Power From Arctic Heat—Our Eyes and the Movies
Suspended Gravitation—The Human Egg

SCIENTIFIC AMERICAN

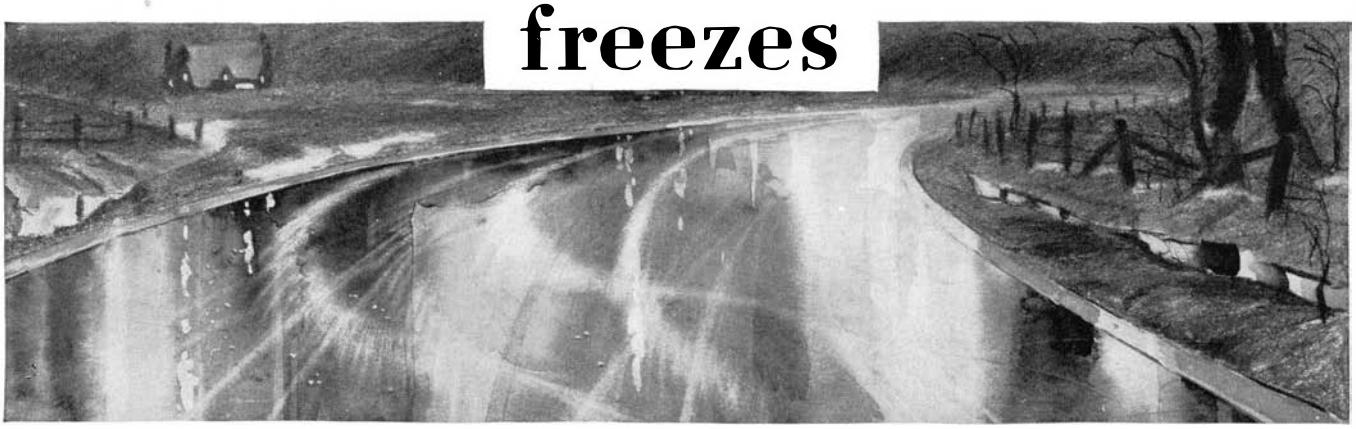
March 1930 ★ 35¢ a Copy

An Air-Minded City of the Future

When it rains

snows

freezes



and roads are slippery

-then you'll wish you had the safety of the

CORD

FRONT DRIVE

AUBURN AUTOMOBILE COMPANY AUBURN, INDIANA

SEDAN $3095 · BROUGHAM $3095 CABRIOLET $3295 PHAETON $3295 Prices F.O.B. Auburn, Indiana. *Equipment other than standard, extra*

Looking Ahead *With the* Editor

April—Engineering Number

IN our modern civilization, engineering plays such an important rôle that SCIENTIFIC AMERICAN readers have requested an issue containing more than the usual number of articles on the subject. This we have scheduled for the month of April. Articles in that issue will take the reader on an imaginary journey, first to New York where the Chrysler Building has recently overtopped all other man-made structures; thence through a roundhouse where he may see the human as well as the technical side of railway engineering; from there to Montana to see a huge coal-stripping mine; on down to California to see the result of a novel method of land fertilization by engineering methods—by reclamation; and finally, to France to watch the unique construction methods used in building a beautiful concrete arch bridge which is just about complete. Along the way, the reader-traveler may stop off to see smaller but none-the-less interesting projects under construction.

Snapshots From the Air

WHEN you travel by train, steamer, or automobile, you probably take along a camera. When you made that last journey by air or took that last short hop, did you think of carrying a camera? You probably didn't realize that the amateur can take pictures from the air as well as on the ground. Read the article on amateur aerial photography in a coming issue so you will be prepared before you take to the air again.

"You Can't Win!" Against Them

THE joke: "Another policeman for New York!" which used to be in order when an Irish boy was born, is out of date. New York City policemen are now made, not born. They go through a rigid course of training in the new Police College which gives them not only a knowledge of the business in hand but also an understanding of criminals. This truly scientific college, on the faculty of which there are many able men, will be discussed here in the near future.

