelle folds back against the hull. The wing pontoons can be similarly demounted. The tail surfaces also lend themselves to a similar process.

The 36-foot monoplane, equipped with a 100-horsepower engine, shrinks into its tube in a very few minutes.

While further details for the time being are being held secret by the Navy, it is known that great ingenuity has been used by Grover Loening in achieving these objectives and his plans were accepted by the Navy in the face of severe competition by other constructors.—*A. K.*

Ski-Flying

SKIING is, in itself, an exciting and wonderful sport, but a young Viennese engineer, Joseph Krupka, has improved on its thrills and possibilities. He has constructed a pair of light wings which can be readily attached to a man's shoulders, yet can be easily folded, placed in a cover, and transported like a folding boat.

The procedure is to start off on skiis alone, then to spread out the wings as the speed increases. Finally the man's body leaves the ground and his legs stretch more and more backwards, until his body and the wings alike are in the same horizontal line. In this position, Krupka has been able to fly to a height of 15 yards above the ground.

It is, apparently, quite easy to brake the flight and to make a comfortable landing. With the wings pivotable at the will of the flier, the new device has bird-like maneuverability in the air.

We should imagine this will add to both the amusement and excitement of skiing to a high degree.—*A. K.*

Aircraft Radio Communication

ONE of the most important aids to the safety of airplane transportation is constant communication between pilot and the ground at all times.

Eugene Sibley of the Airways Division of the Department of Commerce, in a paper presented before the American Institute of Electrical Engineers, summarizes in admirable style the status of aircraft radio communication today. We present below salient points taken from Mr. Sibley's paper.

The Department of Commerce will soon be able to provide complete weather reports and give radio direction to all aircraft equipped with a simple type of radio receiver.

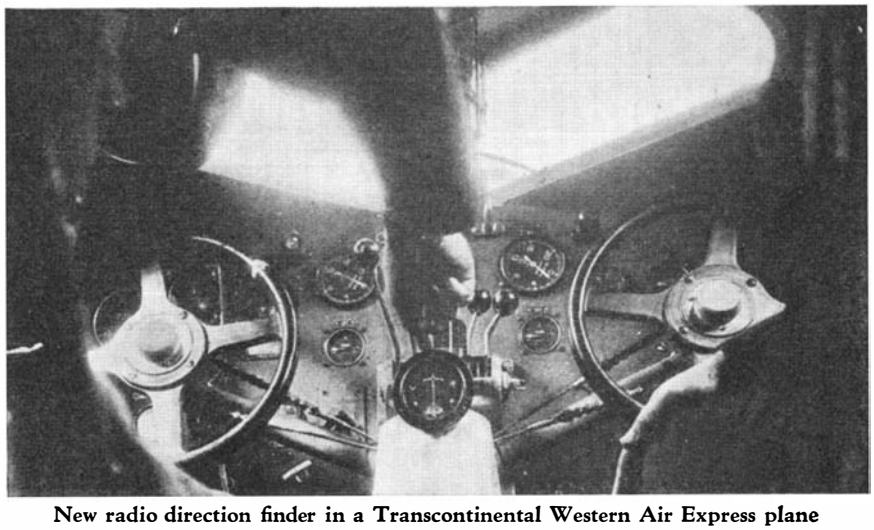
The equipment of a standard radio station of the Airways Division consists of a 2-kilowatt intermediate-frequency transmitter for broadcasting the weather; in addition, a 500-watt high-frequency transmitter is used for point-to-point communication.

Radio stations are also being equipped with a directional radio beacon which may give either a visual or an aural signal to the pilot.

Sometimes the radio beacon is called the "radio range." The radio range has the advantage of serving the pilot throughout the 24-hour day and, unlike lighting aids to navigation, it is not affected by thick weather. The most important feature of the radio range is that it serves as a homing device, making it possible to fly to the exact location of the beacon, thereby locating the landing field at which the radio range has been established. A number of landings under conditions of fog and thick weather have already been made, in cases of emergency, by aid of the radio beacon, and trips that would otherwise have been impossible, have been completed in safety.

Ski-flying down a mountainside

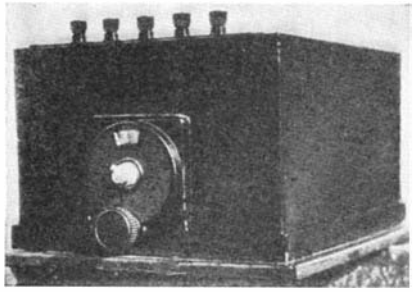
The antenna system of the radio range consists of two crossed loops erected at right angles to each other and supported by poles. In a small building at the foot of the center of the antenna pole, a radio transmitter is located, together with other apparatus required for the operation of the beacon. The radio range sends a characteristic signal



New radio direction finder in a Transcontinental Western Air Express plane

alternately from the loops, sending the letters "A" and "N." Interlocked, these form the letter "T" when the signals are of even strength and the plane is on the right course.

The radio receiver required on board aircraft consists of the receiver, A and B batteries, earphones, and antenna. The receiving equipment weighs approximately 30 pounds and has a frequency range from 200 to 400 kilocycles. The antenna consists usually of a streamlined wooden mast which extends about six feet above the fuselage and is usually mounted to the rear of the cabin or behind the pilot, with the receiver directly beneath it. An insulated wire extends through the length of the mast, and must be insulated from the elements to reduce rain and snow static.



The receiving set used with the inexpensive radio direction finder

Two-way communication between aircraft and ground is now provided for all interstate operation where passengers are carried. In such cases, the aircraft is equipped with a radio transmitter.

The radio beacon is somewhat expensive to install and maintain, but a new radio direction finder has been successfully tested by Transcontinental Western Air Express which avoids this expense. This new radio direction finder can be used in connection with any commercial broadcasting station. The device weighs only 10 pounds and consists of a receiver, a loop antenna, and a small meter. This device was recently used on the 400-mile run from Los Angeles to San Francisco. The pilot found that the needle of the meter pointed to dead center when he was on the proper course and wavered to one side when he deviated from it. When he arrived directly over the station, the needle vibrated.—*A. K.*

New Diesel Racer Will Run 1200 Miles Without Refueling

ADAPTATION of the Diesel engine to a racing car by C. L. Cummins and August S. Duesenberg, the racer and manufacturer, has increased engineering interest in the 1931 Indianapolis Motor Speedway 500-mile race to be run on Memorial Day.

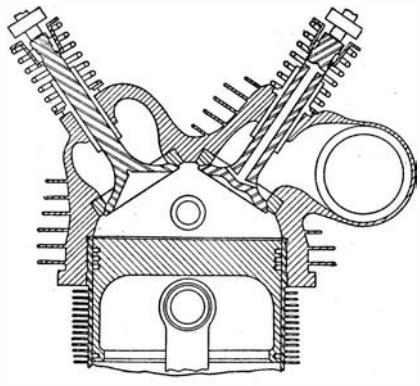
The new car is nearly twice as large as the conventional gasoline racer. It is said to carry sufficient crude oil fuel to run nonstop at 100 miles an hour for 1200 miles. This would give the new car the advantage of not having to stop to refuel, which is estimated to be the equivalent of a five mile start on the rest of the field.

The car cost 15,000 dollars. It is 16½ feet long and nearly four feet high. It is four-cylindered with a piston displacement of 366 cubic inches.

No ignition system is used in the new car, the heat of compression serving to fire

the fuel. The fuel tank holds 47 gallons of crude oil and the radiator has a capacity of 42 quarts of water. Mileage is 40 miles to the gallon under ordinary driving conditions. At a speed of 100 miles an hour, the mileage is about 25 miles to the gallon. When tested for speed at Daytona Beach, Florida, the car made 100.772 miles per hour under A.A.A. timing.

Diesel engines offer advantages in strength and economy of fuel and consequently have been adapted to many uses in the past. This is thought to be the first time a Diesel



engine has been tried in a racing car, however, though they have been used in airplanes.

Mr. Cummins, who lives at Columbus, Indiana, has a long record of developing Diesel engines to new uses and has written a number of papers on the subject. His co-worker, Mr. Duesenberg, is a well-known racing figure.—*Science Service.*

An Internally Cooled Exhaust Valve

IN a paper presented before the Society of Automotive Engineers, Manse M. Harris describes an interesting and novel form of exhaust valve.

Exhaust valves have a hard time of it. Besides the repeated shock, they have to withstand the presence of sulfuric acid in the exhaust and above all, enormous temperatures rising often as high as 1700 degrees, Fahrenheit. The design of the valve and the selection of material are, therefore, very difficult problems and valve troubles are still a little too frequent in aircraft engines.

Many ideas have been tried out for cooling of valves. Internal salt filling of the valve and valve rod has been successful; salt filling, however, is expensive and cannot be used in many engines.

In the Friedl valve described by Mr. Harris, internal air-cooling has been applied with very successful results. The Friedl valve is illustrated in two of our drawings. In the photograph, the valve is sawed open at either end to show the cooling passages. In the center of the photograph is a similar valve showing the holes at both ends of the air passage. At the right is an ordinary inlet valve taken from the same engine.

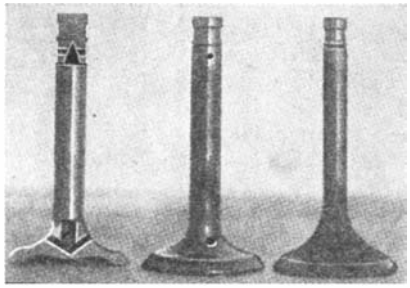
As will be seen from these illustrations, an air passage is provided very near the end of the stem, to a point close under the head of the valve. Used in connection with this valve is an exhaust port in the form of a Venturi tube. This Venturi causes a stream of air to be drawn through the valve stem and out of the port, with the exhaust valves closed. The expansion of the air under the action of the Venturi produces a refrigerating effect which is most helpful. The Venturi also constitutes an exhaust stack and emits only a faint blue flame (thanks to this refrigerating effect) instead of the usual ring of red flame. Therefore, the exhaust manifold can be dispensed with which means a saving in weight and head resistance.

The air-cooled valve and Venturi exhaust stack system have been tried successfully under many conditions of flight and are most promising.—*A. K.*

Monochromatic Rainbow

SOME of our readers may perhaps have witnessed a red rainbow similar to the one described in a communication received from D. Moreau Barringer, Jr., a geologist. Mr. Barringer was the author of a three-part article entitled "The Most Fascinating Spot on Earth," a description of the famous Meteor Crater in Arizona, which appeared in our July, August, and September numbers in 1927.

"Your readers may be interested in a description of an unusual sight that I was



Above: **At left, an internally cooled exhaust valve cut away to show passages; center, a whole valve; right, an ordinary valve.** ***Upper left:*** **Cross-section of cooled valve installation.** ***Right:*** **Venturi stack**

lucky enough to see last summer," Mr. Barringer writes. "The phenomenon was a red rainbow, containing no other colors of the spectrum.

"I was driving east from Tucson, Arizona, on the road toward Bisbee and El Paso, and had reached a point some 20 miles from Tucson when the sun set. The western sky was comparatively clear, but in the east there were great masses of cumulus clouds, some of which were dropping rain. One cloud in particular hung directly above the road ahead, some five miles distant. The sun, shining from below the horizon over my head, lit up this cloud with a deep purplish-red glow. Rain was falling from the cloud, the long streamers of it being also colored red by the sun's light.

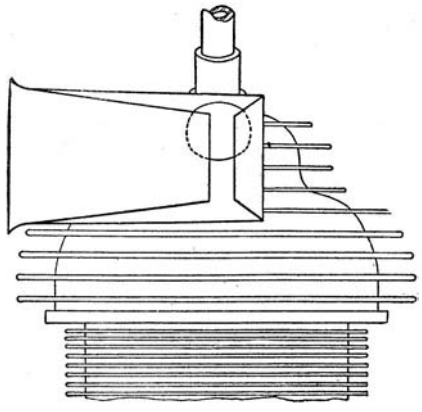
"Encircling the cloud was a narrow, semicircular band of red light, similar, except for its color, to a perfect rainbow. I looked for traces of the other spectral colors, but could see none except the red. The rainbow lasted perhaps two minutes, at the end of which time the sun's light began to fade from the rain-streamers below the cloud, and the bow simultaneously faded out.

"The explanation, of course, is simply that the great thickness of atmosphere traversed by the sun's rays had filtered out of them all the shorter waves of the spectrum, leaving only the red light, which has the greatest penetrating power of the visible spectrum. But it was the great beauty of the spectacle, together with the fact that I had never heard of the phenomenon before, that called my attention to it particularly. Perhaps others among your readers have seen it or heard of it before, but the combination of conditions necessary to produce the spectacle must be rather unusual, and I have thought it worth while to record the observation."

By-product Becomes Chief Product

THE writer retains a very vivid recollection of certain yellow-green lakes of solidified niter-cake which generally adjoined the plants producing nitric acid during the World War. Niter-cake, or sodium acid sulfate, was a by-product of the manufacture of nitric acid by the interaction of Chilean saltpeter with sulfuric acid. Being somewhat of a drug on the market, it was poured, while molten, into depressions in the ground, forming the "lakes." Recently, however, new processes for the manufacture of nitric acid have eliminated this source of the by-product niter-cake, and we now find that the demand for this substance is sufficient to warrant the erection of plants for its manufacture. Thus, at Copper Cliff, Ontario, a plant has recently been built to manufacture niter-cake, a product that was, until recently, hard to dispose of.

The process is relatively simple, chemically. Sodium sulfate is cooked with sulfuric acid in retorts, the resulting niter-cake being poured molten into pans in which it solidifies. The sodium sulfate is obtained



from Horse Shoe Lake, Saskatchewan. After harvesting from the lake, the natural sulfate is dried and is shipped practically anhydrous and analyzing 90 percent sodium sulfate. The new plant makes its own sulfuric acid, mixing the dry sodium sulfate with 93 percent acid to form a thick paste. This mixture is fed to oil-fired retorts where the niter-cake is formed. The molten sodium acid sulfate overflows continuously through an opening in the side of the retort, and is caught in a series of pans attached to a moving chain. This conveyor system passes away from the retort at a rate of 120 feet per hour so that the niter-cake has a chance to set and cool in the pans of the conveyor. The cooling is promoted by passing water under the pans on the conveyor. An interesting point is the spraying of the pans with oil so that the cakes will drop out readily when cool. An automatic hammer strikes each pan as it is turning on the cool end of the conveyor, releasing the cake.

All the niter-cake produced in this plant is sold to the International Nickel Company for smelting its copper-nickel matter, whereby the two metals are separated. —*A. E. B.*

Electrical Equipment for the "Nautilus," Arctic Submarine

THE *Nautilus*, a submarine which is being prepared to travel across the top of the earth and beneath the ice at the North Pole, will be elaborately equipped with electric devices, it has been announced by Sir Hubert Wilkins, explorer. Together with other special apparatus of unique design and purpose, these electric

Sir Hubert Wilkins in the *Nautilus*. Note electric refrigerator in rear

appliances will make the submarine a more perfect dwelling place for the crew of 20 than even Jules Verne's famous *Nautilus*, the name of which this modern craft will bear in memory of the great scientific fictionist.

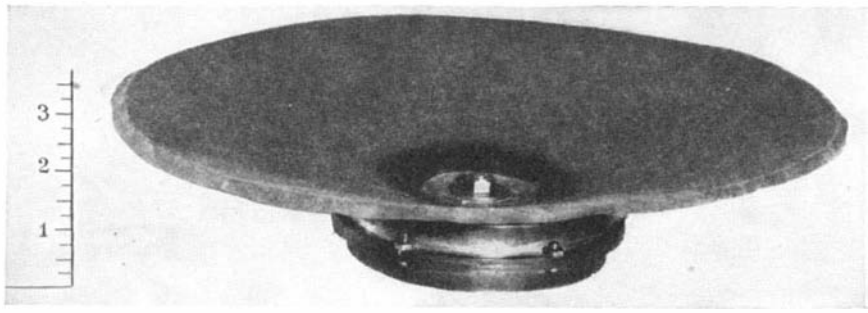
Paradoxically perhaps, but none the less truly, Sir Hubert's *Nautilus* will carry a General Electric refrigerator into the Arctic Ocean. The interior of the submarine will be warm enough, even in the frigid zone, to cause food to spoil; the electric refrigerator will be used for the preservation of the food rations of the crew.

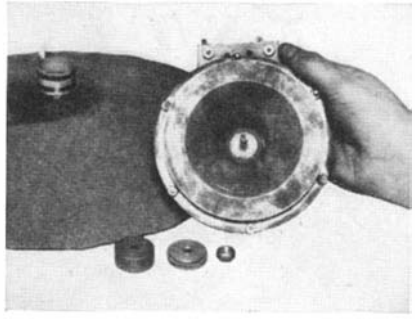
The *Nautilus*, recently completed at Philadelphia for its trial runs this spring, will also have a complement of General Electric sunlamps, since the boat will be under water so much of the time that, even though the sun shines 24 hours a day in the land of the midnight sun, the men will be exposed to natural sunlight but little. The crew will need the ultra-violet rays of the artificial sun to keep them in good physical condition.

There will be electric fans to stir up the air when the submarine has been submerged for a long time, giving the air a fresh and invigorating feeling as it is breathed.

One of the General Electric Company's new-type radio receivers will provide the crew with entertainment from broadcasting stations during off-hours of the expedition.

The matter of cleanliness will be taken into account far more than is usual on one of these expeditions through the use of an electric washing machine and an electric vacuum cleaner. An electric stove will be





Above: **New loudspeaker, showing compactness of unit.** ***Right:*** **Unit and cone with the voice coils attached; core is removed from field**

used for cooking, and there will possibly be a number of electric radiant heaters.

Electric current for these various items of equipment will be supplied by a large storage battery which will also be used for starting the Diesel propulsion engines. There will be an auxiliary Diesel operated electric generator for recharging the storage batteries when necessary.

The *Nautilus* will be able to remain six days under water, if required, without a recharge of the battery or a change of air. It will travel under the ice by the unique method of the "sledding" principle applied upside down. A sled deck and a guide will slide along in light contact with the under-surface of the ice, so that the vessel will behave like a marine fly crawling swiftly along a ceiling of ice.

By means of an ice-cutting tool on top of a special collapsible conning tower, a hole can be bored through several feet of ice, allowing the crew to crawl out through the conning tower to the top of the arctic ice.

A New Loudspeaker

LOUDSPEAKING reproducers in general have not kept up with the advances made in the amplifying equipment that is associated with them. For years the well-known principles of magnetic and dynamic speakers have remained unchanged, refinements in design and construction being the only forward steps that have been made. Now, however, comes a cone-type speaker of radically new design which holds promise of creating a new criterion in reproducer operation. It was invented by H. J. Fanger, formerly experimental engineer for the Brown-Boveri Company.

There is no wide range of movement of the center of this new cone, as is found in conventional speakers. Rather, the voice coils—there are two of them—are fastened rigidly to the center of the cone and are restricted electrically and mechanically to an amplitude of movement of .001 inch, even when reproducing low notes. The higher tones are reproduced by the center of the cone, and the lower by the outer edge where there is considerable amplitude of motion. This is exactly opposite to common practice.

There are two gaps in the magnetic circuit of the field coil, and one voice coil is suspended in each. The two voice coils are wound on the same support which is fastened to the cone.

This new speaker is said to have great clarity of reproduction throughout its entire range, and since it does not depend upon cone resonance for the reproduction of low notes, there is none of the "barrel-like" distortion that is so noticeable in the average speaker.

Because of the type of construction used, it is possible to build this new speaker in very large sizes to handle tremendous power. It is reported that one of them has successfully handled an input of 150 watts. Contrary to the effect produced by the usual speaker, this one does not produce unusual distortion when overloaded. It is said that as the input is increased, the volume builds up until the limit of the speaker is reached; greater input has no effect whatever on volume or quality of reproduction.

At present this speaker is available only in large sizes which, because of the power required to operate them, are not suitable for use in the home.

New Emulsifying Agent Used in Polishes

ANYONE who has ever made mayonnaise knows a little something about emulsions—how careful you have to be to add the oil slowly and what a lot of "elbow grease" you must use to mix the ingredients to form a nice smooth emulsion. These same difficulties, and more, have tried the patience of makers of many industrial products which are also emulsions. But recently they have learned to use substances known as emulsifying agents which greatly simplify the procedure and guarantee the uniformity of the product.

A new emulsifying agent, which comes in the form of a paste and is known as ammonium linoleate, is described by H. Bennett in a recent issue of *Industrial and Engineering Chemistry*. This product is finding many novel applications. To prepare the emulsion, the required amount of ammonium linoleate paste is completely dissolved in water and the oil to be emulsified is added slowly with vigorous stirring until emulsification is complete.

Emulsions made according to the predetermined formulas are useful as sprays, disinfectants, insecticides, lubricants, cleaners, et cetera. When volatile hydrocarbons are emulsified, their flash points are raised sufficiently to make them non-inflammable; thus fire hazards are reduced. Moreover, their vapor tensions are so reduced that they do not evaporate so readily and the resultant loss by volatilization is reduced to a minimum. The formula for making mineral-oil emulsions is typical of the usual oil polish for furniture or automobiles. If desired, a varying amount of tripoli or air-floated silica may be added to produce a silver or other metal polish. In the case of metal polishes the use of ammonia and the evil-smelling oleic acid is eliminated by using the paste.

Good stable wax emulsions have been the despair of many chemists. Many have tried and but few have succeeded. The quest is continued because wax is used in many industries and would be used in many more were it not for the difficulties involved in applying this class of materials. Since waxes are usually solids, they must be melted or dissolved. The former procedure is not usually economical because the wax hardens quickly and unevenly. In dissolving the waxes inflammable solvents must be heated with the wax, with resultant fire hazards.