Secrets of the Mummies

YOU'VE heard so much about Egyptian mummies that you realize how many scientific facts can be learned from them. It is the same with the mummies of ancient Peruvian Indians. An article on hand, based on mummy and skeletal evidence, gives an insight into their culture and some of the diseases from which they suffered. Very little has been published on this subject heretofore, so you'll find this article stimulating.

Every Issue Fully Illustrated

¶ *Read this magazine carefully. If you like it, you will like succeeding issues also. Better make sure of getting it regularly every month. A subscription, costing only four dollars, brings 12 issues to you.*

Among Our Contributors

H. Barjot

DR. BARJOT of the faculty of the University of Bordeaux has been an attaché on the staff of the great Belgian mining company in Africa, the Union Minière du Haut-Katanga, which, although a young concern, has the world monopoly of radium production and whose copper production bids fair to lead the world. When his Arctic power project was submitted to the French Academy of Sciences, the president of the Academy, M. Lecornu, discussed it favorably before the Institute of France, pointing out its economic importance for the future.

Carl G. Hartman

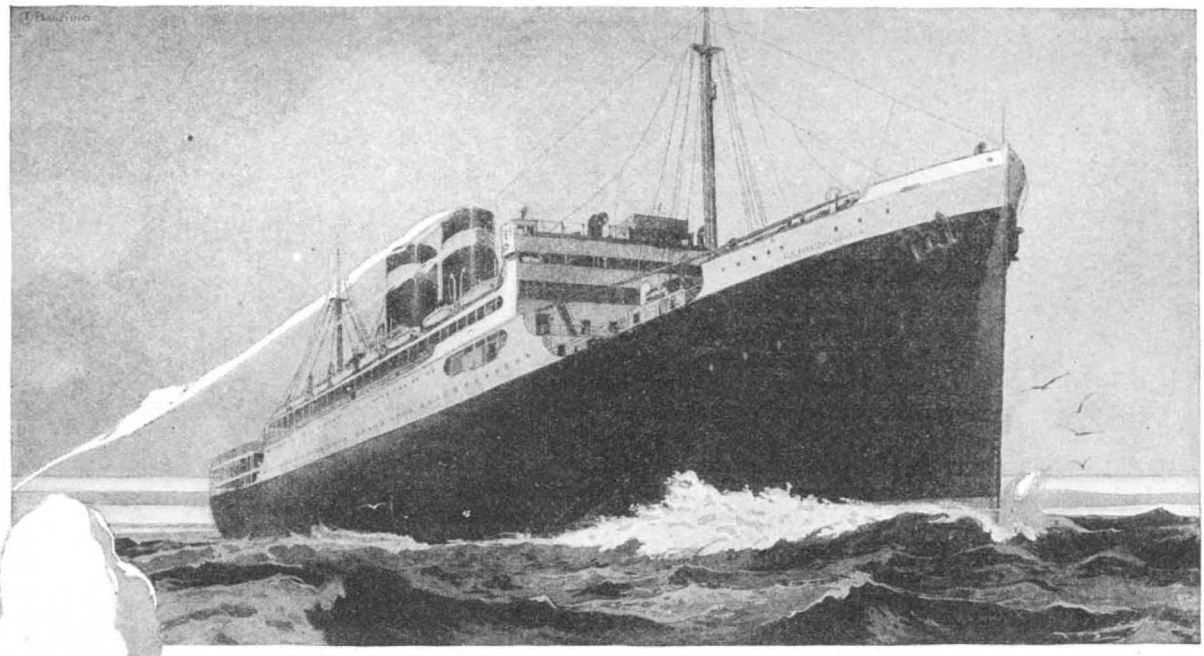
DR. HARTMAN of the Carnegie Institution chooses to do advanced research in embryology at Johns Hopkins University. He is a Texan, and his past research has involved studies of the habits of solitary wasps, the embryology of the 'possum, and the physiology of reproduction. Most of these researches are of a nature to arouse defense mechanism in the minds of some people but Dr. Hartman believes in calling a spade a spade when by so doing he can demonstrate scientific truths.