In emulsifying waxes the ammonium linoleate paste is dissolved in water and heated above the melting point of the wax that is to be emulsified. The wax is melted in a solution with vigorous stirring. If this method is followed exactly, using the proper proportions, excellent stable wax emulsions will be formed. Such emulsions make excellent polishing, waterproofing, lubricating, and filling compounds.—*A. E. B.*

Sensitivity to Cold

SOME people are much more sensitive to cold than others; indeed, some people respond to changes brought about in the body by cold with eruptions in the form of wheals and blisters that are similar to those produced by sensitivity to various products or drugs. Dr. L. Minor Blackford has described a case of a boy 17 years old

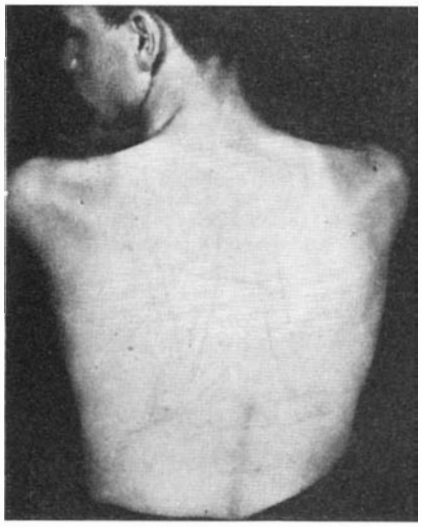
Wheals on legs ten minutes after a 20-minute bath at 20° Cent.

who had stood in the water in a swimming pool for 20 minutes and who was observed when coming out of the pool with the typical reaction of sensitivity to chemical products on the skin. The boy had blisters which itched greatly and burned. This discomfort passed away a half hour after he was removed from the cold.

In order to determine whether he was sensitive to cold or not a glass of ice water

was held against one thigh for five minutes and a glass containing water of ordinary temperature was held against the other thigh. The thigh on which the ice water was applied developed large blisters in a few minutes. Similar reaction followed the application of ice.

The skin of a person who is sensitive in this way is sensitive to all sorts of irrita-



Dermographia resulting from stroking the skin with the finger-nail

tions; one of the manifestations of a sensitive skin is the condition called dermographia, in which rubbing of the skin by a pencil or finger-nail leaves marks which persist for a considerable time. Dermographia, resulting from stroking with a finger-nail is shown vividly in an accompanying illustration.—*M. F.*

Auto Leads as Necessity?

THE automobile apparently is a greater necessity in American life than the telephone or radio, American Research Foundation stated. There are 23,122,000 automobiles, it said, against 20,206,000 telephones and 13,000,000 radio receiving sets.—*Barron's.*

Triple-fast Movie Film

FROM the astronomical observatory to the movie lot a new triple-fast photographic emulsion has come to make motion picture production cheaper and more flexible.

The motion picture film introduced to the profession recently is described by the Eastman Kodak Company as "the greatest advance in motion picture materials since the introduction of panchromatic film 18 years ago." Its sensitive emulsion is very closely related to one prepared for astronomical photography which has been used to reduce the time required for making exposures through large telescopes. An improvement in the photographic plates used is just as effective in this case as though the telescope itself were increased in size. The super-speed panchromatic plates produced for newspaper photographers are also very similar to the new movie emulsion.

When the movies went talkie it was necessary to banish the familiar arc lamps on account of their noise. Large incandescent

(*Please turn to page* 350)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

NOW and then someone with the best of intentions proposes that the telescopes made by amateur workers be "standardized" by means of uniform instructions for making—blueprints and all that kind of thing. As soon as we have recovered from the shock occasioned by this heresy we say to such reformers that, on the contrary, the most interesting and promising aspect of the amateur telescope making hobby has been the extreme *variety* of the designs produced. Like human faces, no two are alike. Starting with the fundamental principles of design stated in the book "Amateur Telescope Making" every worker concocts his own telescope and this is half the fun. The telescopes shown this month are originals.

HERE is a letter from A. Wade, mechanical engineer, connected with the Industrial Accident Commission of the Department of Industrial Relations of the State of California, 906 Associated Realty Building, Sixth and Olive Streets, Los Angeles. "In June, 1926, you published the picture of my first telescope. The present photograph shows my latest. Nothing is being said about the score or more of intermediate ones, though only four pieces of glass and three different mountings were involved in the struggle.

"The picture tells most of the story, though it may not be obvious that the tube can be rotated in the mounting. The mirror is 11¼ inches in diameter, with a focal length of 100 inches. The little electric motor that drives the polar axis is in the bottom of the pier.

"Some time ago you invited amateurs to tell what their telescopes would do in the way of definition, but I have seen but little on this point. (Reason: nothing came. —*Ed.*) Perfection is not claimed for this creation, but the components of double stars separated by one second of arc can been seen; for example, *Eta Orionis*. I can also see the chain of lunar craterlets near Copernicus, and the less conspicuous indentations in the submerged crater Stadius.

"In the picture of the telescope the bright line near the worm gear is part of the *sidereal* circle mounted on the gear. The hour circle is on the polar axis."

Mr. Wade cut the slots in the tube to ventilate it better, with the purpose of gaining improved seeing. He says he has not yet discovered any improvement.

THE first telescope tube in the universe made of an organ pipe was used by

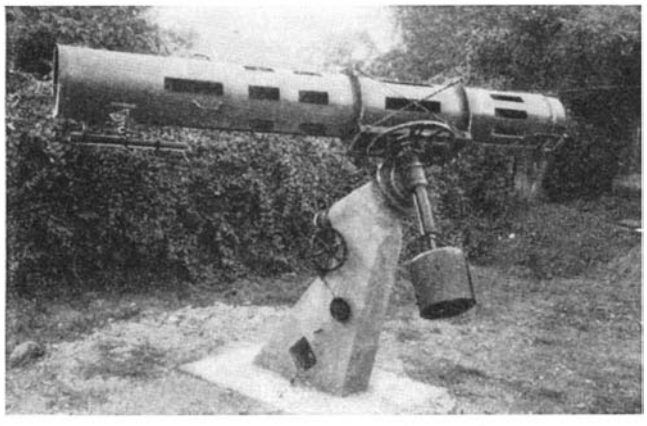
The optical pipe organ—Stoot

Stephen Stoot, connected with Casavant Frères, pipe organ builders, St. Hyacinthe, P. Q., Canada, on his telescope. He writes: "In addition to the vast amount of information on mirror making contained in the SCIENTIFIC AMERICAN book 'Amateur Telescope Making' I received some valuable hints from Mr. H. L. Rogers of Toronto. He has made four telescopes, three being of six-inch diameter and one of 12-inch. The telescope works well and results were beyond my expectations.

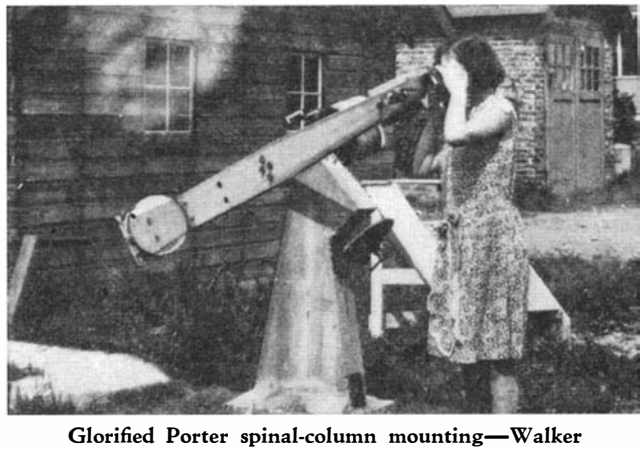
"The tube is a portion of a 6¼-inch organ pipe of hard-rolled zinc, 16-gage, and may be rotated in its cradle of maple. The polar axis was made from a discarded check-valve case from the old steam heating system in our factory. It had an inclination of 45°, and as the latitude of St. Hyacinthe is 45° 37′ 15″ I decided to use it. The rest of the mounting is made of pipe fittings. The slow motions are from an old-time gramaphone drive. For the base a block of concrete two feet square at the bottom, one foot square at the top and four feet high was set in an excavation four feet deep. Embedded in its center is a three-inch iron shaft surmounted by a flange seven inches in diameter. Upon this platform the rest of the mounting is constructed and in such a manner that it can be removed and taken indoors. When the upper part of the mounting and telescope are removed the cell is left on top of the pillar. The parts may seem heavy for a six-inch telescope but I have found it difficult to err on the side of rigidity if one wants comfort in observing anything in the heavens."

Mr. Stoot's insistence on rigidity surely requires no apology and his mounting contrasts favorably to some of the "India rubber" mountings we have seen. As for keeping the mirror out of doors, that is where we keep ours—right on top of the tube of our 10-inch Springfield mounting, covered by a tin cap, and always self-adjusted to the temperature.

THE simple wooden "spinal column" mounting for a small mirror, described by Russell W. Porter in "Amateur Telescope Making" (page 28-30), has been expanded to take a 12-inch mirror of 99 inches focal length by George F. Walker, 920 Twelfth Street, Bremerton, Oregon. Mr. Walker writes: "The cement, sand, and gravel cost about two dollars. I cut the steel reinforcing rods from old bed ends. A bronze bushing 14 inches long, cast in the concrete, provides a bearing for the polar axis; it came from a junk pile and happened to be a snug fit for the 1½-inch cold-rolled steel axis. The yoke is a piece of three-inch steel channel. Two split bearings cast from babbit metal carry the 1¼-inch declination axis and the latter has a flange which bolts to the wooden "backbone" of the telescope. Notice the concrete counterweight cast into a pipe which adorns the other end.



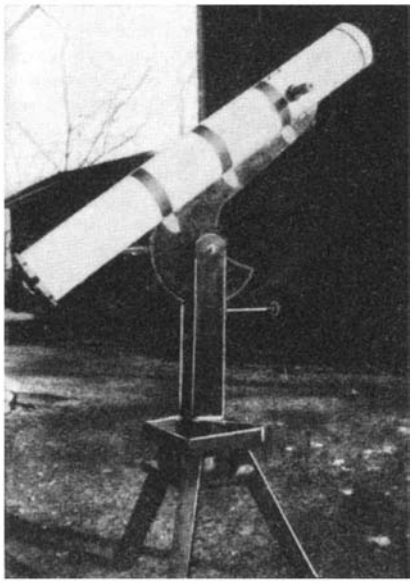
An 11¼-inch reflector with louvres—Wade



Glorified Porter spinal-column mounting—Walker

"The declination and polar axes are driven by two 360-tooth worm gears, and for moving the declination axis the worm lifts out of mesh. Just now I am casting about for a cheap, husky clock to keep the zero mark pointing at the celestial meridian.

"The backbone of the telescope is a good clear two-by-six cut from Washington's famous Douglas fir. The mounting is



A philatelist's alt-azimuth—Davis

rugged and relatively steady but I notice that when anyone is walking nearby, the earth itself is only relatively steady."

WE never had flattered ourselves that telescope making was as serious a disease as stamp collecting (our wife collects stamps and we therefore speak advisedly) but the impossible has now come to pass. A stamp enthusiast, the secretary of the American Philatelic Society, Dr. H. A. Davis, 3421 Colfax A, Denver, Colorado, has made a telescope, and sends in a picture of it. The accompanying confession reads: "I was one of the first to purchase 'Amateur Telescope Making,' in 1926 and have finished a telescope after all this time. Never have I put more than 30 minutes' work on the job at a given time. In fact, it was done principally in five and ten-minute periods, demonstrating that a man with absolutely no spare time (seemingly) can accomplish much by making use of short snatches of opportunity.

"The mounting is an alt-azimuth and has one worm gear working directly in the quadrant cut from an auto ring gear. For the slow motion in azimuth I used a stock brass plate gear of 16-pitch, with worm to match. The mounting is made of sugar pine."

Mr. Davis's telescope is trim and workmanlike. We hope the publication of the above evidence of his partial apostasy from stamp collecting will not result in his subjection to trial by the philatelists for worshipping false gods. Besides, there may also be telescope addicts who have indulged, on the sly, in stamp collecting. But when it comes to being addicted to both diseases it seems almost like leading a double life.

We have three lines left—just enough to beat the tom-tom about a big book every amateur has cried for. See page 355, quick!

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 347)

lamps are used. These are rich in red light which does not register effectively on ordinary movie negative. The new supersensitive film is affected by both red and green light to a much greater extent than previous film.

Camera men will now be able to "stop down" their lenses and get an increased depth of focus which will allow the actors to move around with less fear of getting out of focus. Or they will be able to use less light and save money.—*Science Service.*

Russia Plans 16 Rayon Plants

THE Soviet Government proposes to construct 16 rayon plants, costing 125,000,000 dollars with an annual productive output of 35,000 tons, according to Soviet reports received by the United States Department of Commerce. Three rayon mills are under construction and are expected to commence operation this summer.

The productive capacity of the three mills under construction is estimated at between 8000 and 9000 pounds per day, according to Soviet information.

Two Soviet trusts have signed five-year contracts with a German firm for constructing and starting in operation two rayon factories, the German firm to prepare plans for construction, to give expert opinion, and to turn over to the Soviet trusts licenses for all its patents and processes. The German firm is also to train Soviet engineers and workmen in its German plants, as well as send German specialists to Russia. The equipment will be ordered partly in Russia and partly from abroad. Only domestic raw materials will be used for rayon production in these factories.—*A. E. B.*

Effects of Training on Efficiency

IN 1930, investigators in the department of physiology of Johns Hopkins University showed that the daily repetition of the same amount of light muscular work on a bicycle brought about a gradual increase in the total ventilation of the lungs and a decrease in the pulse rate as the training progressed. The total amount of chemical interchange in the body during such work also showed a slight decrease. The investigators have now made available a study of the effect of training on track athletes in the university.

Seven men with athletic training and seven non-athletes were selected at the beginning of the season, and the amount of chemical interchange in their bodies, as represented by the metabolism developed in running 70 yards, was calculated. The investigations included also studies of the ventilation of the lungs, the rate of the respiration and the pulse, and the blood pressure during the period of recovery following exercise. It was found that the metabolism, the blood pressure, the pulse rate, and the ventilation for the recovery period did not change during the training. Two of the men carefully studied noticed that they were able to run faster and for longer distances and that the running became easier as the training proceeded. Apparently the main factor contributing to this increased ability is the factor of increased total ventilation of the lungs.—*M. F.*

Electric Refrigerator Most Popular Appliance

THREE million American families now protect their food supply by electric refrigeration, a co-operative survey by 20 leading refrigerator manufacturers reveals.

Sales in 1930 totalled 770,000 refrigerators, valued at 223,320,000 dollars, a sum equal to about 31 percent of the value of all household electric supplies sold in the year. Including refrigerators sold for commercial use, the year's sales were 1,002,000 refrigeration units, having a value of 380,120,000 dollars.

Notwithstanding the volume of business done with the cooling units, only 14.7 percent of American homes are equipped with electric refrigerators, the survey shows.

Chile's Saltpeter Tax Income

WHILE American chemists concern themselves with new methods of making nitrates, as, for example, by the catalytic oxidation of ammonia, the producers of natural sodium nitrate in Chile are planning to defend their world markets against the threat of synthetic competition.

The Government of Chile has long depended upon the export tax on nitrate as a major source of income. With the formation of the Cosach, the export tax was lifted, the government instead sharing as an equal partner in the future operation of the industry with a guaranteed return in 1931, 1932, and 1933. The managing interests in the company now favor utilizing its earnings in the modernization of the company, thus tending to cut off financial returns to the government. At the current conferences, alternative methods of financing the government to carry out this program will be considered. The agreement under which the company was formed provided for minimum payments to the government on its stock interest for the sacrifice of the export tax. That tax amounted to $12.32 per metric ton.

It is understood that a tentative proposal may be suggested to the Chilean delegates, calling for the return of the earnings of the nitrate companies to their businesses for the next year, instead of the payment of 22,500,000 dollars of it to the government as part compensation for the remission of the export tax on nitrates and iodine. For the government's immediate compensation, and to provide it with funds for expenses while the tax is inoperative and nothing is received from the companies, it is understood that there will be a proposal for a direct Chilean Government bond issue. Amortization of these bonds would take place with funds paid in by the nitrate companies as they achieve larger earning capacity.—*A. E. B.*

Coating Applied to Pipes Automatically

A MACHINE to coat pipe lines automatically with cement is being marketed by the Conley Plastering Machine

Company of Compton, California. It is asserted by the manufacturer that cement coatings applied by this method prevent corrosion, as shown by many tests. The machine instantaneously mixes and applies the plastic coating, using only enough water to hydrate the cement properly, giving a dense, mechanically water-proofed mass and a centrifugally welded bond between the pipe surface and coating.

The machine weighs approximately 1500 pounds, is easily handled in soft or marshy ground or over mountainous places, incorporates its own power plant and will cover from 2000 to 3000 feet of 4-inch pipe in eight hours with a cement coating one half inch thick. It can be used also to apply asbestos coatings for fractionating towers, boilers, and steam pipe insulation. —*A. E. B.*

Headaches of Nasal Origin

THERE are innumerable causes of headaches, but among the most frequent are infections of the sinuses surrounding the nose. In such cases the headaches may be either in the front of the head or back. In anterior cases, the pain is usually over the eyes and is associated with moving the eyes. The pain usually comes on at a definite hour, rapidly becomes more severe, and after a few hours lessens, but returns again next day. The region over the eyes and the teeth will be found sensitive to pressure. The interior of the nose is usually swollen and tender.

When the nasal congestion is diminished, a free flow of secretion takes place and the headaches disappear. In the chronic cases there is usually some anatomical obstruction to the passing of mucus from the frontal or maxillary sinuses. People find that these headaches become worse by close application of the vision, such as occurs in reading or sewing. When the X ray is applied to these cases, the sinuses will be found cloudy because of the presence of retained secretion.

Headaches in the back of the head are usually associated with inflammations in the ethmoid and the sphenoidal sinuses. Dr. Georges Canuyt finds that these headaches are more frequent in young women who may show extreme nervousness and who complain of pain in the center of the head, back of the head, or behind the eyes. Inflammation or infection of these sinuses is extremely difficult to diagnose and involves the most careful study by competent specialists in diseases of the nose and throat. In such cases treatment by cocainization of the sphenopalatine ganglion and various surgical procedures applied to the turbinates and the ethmoids may relieve the headaches permanently.—*M. F.*

Measuring the Temperature of Flames

THE temperature of solids may be estimated by the eye or accurately measured by means of a thermometer, thermocouple, or optical pyrometer. Flames, particularly non-luminous ones, present a more difficult problem. A flame may be hot enough to melt platinum and yet look fairly cool to the eye; conversely, there are certain luminous cool flames which will not burn the hand. This is because the radiation from flames does not follow the laws which apply to solids; for example, much of the radiation from the ordinary Bunsen type of flame is in the invisible infra-red region of the spectrum.

In a method for measuring flame temperature being employed at the Pittsburgh Experiment Station of the United States Bureau of Mines, the flame is colored yellow with sodium vapor and the intensity of this light compared in a spectroscope with the light from a heated solid at known temperature. Values have been obtained for stationary flames of different mixtures of air with methane, ethane, propane, butane, isobutane, ethylene, propylene, and butylene. Maximum flame temperatures vary from 1880 degrees Centigrade for methane, to 1975 degrees for ethylene.—*A. E. B.*

CLEMENCEAU AND FOCH

By Captain W. D. Puleston

(*Continued from page* 331)

Clemenceau did not hesitate to take a bold stand against Germany; but not until he had consulted the Minister of War, General Picquart, and been advised that the French Army was ready for war and after he had received assurances from the British Government that if Germany were the aggressor, public opinion in Britain would cause the Government to intervene. The fiery Premier was careful to consult his possible allies and the head of his own army before involving his country in the hazards of war.

It was during this period and at the insistence of General Picquart, War Minister, that free-thinking, anti-clerical Clemenceau appointed Foch to be Commandant of the Ecole de Guerre, although his brother was a Jesuit priest, and Foch, himself, a devout, almost mystic Catholic. Foch was surprised at his selection by Clemenceau. This was the first official contact of the two men, and their paths quickly separated until 1914; for Foch, absorbed in his profession, had little time for politicians, and Clemenceau, busy with his own affairs, paid little heed to Foch.

Clemenceau resigned office in 1909 convinced that Germany was an implacable enemy awaiting only a favorable moment to attack France. He was still the formidable foe of French cabinets but he took a more national view after his premiership. The responsibilities he faced as head of the Government prepared him for his more difficult war premiership.

In 1913 he founded his last journal, *L'Homme Libre*, which treated all current and domestic subjects, but continuously reminded France of the German menace. He gave his powerful support to all efforts to increase the efficiency of the French Army and to strengthen the ties of the Triple Entente.

When the World War began, a political truce was declared in France and on August 26 Prime Minister Viviani admitted additional members to broaden the base of his cabinet. This coalition cabinet resigned when the Allied efforts in the Balkans failed in October, 1915. Briand formed the new government and admitted members of other political groups, making a still more representative but an exceedingly unwieldy cabinet. This cabinet conducted the war until December, 1916, when it was reduced

by half and the direction of the war entrusted to a War Committee of Five.

When the war came, Clemenceau did not hesitate to criticize the short-comings of the coalition governments in his paper, and when the censor interfered, he changed the title of his paper to *L'Homme Enchainé,* but continued his criticism. His criticisms were really exhortations to the Government to take more vigorous action against both foreign and domestic enemies, and while the censor continued to blot out many columns of his paper, he never stopped his attacks, and gradually came to personify those Frenchmen who were determined to endure all and risk all rather than to submit again to Germany.

Briand resigned in March, 1917, and was followed by two other coalition governments headed by Ribot and Painleve, that together lasted only about eight months. Then, finally, but only in response to a growing public opinion that Clemenceau was the one leader who could save France, Poincare, much against his will, summoned Clemenceau to form the Government. Clemenceau abandoned the coalition scheme of government, and in November, 1917, formed a more homogeneous cabinet and one closely allied to the radical-socialist party. He purged the cabinet of monarchists, conservative republicans, socialist-republicans, and unified socialists. He drove Malvy, who had served as Minister of the Interior in every war cabinet, from office; he banished the powerful Caillaux and executed the notorious Bolo Pasha. He did not hesitate to accept the Government when a large portion of the French Army was mutinous and when the French legislature was honeycombed with defeatists. Nor did he complain when he took over the Army that he was given a desperate situation to cure; he took his position proudly, as if he were convinced, like the great Pitt, that he could save his country, and no one else could.

FOCH remained at the Ecole de Guerre until 1911, leaving to command a division of troops. In 1912 he was given command of the XXth Army Corps, in the Nancy area, specially formed and trained to cover the mobilization of France from a sudden German attack. The outbreak of war found Foch still in command of the XXth Army Corps, and a part of Castelnau's Second Army. On August 27th he was recalled by Joffre to form the Ninth Army, in command of which he distinguished himself at the first battle of the Marne.