Peter V. Karpovich

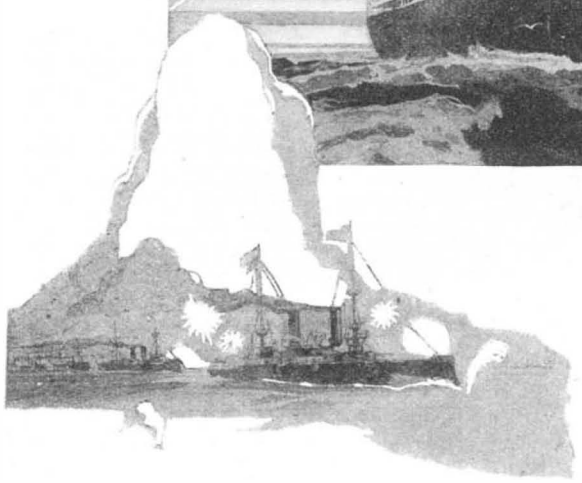
NOT content to accept old theories relative to the speed and efficiency of swimming strokes, Professor Karpovich preferred to determine facts. With his ingenious Natograph, he has already upset some old beliefs and it is possible that his further researches may revolutionize certain phases of physical education teaching.

R. W. Wood

PROFESSOR WOOD, of Johns Hopkins, is a widely known figure in the world of physicists. His work consists mainly in experimental rather than formal teaching. The number of interesting researches he has led—such as submarine location (during the World War), mercury telescope mirrors, exposing of Blondlet's famous, or rather infamous, "N-rays," the super-sonic ray (the "death ray" of sensational periodicals)—are almost unlimited. He works on things that are intrinsically interesting and he makes them extrinsically more so.



The combined tonnage of Admiral Dewey's fleet in the battle of Manilla Bay was 19,000 tons—less than the tonnage of the *Pennsylvania* or her sister ships, the *California* or the *Virginia*, the new electrically driven ships in the service of the Panama-Pacific line.



BIGGER than Dewey's whole fleet

BUILT not for war but for peace, the 35,000-ton *S. S. Pennsylvania* is not only bigger than all the ships of Dewey's heroic squadron put together, but more efficient than any of them. Her 17,000-hp. motors have enabled the *Pennsylvania* and her sister ships, the *California* and the *Virginia*, to cut the coast-to-coast schedule of the Panama Pacific line to thirteen days, and have set a new standard of noiseless, vibrationless ocean travel.

General Electric engineered and built the electric equipment of these magnificent new vessels. Other General Electric research scientists and engineers are doing equally important pioneer work on land and for the new traffic of the air. The G-E monogram appears on thousands of electric products and appliances as a symbol of research, an assurance of advanced electrical correctness, dependability, and service.

FOR THE HOME—General Electric and its associated companies manufacture a complete line of electric products and appliances, including G-E MAZDA and G-E Edison MAZDA lamps, G-E refrigerators, G-E fans, G-E vacuum cleaners, G-E wiring systems, Edison Hotpoint ranges, percolators, toasters, and other Hotpoint products.

FOR INDUSTRY—Several thousand electric products and appliances including generating and distributing apparatus, motors, electric heating apparatus, street lights, floodlights, traffic lights, airport lights, Cooper Hewitt lights, X-ray equipment, motion-picture apparatus, electric locomotives and equipment, street-car equipment.

GENERAL ELECTRIC

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

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SCIENTIFIC AMERICAN

March 1930 *ORSON D. MUNN, Editor* *Eighty-sixth Year*

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.