After the battle of the Marne he was sent by Joffre to control and coordinate the efforts of the French, British, and Belgians in the fighting around Ypres in October, November, and December, 1914. His long friendship with Sir Henry Wilson, Deputy Chief of Staff of the British Army, greatly facilitated the co-operation of the British and French in 1914, and indeed throughout 1915, when as Joffre's deputy on the northwest front in command of the Group of Armies of the North, he took part with the British in the Second Battle of Ypres and the Battle of Artois. In 1916 Foch was again in close touch with the British in the Battle of the Somme, which was intended primarily to relieve the German pressure of Verdun and secondly to drive the Germans out of France. During 1914 and part of 1915 he was in desultory communication with Clemenceau through Clemenceau's brother, who was an enlisted man.

The results at Verdun and the failure of the Somme offensive caused the replacement of Joffre on December 12, 1916, by General Nivelle. The failure of the Somme had previously caused the retirement of Foch from an active command to head of a board to investigate Inter-Allied questions.

Nivelle launched his famous offensive in April, 1917; it failed and he was relieved as Commander-in-Chief of the Army by Petain, the Chief of Staff, who was succeeded by Foch on May 15, 1917. In this position Foch was the official military adviser of the French Government. So when Clemenceau became Premier in November, 1917, he found Foch already established as Chief of Staff of the French Army, after having narrowly escaped complete retirement. For the second time Foch came into close official contact with Clemenceau, who nobly supported him and Petain in recreating the morale of the French Army, badly shaken by the failure of Nivelle's offensive. During this period although Clemenceau and Foch had some differences they were able to settle them amicably over the tea table. At this time Foch apparently supported Clemenceau's view that American battalions should be brigaded with British and French Armies.

ON March 21 Hindenburg launched the expected German attack against the Third and Fifth British Armies; it was temporarily successful and it seemed certain to drive a wedge between the French and English armies near Amiens. The situation rapidly became critical; on March 23 by the advice of General Petain, Clemenceau had told President Poincare that the Government should prepare to abandon Paris. On March 24 Foch submitted to Clemenceau his considered opinion of the situation, ending with the ominous statement that "Nothing is ready for the maintenance of an indispensable collaboration between the French and British Armies." Clemenceau, under the enormous strain, hastily and unjustly concluding that Foch was preparing his own exoneration, exclaimed, "So you are abandoning me!" Foch quickly reassured him, and as they both were convinced that the British and French Armies must maintain contact at all costs, an agreement on the allied objective was easily reached, and during the last dangerous days of March, they worked in complete harmony.

This occasion reveals the responsibilities resting upon Clemenceau; he had promised the Deputies victory and they had given him a free hand, but after three days of battle Petain, the French Commander-in-Chief, despaired of maintaining contact with the British Army and defending Paris. Nivelle was in military disrepute. Joffre no longer enjoyed the confidence of his countrymen, and Foch, the last military hope of France, was apparently seeking to justify himself when the seemingly inevitable crash was about to be fully revealed to the French people.

It was a recognized procedure among French political leaders to disassociate themselves quickly from a cabinet about to be overthrown, and Clemenceau for a moment believed Foch was preparing to aban-

don him in similar precipitation. But Foch had no such intention and while he once indulged in a snarling growl about the desperate situation he was called upon to remedy, he never intended to separate himself or his professional reputation from the fortunes of France. He had memories of 1870, as poignant as Clemenceau's.

At Doullens, on March 25, 1918, Foch was made Generalissimo of the Allied Forces. He was summoned to take command of the British and French Armies when the British Fifth Army was in full retreat and the remainder of the British Army and the French Army were both apprehensive of the next German attack. His first task was to prevent the rupture of the British-French line at Amiens.

IT was around Amiens during this trying period of March and April, 1918, that Clemenceau and Foch drew closest together. Clemenceau has testified how Foch inspired the British and French leaders, civil and military, with his stirring declaration: "I would fight them in front of Amiens; I would fight them in Amiens; I would fight them behind Amiens." No less intrepid was Clemenceau, and Lord Milner testifies that on March 25 he was "in great form, and very full of fight, and while acutely realizing the gravity of the situation, showed not the slightest sign either of despondency or confusion."

Haig had already turned over the remnants of Gough's Fifth Army to Petain, who had put in six French Divisions at Noyon and was bringing up nine more French Divisions. Both Petain and Haig felt they could spare no more divisions without incurring grave danger of disaster in other parts of the line that lay open to German attack.

Foch immediately on taking supreme command proceeded to Gough's headquarters at Dury and inspired him to make still further demands on his hard-pressed army, for Gough's army must hold until Debeney's army could be constituted. During the next few days Foch was repeatedly questioned by high British and French officials whether he would defend Paris or the Channel ports in case the allied line was pierced. He invariably answered that he "would defend them both." No amount of questioning budged him from this attitude; even his old friend "Henri" Wilson failed to obtain any other answer. And in the end he did what he had promised.

Having blocked the German advance at Amiens, Foch's next task was to dispose the allied reserves so that any German thrust at the Channel ports or at Paris could be parried and still leave him with enough fresh divisions to make a counter attack when the German attacks were fully countered. For though temporarily restricted to the defensive, Foch looked forward to assuming the offensive as early as possible.

The Germans' next blow fell on the British Army in the north of France. On April 9 heavy fighting forced the British to give ground and on the 12th, Haig issued his famous "Backs to the wall!" appeal to the men who stood between Hindenburg and the Channel ports. Foch steeled his heart to refuse Haig's request for reinforcements. So close was the decision in the north that Foch temporarily incurred English displeasure, but as Foch had estimated, there was just enough strength left in the British line to deny the German advance.

On May 27 Hindenburg turned from the British to the French front, and attacked along the Chemin des Dames, and after four days of fighting the Germans reached the Marne at Jaulgonne. This time the French Army demanded Foch's reserve divisions, but he gave them very grudgingly and only after it was clearly apparent that the German thrust towards Paris was their major effort. By June 4 the German advance towards Paris was definitely checked. And Foch by his extreme frugality in using the allied reserves, had enough fresh divisions to launch a counter attack and his eye had already noted the point of the great bulge in the German line near Soissons where a successful attack would force a hurried German withdrawal. Since receiving the Allied Command in March, Foch had been forced to conform to Hindenburg's moves; in July the German reserves were consumed and Foch on account of his former penuriousness, had some fresh divisions in hand. The initiative passed to Foch and the world knows how successfully he employed it beginning at Soissons in June and continuing until the Armistice.

The whole world applauds Foch now, but on May 30 there was agitation among the Deputies demanding his removal on account of the German successes along the Chemin des Dames and then Clemenceau rose to his full stature and on June 4 offered his resignation if need be, but firmly supported Foch, who was even then planning his counter stroke against the Germans. There both Clemenceau and Foch were truly magnificent: Foch, on the eve of reaping for the Allies the reward of his patient and successful resistance to German attack, about to be struck down by Deputies, for the most part patriotic but who knew not what they proposed to do; and Clemenceau, not entirely approving Foch's actions, not thoroughly understanding his motives, but trusting his ability and patriotism, threw about Foch his own authority, and stood between Foch and retirement, and between France and disaster. Fortunate was France that, in this supreme trial, her civil and her military establishments could produce a Clemenceau and a Foch.

●

If any of our readers are interested in the full biographies upon which the above article is based, we refer to the following:

"Foch" by Maj. Gen'l. Sir George C. Aston, K. C. B. The English viewpoint.

"Life of Marshall Foch" by Capt. B. H. Liddell Hart.

"My Conversations with Foch" by Raymond Recouly.

"Grandeur and Misery of Victory" by Georges Clemenceau.

"In the Evening of My Thought" by Georges Clemenceau.

"Georges Clemenceau" by Jean Martet, his secretary and personal friend.

"The Tiger: Georges Clemenceau" by George J. Adam.

The next article by Captain Puleston will deal with disputes that arose over the methods to be used in employing the American forces in France, and with the Armistice.—The Editor.

CURRENT BULLETIN BRIEFS

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

SUPPLEMENTARY LIST OF PUBLICATIONS OF THE BUREAU OF STANDARDS (July 1, 1925 to February 28, 1930) is a very complete index and annotated bibliography of books and pamphlets published by the Bureau. For all previous papers refer to Circular No. 24, of June 30, 1925. *Bureau of Standards, Department of Commerce, Washington, D. C.—Gratis.*

AMERICAN STANDARD SPECIFICATIONS FOR DRY CELLS AND BATTERIES (Circular No. 390, Bureau of Standards, Department of Commerce) gives brief and approved specifications. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

LE GÉNIE CIVIL (Semi-Centennial Number 1880-1930) is a huge quarto publication of 236 pages and reviews (in French) progress along all the lines of engineering for the last half century. It is profusely illustrated. *Le Génie Civil, 5 Rue Jules-Lefebre, (IX) Paris, France.—25 francs. International money order.*

WESTINGHOUSE INSTRUMENTS, RELAYS AND ELECTRONIC DEVICES (Catalogue 211) is a valuable manual of 186 pages, profusely illustrated with half-tones and diagrams. *Westinghouse Electric and Manufacturing Company, Newark Works, Newark, N. J.—Gratis.*

FERTILIZERS FOR PECAN SOILS (Leaflet No. 71, U. S. Department of Agriculture) by J. J. Skinner gives valuable information about an important crop. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

HEAT TRANSFER IN AMMONIA CONDENSERS PART III (Bulletin No. 209, Engineering Experiment Station, University of Illinois) by Alonzo P. Kratz, Horace J. Macintire and Richard E. Gould is an important study in refrigeration. *Engineering Experiment Station, University of Illinois, Urbana, Ill.—35 cents.*

PULLMAN FACTS NUMBERS 1 to 12 are fascinating little booklets which each tell a story.—The titles are as follows: 1, Service You Get With a Pullman Ticket; 2, Evolution of the Pullman Car; 3, The World's Greatest Housekeeper; 4, Building a Pullman Car; 5, Safety; 6, Scientific Ventilation in Pullmans; 7, How a Pullman Car is Lighted; 8, Hidden Mechanism of a Pullman Car; 9, The Pullman Bureau of Tests; 10, The Peripatetics of a Pullman Car; 11, Exploding the Myth of Cheaper European Rates; 12, Travel, the Educator. Order by number. The covers are printed in color making the booklets very attractive. The entire set will be sent to teachers and really interested parties. Published by *The Pullman Co., Chicago, Ill.—Gratis.*

WHERE TO BUY EVERYTHING FOR SUMMER CAMPS gives valuable lists of classified addresses. *Porter Sargent, 11 Beacon St., Boston, Mass.—Gratis.*

COLLOIDAL GRAPHITE describes its properties, uses, and advantages as a lubricant. *Acheson Oildag Company, Port Huron, Mich.—Gratis.*

MY HOUSE AND CAR contains 10 pages of plans of small houses with attached garages. One gives a striking façade following automobile body lines. *Model Plan Service Studio, 3725 Valentine Road, Kansas City, Mo.—20 cents.*

THE ANCIENT MIMBRENOS by Paul H. Nesbitt. The first comprehensive account of a piece of excavation in this area in New Mexico. *The Logan Museum, Beloit College, Beloit, Wisconsin.—$1.50 postpaid.*

N. W. D. A. CHEMICAL MAP OF NORTH AMERICA is a beautiful map brimful of information. It is very large, being intended for window display. Only a limited number remain of this costly and informative map. *The National Wholesale Druggist's Association, 51 Maiden Lane, New York.—25 cents.*

THE HOWE WEIGHTOGRAPH is a device which may be attached to any beam scale and when attached makes an automatic scale out of an old-fashioned beam scale. The literature shows its application in industrial plants. *The Howe Scale Company, Rutland, Vt.—Gratis.*