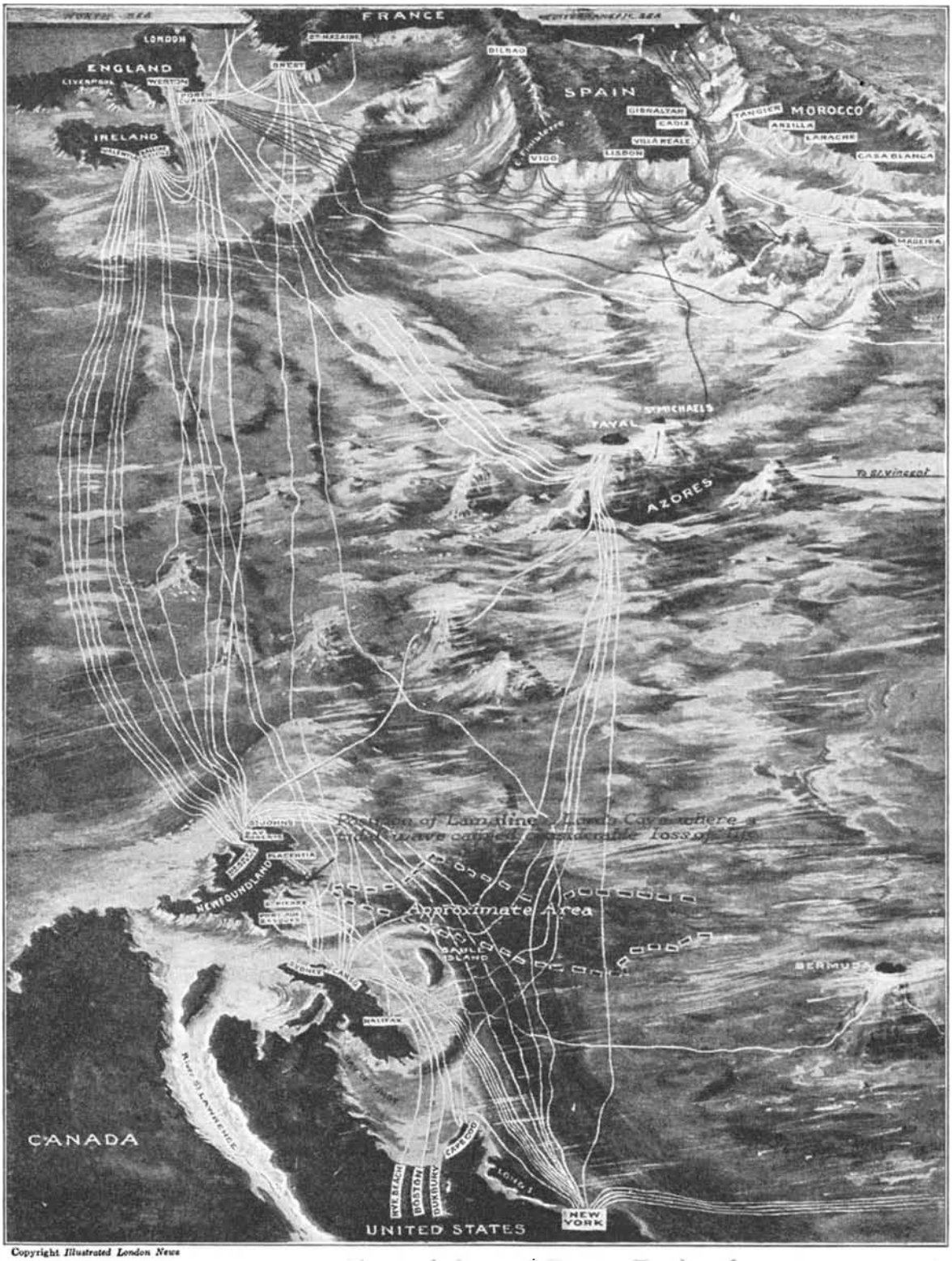
IN THIS ISSUE

COVER

In the design from which our cover was painted by our artist, Howard V. Brown, the noted architect Francis Keally brings the airport to the city or, to be exact, redesigns a great city around its airport. He has visualized a circular airport over a mile in diameter with space for hangars, mooring mast, hotels, et cetera; a wide park to surround the landing space; and streets radiating from the airport. Mr. Keally advocates the pneumatic tube mail delivery system outlined in our article on page 210, and predicts that this method of expediting mail and express to and from the landing platform will be incorporated in important airports of the future.

Prince Louis-Victor De Broglie

TO Louis-Victor de Broglie, brilliant French physicist, younger brother of the X-ray physicist Duc Maurice de Broglie, is due the credit for first suggesting the new concept of the wave atom. Since his first publication of this revolutionary concept, it has been widely and frequently discussed throughout the world of science. Other capable workers, notably Schrödinger of Germany, G. P. Thomson of Scotland, (temporarily lecturer at Cornell University), Rupp of Germany, and Davisson and Germer of America, have taken it up and extended it until there is now a large literature, mostly abstruse, about the wave atom. For his original suggestion de Broglie has just been awarded the 1929 Nobel Physics Prize. What de Broglie did was to synthesize brilliantly some of the main concepts of physics which previously seemed contradictory. His hypothesis, as stated by the American physicist Heyl, "was that every mass-particle was enveloped and surrounded by a group of waves traveling with the particle as a sort of body-guard." Thus electrons, the fundamental basis of matter, have some of the qualities of particles and some of the qualities of light; matter becomes more shadowy, less material, and light more material, suggesting a kind of "merger" of previous concepts. The scientist de Broglie is also a nobleman. He was born in 1892. His great grandfather served in the War of the American Revolution as Gen. Lafayette's chief lieutenant.



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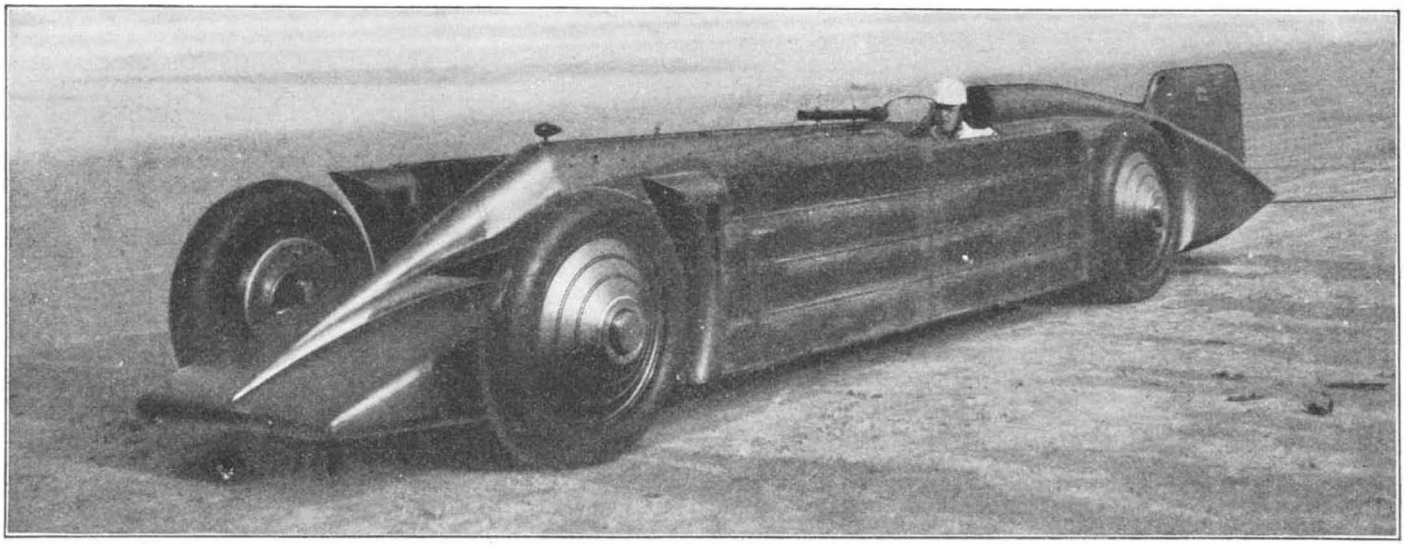
Submarine Cables and Area of Recent Earthquake

NEWSPAPER readers who were justly not satisfied with current, hasty explanations of the Newfoundland submarine earthquake will take interest in accurate data, necessarily delayed but dependable, communicated to the British scientific journal *Nature* by the noted Scottish geologist J. W. Gregory. The cable companies located 23 breaks in 11 cables. Plotting these accurately on a map, Professor Gregory saw that they were not haphazard but occurred in two north and south rows averaging 115 miles apart. New soundings between these rows showed that the sea bed had there actually dropped as much as 1710 feet, creating a great submarine trough. This is a new extension of the trough already existing between Newfoundland and Canada. Doubtless the rows of cable breaks mark two geologic subsidence faults.