GLIDERS AND GLIDING (Aeronautics Bulletin No. 22, Aeronautic Branch U. S. Department of Commerce) gives information that everyone needs who wishes to try gliding for sport, recreational purposes, or for the furtherance of aviation. *Aeronautics Branch, Department of Commerce, Washington, D. C.—Gratis.*

AIRCRAFT ENGINE TESTING (Aeronautics Bulletin No. 12, U. S. Department of Commerce) gives invaluable information as to equipment and tests. *Aeronautics Branch, Department of Commerce, Washington, D. C.—Gratis.*

CIVIL ENGINEERING, a comparatively new publication, fills a long felt want for a periodical on civil engineering which the tired C. E. can read and enjoy in his spare time. The price is five dollars a year and four dollars to members of the A. S. C. E. and to libraries. It is profusely illustrated and is well printed. It is not published by the American Society of Mechanical Engineers as erroneously stated in a former notice, but by the *American Society of Civil Engineers, 33 West 39th St., New York City.—Single copies 50 cents.*

THE FEDERAL AIRWAYS SYSTEM (Aeronautics Bulletin No. 24, Aeronautics Branch U. S. Department of Commerce) gives an account of the establishment by the Aeronautics Branch, of 15,000 miles of airways lighted and equipped with intermediate landing fields, and plans for extending the system. *Aeronautics Branch, U. S. Department of Commerce.—Gratis.*

SORBITIC MEEHANITE—A NEW METAL TO REPLACE CAST IRON. This is a circular concerning a sorbitic iron with remarkable properties. It has the advantages of gray iron but is tough like steel, resists abrasion, and may be treated or chilled. *Dodge Manufacturing Co., Toronto, Canada.—Gratis.*

NICKEL STEEL DATA AND APPLICATIONS (From Report of the Iron and Steel Division, Society of Automotive Engineers) gives in leaflet form standard specifications for steels. *International Nickel Company, Inc., 67 Wall St., New York.—Gratis.*

THE PROGRESS OF AMERICAN CHEMISTRY SINCE THE OUTBREAK OF THE WORLD WAR (Reprint from January, 1931 issue of *Industrial and Engineering Chemistry*) by William A. Hamor and Lawrence W. Bass gives the events in the chemical world from 1914-1930. *Address Mellon Institute of Industrial Research, Pittsburgh, Pa.—Gratis.*

PRESERVATION OF LEATHER BOOKBINDINGS (Leaflet No. 69, United States Department of Agriculture) by R. W. Frey and F. P. Veitch, gives exceedingly valuable formulas for dressing for bindings. The few illustrations are excellent. *Office of Information, United States Department of Agriculture, Washington, D. C.—Gratis.*

DEVELOPMENT OF OXWELDING AND CUTTING (Jan. 1931 issue of "Oxy-Acetylene Tips") describes the commercial development of the oxy-acetylene process which has taken place in the last 30 years. *Technical Publicity Department, The Linde Air Products Company, 205 East 42nd Street, New York City.—Gratis.*

A RAPID METHOD OF PREDICTING THE DISTRIBUTION OF DAYLIGHT IN BUILDINGS (Engineering Research Bulletin No. 17, Department of Engineering Research, University of Michigan) by Waclaw-Turner-Szymanowski describes a method which has given wonderful results. With the system it is possible to predict the lighting during any season; it also shows the difference between clear and dirty skylight lighting. It is profusely illustrated with diagrams and graphs for use with various types of buildings. *Department of Engineering Research, University of Michigan, Ann Arbor, Mich.—$1.00.*

BOOKS SELECTED BY THE EDITORS

THE SPLENDOUR OF THE HEAVENS—*Rev. T. E. R. Phillips, Sec't'y Royal Ast. Soc. and Dr. W. H. Steavenson, F.R.A.S., Editors*

GREAT good news for the amateur astronomer! This well-known work for which everybody has clamored so long, many offering as high as 20 dollars for all-but-unobtainable second-hand copies, is once more in print and at a greatly reduced price despite its large size. The inscription on its title page—"a popular, authoritative astronomy"—describes the work with strict honest accuracy. It is popular but not too popular; as authoritative as would be implied by the fact that each of its 18 authors is a widely known member of the British Astronomical Association, writing on his own specialty; and it is an astronomy in that it covers that modern science as adequately as the average intelligent layman requires. There is less emphasis on abstruse astrophysics than on the planets and other things which the amateur is in a position to "get hold of" with his own telescope. The book also contains a 40-page special study of the moon's many surface features, with a detailed map; also a star atlas and other special features. Amateur telescope makers and users will especially appreciate the practical well-seasoned material in the 52-page section entitled "The Amateur at Work." Physically this big book is splendid, measuring 8¾″ x 11″ x 2″ containing 976 text pages, 1104 fascinating illustrations, and 25 color plates. It is printed on fine paper, stitched and bound in blue cloth with a gold design. A large book—7¾ pounds. Judging from the clamor for this deservedly famous work during the two or three years while it was out of print, thousands of our readers will sit down and order it before they eat or sleep. —$8.75 postpaid.—*A. G. I.*

MACHINE DRAWING—*By C. L. Griffin and R. H. Fortman*

A BOOK that should be in every mechanical library for it gives in simple form practically everything that will come up in modern practice such as the necessary details to make clear to the pattern maker, machinist or tool maker, as to how the different parts are to be fashioned. Right here, often a considerable saving in production costs can be assured by the right kind of working drawings and this book is built on the results obtained by engineers and designers of wide practical experience.—$2.15 postpaid.

MACHINE SHOP WORK—*By Turner-Perrigo-Fairfield*

THESE authors' names are well known in technical circles having individually produced books of importance. Here they give a comprehensive treatise on approved shop methods, including the construction and use of tools and machines, the details of their efficient operation with a discussion of modern production methods. Just the book needed by one who is working into an executive position, for it is very practical yet not encumbered by intricate details or "kinks." Even experienced engineers will find much valuable information over a wide range.—$2.65 postpaid.

DESIGNING HEATING AND VENTILATING SYSTEMS
By Charles A. Fuller

MORE consideration is being given today to the ventilation of offices and factories than ever before. Many individual units are now available for ready installation, but in the design and specification for these there is no fixed rule—so many considerations enter into the solution. Here we have the third up-to-date edition of a standard work that completely covers the entire subject in such a way anyone can readily work out the final specifications from given data and requirements. Both the theoretical and practical sides are amply covered.—$3.20 postpaid.

AIRCRAFT MECHANIC'S HANDBOOK
By I. W. Miller, Lieut. U. S. M. C.

A GUIDE for airplane mechanics and a reference on certain engineering data which the skilled mechanic should know. It covers the use of hand tools and the essentials of materials and methods of maintenance. These are in the main those of the government services. 4½ x 7¼, 174 pages. Concise, and covers a bit different ground than the other books we have seen.—$2.15 postpaid.

MODERN DIESEL ENGINE PRACTICE
By Orville Adams

DEALS more with the installation, operation, and repair of Diesel engines than the technical design and engineering phases. It presents definite and basic principles, suggestions for the solution of operating problems, and aids in the correction of mechanical defects, and meets abnormal conditions in maintenance. Applications to aircraft and locomotives are detailed, the Packard Diesel being illustrated fully. An indispensable guide book.—$6.25 postpaid.

CHEMISTRY OF ENGINEERING MATERIALS
By R. B. Leighou, Prof. Chem., Carnegie Inst.

A NEW third edition to give engineers, particularly in the machine and building industries, the practical up-to-date information on the chemistry of materials which they need for their proper selection and use. The work is thoroughly revised and enlarged to cover changes in processes and methods demanded by recent rapid development in many fields of manufacturing, such as the conversion of coal, petroleum cracking, heat treatment of alloys, manufacture of wrought iron, and so on.—$4.70 postpaid.

EXPERIMENTAL CHEMISTRY—*By A. F. Collins*

FOR the demonstrator who wants a very complete set of easily accomplished experiments, with the reason why of their reaction and a description of some of the latest developments in chemical science. Classroom or parlor tricks in abundance to catch interest and drive home principles, with only simple apparatus as the working medium. Toward the end experiments become more involved, furnishing sufficient incentive for quite advanced work. The fascination of chemistry is revealed throughout to urge the reader on.—$2.15 postpaid.

ELEMENTS OF CHEMICAL ENGINEERING
By Walter L. Badger, Prof., and Warren L. McCabe, Asst. Prof. Chem. Eng., Univ. Mich.

A DISCUSSION of the unit operations of chemical engineering, covering both theory and practice. The theory is developed from the simplest considerations, but in a rigorous manner. A serious attempt has been made to classify the various types of equipment used in the chemical industries, and so far as possible, to co-ordinate theory with design.—$5.20 postpaid.

FROM RECENT PUBLICATIONS

ELEMENTARY ELECTRICITY

By Edgar P. Slack, Asst. Prof. Physics, Brooklyn Polytechnic

THIS is a simple, practical textbook on electricity for the beginner, covering both alternating and direct current, and based on modern electron theory. It is marked by clear, simple treatment throughout; the use of mathematics is reduced to a minimum, and principles are illustrated by many practical examples and problems. A chapter on the elements of vacuum tubes and radio reception is included.—$2.15 postpaid.

DRAKE'S RADIO CYCLOPEDIA

By Harold P. Manley

THE fourth edition of this 1000 page volume prepared for radio set owners, service men, experimenters, set builders, salesmen, and students, makes a highly successful attempt to cover the entire field of radio from "A Battery" to "Zero Beat." It is replete with illustrations which serve to clarify and enhance the carefully written text. The circuit diagrams which are an essential part of any radio text book range from fundamentals to complete schematic hookups of various standard receivers. The section on Television gives an excellent résumé of the work that has been accomplished and is being done in this field. A reinforced binding gives promise that the rather bulky volume will hold together under the strenuous usage that it is sure to get at the hands of its owner. Postpaid $6.25.—*A. P. P.*

MODELMAKER VOL. 7

THOSE who have other volumes of this most interesting and practical little work will want this one, for it is filled with valuable data for all working in this line. There is a fascination in this work which even the casual reader catches in a browse through its pages. Every kind of model is included, as well as addresses where different classes of models can be obtained.—$2.25 postpaid.

MATERIALS OF INDUSTRY—*By S. F. Mersereau, Ch'm. Dept., Industrial Processes, Brooklyn Tech. High School*

THIS gives the student a logical working knowledge of the important topics of industry and industrial processes, especially from the standpoint of the raw materials, their distribution and their production, their general properties, transportation, conversion into commercial forms and their economic importance. It is well illustrated with maps and drawings which focus the attention on the important details.—$2.15 postpaid.

OUR AMERICAN MUSIC—*By John Tasker Howard*

WE hear so much music of foreign origin at concerts and over the radio that one feels sometimes that we have no indigenous music. This is a mistake for we only have to cite Theodore Thomas, William Mason, Dudley Buck, Ethelbert Nevin, Edward MacDowell, Charles Wakefield Cadman, Henry K. Hadley, Victor Herbert, and the astonishing Deems Taylor, for the moderns. There are other musicians and composers who deserve an honored place such as John Philip Sousa, George Gershwin, Cecil Burleigh, and Irving Berlin. As a matter of fact we have had American music for three hundred years. The early psalmodists of New England did not do much to elevate music, and we have had no real composers until the time of Francis Hopkinson (1737-1791) and William Billings (1746-1800). One thing deserving of comment is what our national airs have done for us—they still persist; it was only the other day that the "Star Spangled Banner" was formally accepted. The book is comfortable to read and is fully illustrated. There is a list of works, a bibliography, and an excellent index. A valuable addition to both the history and criticism of music.—$6.35 postpaid.—*A. A. H.*

YACHT RACING—*By Manfred Curry*

LAST October we stated there was a book on the aerodynamics of sails and racing tactics that soon would be published. Here it is and it exceeds our expectation. The theoretical side of yacht designing and the physical laws governing the wind pressure which drives a yacht as well as the development of hull forms are given for the first time in this country. The author is an American living in Munich, a helmsman par excellence, and a trained scientist as well. About half the book is devoted to the laws governing the construction and proper use of sails, as revealed in the wings of birds and material developed in the dynamics of aeroplane. The tactics of yacht racing are most thorough and scientific and all is presented in a practical and interesting way with abundant illustrations. A book every yachtsman must own.—$7.75 postpaid.

THE AMERICAN YEAR BOOK 1930

A. B. Hart and W. M. Schuyler, Editors

ONE of the important features of this annual publication is the comprehensive list of societies and organizations of national scope which relate to the subject of each of 27 divisions into which the text is divided; a useful reference not found as complete in any other place, to our knowledge. A record of significant events, personalities, and tendencies presented by an organization of 47 persons, each chosen for the purpose by a recognized learned society; each especially concerned with the authenticity of his material. An essential reference for every private and public library.—$7.75 postpaid.

CONQUEROR OF SPACE—*By Georgette Carneal*

THIS is the life of Lee de Forest, called in this country the Father of Radio, being to us what Marconi is to Europe. From an Alabama village, having no toys, no amusements, but with an impulse to find out what makes things work, he finally achieved his dream and finished his postgraduate work in Yale Sheffield with this reviewer's class in 1899. Through many vicissitudes he finally developed ideas which have grown into today's great public utilities. Concentrated on his work, he was most shamefully buncoed in business matters, though he has recently been justified after long drawn-out litigation. A book everyone should read. —$3.20 postpaid.

THE PINKERTONS—*By R. W. Rowan*

BEGINNING with Allan Pinkerton who was head of the Federal Secret Service in 1861, this detective dynasty has come down to modern times and is still operating as an agency. Many of the most interesting cases are given here in detail—a series of short stories, famous the world over in the history of crime detection. For intermittent reading which is exciting and historical at the same time, this book would be hard to beat.—$3.20 postpaid.

FOR YOUR CONSIDERATION

ARCHEOLOGY OF THE ARKANSAS RIVER VALLEY
By Warren King Moorehead

A WELL-ROUNDED scientific account of Indian archeology in Colorado, Kansas, Oklahoma, and Arkansas, written by one of America's ablest professional archeologists. This book of 200 large pages is handsomely produced on fine paper and splendidly illustrated. It also contains a full account of the excavations at Jacob's Cavern, Missouri.—$4.20 postpaid.—*A. G. I.*

AIRCRAFT YEAR BOOK 1931

COMPILED with the facilities of the Aeronautical Chamber of Commerce each year this work appears as the official record of what has happened in Aeronautics. Records, developments, new designs, projects, manufacturing data, laws, schools, world progress, in fact every phase of activity is covered in 21 sections beside a chronology, a sizeable appendix, and a trade index. It is the one extended and reliable source which must be at the elbow of everyone affiliated with the industry.—$6.25 postpaid.

THE ENDURING QUEST
By H. A. Overstreet, Prof. Psychology, C.C.N.Y.

THROUGH the upheavals of modern science the author searches for the philosophy we can live by—a philosophy which should bring a new promise out of the pessimism of this age that sees most of the cherished beliefs of our childhood wrecked before the advance of materialistic analysis. Particularly happy in his style of presentation, Prof. Overstreet's writings, while based on erudite knowledge, come so much within the circle of the intelligent layman's thoughts that they assume a rank among the best sellers of the non-fiction class.—$3.20 postpaid.

ANNALS: AMERICAN ACADEMY OF POLITICAL AND SOCIAL SCIENCE—*T. Sellin and D. Young, Editors*

WITHIN the last few years the industrial development of the South has assumed proportions that demand recognition in any economic outline. Here are presented 27 papers by prominent economists, developing a wide range of important phases which are vital in any consideration of the accomplishment and trend of this revivification. An important and interesting compilation which must find a place in any reference library.—$2.15 postpaid.

RACE MIXTURE
By E. B. Reuter, Prof. Sociology, Univ. Iowa

STUDIES in intermarriage and miscegenation—each complete in itself—and each presenting a significant aspect of racial contact and intermixture. All of the subjects are considered from the sociological rather than the biological viewpoint. Special emphasis is placed on the relation between whites and negroes in North America and the problem of the hybrid is discussed thoughtfully and without prejudice.—$2.65 postpaid.

DREAMS AND PERSONALITY—*By Frederick Pierce*

WITH much discretion the author selects for further study 18 interesting and significant types from hundreds of individuals examined. The waking and sleeping personality is differentiated, some studied for two to three months; some for as much as three years. In all 204 such studies were completed in 12 years. The style is most readable and particularly fascinating to anyone who likes to explore beneath the surface of human nature.—$3.20 postpaid.

RACE PSYCHOLOGY
By T. R. Garth, Prof. Psychology, Univ. Denver

A STUDY of racial mental differences with most interesting analyses in color preference, musical talent, personality, mental fatigue, and community of ideas. The unique conclusion is drawn that there is no particular difference in characteristics, when all considerations are reduced to a common denominator. All available sources are drawn upon, as well as the author's own extended researches. The deductions are judicial and painstaking, so the reader is irresistibly compelled to agreement as the analysis is developed. A work of much importance in a hitherto scattered field.—$2.65 postpaid.

PREVENTIVE MANAGEMENT—*Henry B. Elkind, Ed.*

MENTAL hygiene in industry considers the human factor and plain common sense indicates sound preventive principles and a close study of the mental condition of workers and of the management. But if these are applied in too standardized a form, thinking on the part of the workers will come to a stop and their growth will end. Then industry ceases to develop. This series of essays by noted men in various lines is designed for men and women holding supervisory positions in business and industry.—$3.20 postpaid.

SECRET TREASURE
By A. Hyatt Verrill

TELLS the legend and history of the hidden riches of the British Isles and is a sequel to the "Lost Treasure" by this same author, which covered South and Central America and the Spanish Main. The scope of this story embraces England, Ireland, Scotland, and Wales, and one reads with fascination and amazement that one of the richest fields has been Ireland, supposedly so poor and downtrodden. This entire theme is one that fires the imagination of old and young alike, being here set forth in the author's best style.—$2.65 postpaid.

THE BRIDGE OF DESIRE—*By Warwick Deeping*

THERE is a particular intriguing charm in the pen of this author even though the theme of his story may not be especially lofty. In this story of marital unrest, one is ever conscious of the smooth flow of precise English that carries along irresistibly. A novel that was well received in England and now first printed here. Warm philosophy and sound sense furnish pleasurable entertainment.—$2.00 postpaid.

COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY

Member of the New York Bar
Registered Patent Attorney

Foreign Telephone Patent Suit Settled

A COURT of arbitration in London has handed down a decision in favor of the Standard Telephone and Cables, Ltd., British affiliate of the International Telephone and Telegraph Corporation, the defendant in a claim for compensation made by the German electrical manufacturing company, Siemens and Halske Aktiengesellschaft, for an alleged breach of a patent agreement made in 1921.

The court disallowed the claims of Siemens and Halske A. G.; awarded costs to the defendant; and gave the defendant the right to claim damages from the plaintiff.

Siemens and Halske filed the claim against Standard Telephone and Cables, Ltd., for denouncing a patent agreement inherited by the International Telephone and Telegraph Corporation upon its acquisition from the Western Electric Company of the International Western Electric Company in 1925. Standard Telephone and Cables, a manufacturing unit of the International Telephone and Telegraph Corporation, contended, in combating the German claim, that Siemens and Halske were responsible for the breach of the old International Western Electric agreement, and the court found accordingly.

The original agreement between Siemens and Halske and the former International Western Electric Company was concluded in 1913. It gave the Siemens group an increased quota of the world's telephone business. It lapsed at the time of the war but was renewed in 1921 on the basis of an exchange of patents between the two companies and the Automatic Electric companies, affiliated with Siemens since 1909.

An involved patent situation and the intricate marketing problems occasioned by the Siemens and Halske relations with Automatic as well as with International finally resulted in the denouncing of the 1921 patent agreement and the bringing by Siemens and Halske of its claim for compensation. A feature of the claim was that it did not ask fulfillment of the 1921 agreement but merely compensation for nonfulfillment.

Siemens and Halske, one of the principal rivals of the International Telephone and Telegraph Corporation, in recent years has been a brisk competitor of the International interests and upon two occasions has joined hands with L. M. Ericsson Telefonaktiebolaget of Sweden to win telephone concessions in Greece and Rumania. The International group won in Rumania but lost in bidding for a Greek concession. The Ericsson organization, Siemens and Halske, and International are called the "big three" in international telephony.

Automatic Electric, Inc., of Chicago is a manufacturing unit of the General Telephone and Electric Corporation, sponsored by the Transamerica and Gary interests in this country and by affiliated British interests. The company exports all its products and has had patent and licensing arrangements with Siemens and Halske since 1909, embodying the use of the Strowger automatic telephone system.

The victory of the British manufacturing affiliate of the International Telephone and Telegraph Corporation, by disposing definitely of the former Siemens and Halske patent agreement, is believed by observers to have strengthened the hands of the International in its bid for telephone business abroad.

By the purchase of a share in a group of German telephone manufacturing concerns and through an indirect affiliation with A. E. G., the German General Electric Company, the International group has an important share in the telephone business of Germany, as well as in other countries. This has brought about several public clashes between the managements of Siemens and Halske and the Allgemeine Elektricitaets Gesellschaft in recent years.

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.

Glass Trademark Upheld

IN a recent decision Assistant Commissioner Moore held that Louis J. Kolb of Philadelphia, Pennsylvania, is entitled to register, under the Act of 1905, as a trademark for sheets of glass, a mark described as consisting of a band or coating of metallic silver-like compound arranged about the perimeter of glass sheets including laminated glass sheets in the case of small sheets, and extending slightly inward between the glass sheets and showing through the glass in the case of large laminated glass sheets, the fundamental feature being the silver-like band about the perimeter of the glass but no claim is made to the representation of the goods *per se*.

In his decision, after stating that the mark was rejected as being merely a functional feature of the goods and noting applicant's contention that it is not feasible to print words on the glass, and stating that the ruling of the Supreme Court in A. Leschen and Sons Rope Company *vs.* Broderick and Bascom Rope Company, is deemed sufficient authority to hold the mark registrable, the Assistant Commissioner said:

"In the instant case the 'silver-like' color is impressed in a rectangular figure, the figure constituting the mark being applied to the glass by arranging the mark 'about the perimeter of glass sheets.'"

Then, after stating as a general proposition that whether a mark constitutes a trademark depends largely upon the effect which it produces upon the minds of the public, he said:

"In the applicant's case as long as the band or coating of metallic silver-like compound forms no necessary part of the sheet of glass, but is merely associated therewith in the manner indicated, it is believed that the members of the public would regard it as having no other function than that of a trademark."

Fumigant Patent For Public Use

THE benefits of what has proved to be the most effective known fumigant for certain foodstuffs stored in quantity have just been given to the Government and the people of the United States by two scientists of the United States Department of Agriculture, Dr. Ruric C. Roark, a chemist of the Bureau of Chemistry and Soils, and Dr. Richard T. Cotton, an entomologist of the Bureau of Entomology, who recently obtained a patent on ethylene oxide as a fumigant and insecticide.

The value of ethylene oxide as a fumigant was first proved by Doctors Roark and Cotton in the laboratories of the Department of Agriculture in April, 1927, when they inserted one twentieth of a cubic centimeter of this colorless gas into a half liter flask containing a large number of weevils in 200 cubic centimeters of wheat. All the weevils in the flask were quickly killed by the gas.

In 1928 ethylene oxide was first tried on a commercial scale when Doctor Roark and Doctor Cotton successfully used the gas to destroy the weevils in a carload of grain in Baltimore.

Since that time ethylene oxide mixed with carbon dioxide has been used successfully to fumigate great quantities of foodstuffs such as nuts, dried fruits, and packaged cereals in which it effectively prevents the multiplication of insects and consequent deterioration.

This method of fumigation is proving valuable to the raisin industry and it is believed that its use will be rapidly extended to other products such as tobacco, stored silks, wool, textiles, and upholstered furniture.

Ethylene oxide was the reward of a long search by specialists of the Department of Agriculture for a fumigant that could be used almost anywhere without excessive danger of fire or explosion, and without undue danger to human health. The gas, which is free from the fire and explosion hazard when used according to directions, is deadly to insects, but is comparatively harmless to man and does not appear to leave on the treated materials obnoxious odors or residues harmful to humans or animals.

Ethylene oxide has been used already with success in grocery stores, hospital food-supply rooms, in fumigatable storage bins

in dried fruit establishments, work rooms, candy establishments, and for treating tobacco. It has been used with apparent success in large concrete elevator bins containing wheat and in lofts in reinforced concrete warehouses where grain products such as animal feeds are stored. The Navy Department fumigated with excellent results more than 10,000 pounds of sacked rice in a modern quartermaster's depot.

Ginger Ale Need Not be "Six Months Old"

CLIQUOT CLUB COMPANY, of Millis, Mass., is ordered by the Federal Trade Commission to cease advertising that its ginger ale has been or is aged six months or six months in the making, unless or until it actually has been or is of that age prior to its sale.

The Commission found that until April, 1929, Cliquot advertised in periodicals and through radio broadcasting that its ginger ale was unripe and injurious unless it had been aged six months and that the product offered for sale had been aged six months, and had derived a fullness of flavor and mellowness of tone as a result of such aging process.

In April, 1929, the company discontinued its practice of representing that its ginger ale had been aged six months and adopted as a substitute therefor the phrase "aged six months in the making," which it continued to employ in its advertising.

However, the Commission found that such ginger ale has not been and is not aged six months or six months in the making. A flavoring mixture called the concentrate, from which the finished ginger ale product is made, has been and actually is aged six months in storage tanks. After the concentrate has been so aged it is mixed with other ingredients of the product, but is in weight about one fifth of one percent of the product.

The Commission found that the finished beverage is neither aged six months nor six months in its making nor is any other part of it than the so-called concentrate aged six months or any definite period of time.

The Commission held that the representation regarding the age of the beverage tended to deceive the public and divert trade from competitors and furnish to wholesale and retail dealers the means by which they are enabled to mislead customers into believing that the ginger ale is six months old when offered for sale.

Court Bans Tax on Radio Owners

A SWEEPING decision prohibiting taxation of radio receiving set owners, as proposed by a South Carolina law, has been handed down here in the Federal District Court, in the first test case brought at the instance of the Radio Manufacturers Association.

An interlocutory injunction against enforcement of the South Carolina law was granted by the Federal Court and restrains collection of the proposed taxes on radio receiving sets. The decision was made by three Federal judges, Circuit Judge Parker of North Carolina, and District Judges Cochran and Glenn of South Carolina.

The Court's decision was made in the test case of a North Carolina broadcast station, WBT of Charlotte, which contended that radio is interstate commerce and not subject to taxation by a state. The Court's decision sustained the contention that the South Carolina law is unconstitutional as an interference with interstate commerce and cannot be enforced.

The South Carolina law, passed last year, proposed to levy on owners of radio receiving sets a graduated tax ranging up to a maximum of $2.50 per set. It was the first state law against owners of receiving sets, and therefore the decision of the Federal Court is an important precedent in radio law. The WBT case was one of three attacks made upon the South Carolina law at the direction of the Radio Manufacturers Association in the interests of the radio owning and buying public, as well as the radio industry.

Wooden Candle Mark

IN ex parte Saint Louis Candle and Wax Company, First Assistant Commissioner Kinnan held that the company, of St. Louis, Missouri, is not entitled to register, under the Act of 1905, the notation "Waxwood" as a trademark for candles.

The ground of the decision is that, it appearing that these candles have cores of stiff material embedded therein, the mark is descriptive if that core is made of wood.

In his decision, the First Assistant Commissioner noted that the examiner objected to a description of the goods as candles as being indefinite and that description was amended to state that the candles were made of or comprised of wax, paraffin, or similar substances, and was subsequently modified to state that the candles had cores of stiff material embedded therein.

With reference to the question of descriptiveness he said:

"It is deemed self-evident that if these candles are made of wax and have wooden cores, the notation which but recites the names of these two materials is merely descriptive of the goods and its registration is barred by the statute. If the cores are made of material other than wood the notation would not be descriptive."

In his statement the examiner called attention to candles which had been purchased at various department stores which comprised a wooden core covered with wax. The First Assistant Commissioner sustained the applicant's objection to the consideration of these candles as showing the descriptiveness of the term since nothing had been submitted to show that any of the goods were on sale before the alleged date of adoption and use of the mark by the applicant.

Motion Picture Houses Increase

THE United States has more than half of the sound film theatres of the world, and more than a third of the silent and sound houses combined, according to a statement by the Department of Commerce, published in *The United States Daily*.

The first compilation of statistics on sound-equipped theatres by the Motion Picture Division revealed that the world's total was 19,894 and the total for the United States, 12,500, on January 1. The number of movie theatres in the world, it was stated, was 62,365 at the beginning of 1931, and the United States has 22,731. These figures show a 11 percent gain for this country in the number of motion picture houses in the last year.

The world's movie theatres numbered 57,743 at the close of 1929. There was a gain of about 42 percent in the number of theatres in the Near East, with the number increasing from 52 to 74. The increase amounted to 24 percent in Latin America.

Delay Voids Patent

A DELAY of nearly two years in filing a disclaimer as to a claim in a patent after such claim, by interlocutory decree, had been declared invalid by a District Court, is such an unreasonable delay as to void the patent, the Supreme Court of the United States held in the case of Enstein et al. v. Simon, Ascher & Company.

The opinion, by Justice McReynolds, explains that "under the early accepted general rule a patent with an invalid claim was wholly void, and this defect barred suit upon it. Congress undertook to modify this by sections 7 and 9, Chap. 45, Act of 1837."

Voice Culture Advertising Subdued

AN order was recently issued by the Federal Trade Commission to Perfect Voice Institute, Chicago correspondence school, and T. G. Cooke, its president, to stop representing, among other things, that every student can have a beautiful speaking or singing voice by developing a certain muscle and taking simple exercises.

The primary cause of strong and weak, and of perfect and imperfect voices, lies in the development and control of the hyoglossus muscle, so it was represented and taught in the course of instruction furnished by Perfect Voice Institute. It was further represented that the system of instruction had been proved by every law of physics, anatomy, mechanics, and mathematics, and had shown itself to be infallible in practice by tests on thousands of students all over the world.

An alleged post mortem examination of the throat of Caruso, showing a wonderful development of his hyoglossus muscle, proves, according to Cooke, the amazing truth of the Feuchtinger discovery of the true functions of the hyoglossus muscle. It took Caruso many years instinctively to control his hyoglossus muscle, but in the end he became the greatest singer of the century, it was advertised.

The Commission found that there had been no post mortem examination of Caruso.

Every student's throat is constructed exactly like that of Caruso and other world famous singers, with just one exception: they had developed their hyoglossus muscle, according to the Perfect Voice Institute. The main difference between the normal vocal organ of the student and that of Caruso lies in the control, strength, and development of the hyoglossus muscle, the institute declared.

The Commission found that the hyoglossus muscle serves no possible function in voice tone production. It is one of a large group of swallowing muscles intimately connected and its isolation or separate development is physiologically impossible. Its function is to depress the tongue and draw down its sides so as to render it convex from side to side.

SCIENTIFIC AMERICAN ADVERTISERS

MAY · 1931

GEORGE A. TOWNSEND, Mid-Western Advertising Manager
6 North Michigan Ave., Chicago, Ill.

BLANCHARD-NICHOLS-COLEMAN
Western Advertising Representative: Los Angeles, San Francisco, Seattle, and Atlanta

SCIENTIFIC AMERICAN PUBLISHING COMPANY
Formerly Munn & Co., Inc., 24-26 West 40th Street, New York

ORSON D. MUNN, President — LOUIS S. TREADWELL, Vice-President
JOHN P. DAVIS, Treasurer — I. SHELDON TILNEY, Secretary

Vol. 144, No. 5. Price 35 cents a copy. $4.00 a year. Foreign $5.00. Postage prepaid in United States and possessions and foreign countries where eighth zone rates apply. Other foreign countries $5.00 a year, postage prepaid. Canada $4.50 a year, postage prepaid. Illustrated articles must not be reproduced without written permission. The use of Scientific American articles or quotations from them for advertising and stock-selling enterprises never authorized. "Scientific American" registered United States Patent Office.

CIVILIZATION'S DIARY

CIVILIZATION is a manner of living—and civilized people seek to live as comfortably, healthfully and pleasantly as they can.

To this end, the wheels of industry turn unceasingly, producing civilized goods for the use of civilized people. Leaders of industry lay far-reaching plans to provide better services for a civilized world. In countless laboratories, new things and better ways are constantly being developed.

Advertisements are the daily record of civilization's progress. They are civilization's open diary —brought to you in the pages of this magazine. Diaries make good reading, and the advertisements are no exception. Read them every day . . . and keep posted on the things that make civilized living ever more livable.

Sunshine Mellows Heat Purifies

LUCKIES are always kind to your throat

Everyone knows that sunshine mellows—that's why the "TOASTING" process includes the use of the Ultra Violet Rays. LUCKY STRIKE—made of the finest tobaccos—the Cream of the Crop—THEN—"IT'S TOASTED"—an extra, secret heating process. Harsh irritants present in all raw tobaccos are expelled by "TOASTING." These irritants are sold to others. They are not present in your LUCKY STRIKE. No wonder LUCKIES are always kind to your throat.

The advice of your physician is: Keep out of doors, in the open air, breathe deeply; take plenty of exercise in the mellow sunshine, and have a periodic check-up on the health of your body.

LUCKY STRIKE "IT'S TOASTED" CIGARETTES

"It's toasted"

Your Throat Protection—

against irritation—against cough.

TUNE IN—The Lucky Strike Dance Orchestra, every Tuesday, Thursday and Saturday evening over N.B.C. networks