PRESENT HOLDER OF THE WORLD'S SPEED RECORD

Designed and constructed abroad for the purpose of establishing a new world's record on the beach at Daytona, Florida, the *Golden Arrow* fulfilled its mission by raising the recognized speed record to 231 miles an hour. Sir Henry Segrave is shown in his famous car

400 Miles an Hour?

Far Greater Speeds Than Any Yet Achieved on Land Are Predicted by Sir Henry Segrave

By G. H. DACY

AUTOMOTIVE racing cars which will travel so fast that the human eye will be unable to record their passage are mechanical eventualities — speedsters on land which will outrival the swiftest aircraft that have been designed for cruising among the clouds.

That, at least, is the prediction of Sir Henry Segrave, owner and driver of the world's fleetest automobile, the spectacular *Golden Arrow* which was powered to attain a maximum speed of four miles a minute and which was timed at Daytona Beach at the unparalleled velocity of 231 miles an hour.

"What limit automotive speed?" was the question which the writer put to Major Segrave during a recent interview.

"THERE is practically no limit to the motor racing speeds which will be attained eventually," he replied, "provided that suitable speedways are available."

"Five hundred miles an hour?"

"That would make an astonishing lead for your story, now wouldn't it," Sir Henry countered, " 'Segrave says speed of 500 miles an hour possible.' I will not, however, qualify my statement by stipulating any limit to the future motor racing speeds. I am sure that the existing records are far below the marks which will be registered in the years to come."

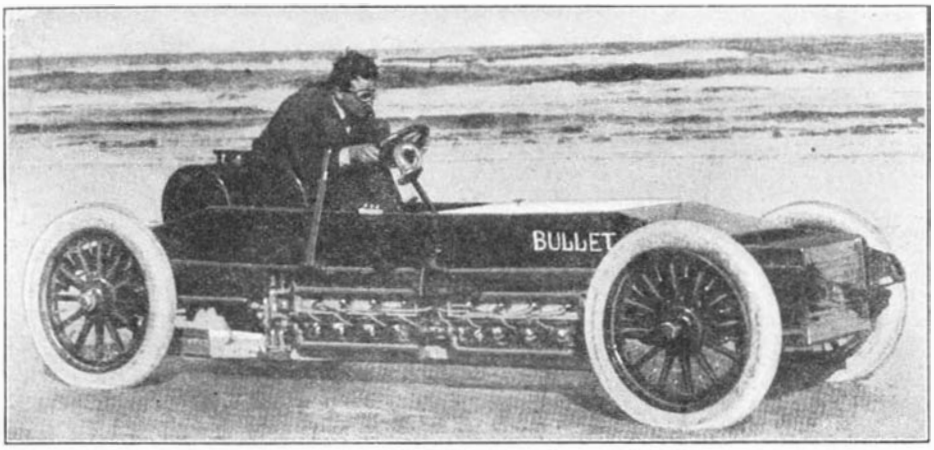
"Master all phases of aerodynamic resistance," continued the former Ace, "as this is the salient factor which must be conquered in the consummation of thrilling flights in automotive vehicles on land, and our racing records will get better and better year by year. Improving the mechanics of motor cars for the attainment of ever-increasing speeds is easily possible. Even today, experimenters are able to build automotive power plants which will develop such amazing speeds that there are no speedways safe for the testing of such machines at peak velocities. We can now build machinery qualified to turn at more revolutions per minute than such mechanical parts ever moved previously.

SIR HENRY SEGRAVE

"Among other problems which must be solved before future cars are perfected and raced, at speeds faster than the velocity of the most devastating hurricane, are those which may appear to be insurmountable but which can be answered if enough technical research and money are devoted to such purposes. One need is the provision of either a natural or artificial speedway which will permit of time-trials at speeds of five miles a minute and faster. Such a course must be both smooth and compact. Daytona Beach, for example, would have to be lenthened considerably and measurably improved for such amazing trials against time. Car design must be improved so that air resistance is reduced to the minimum. Tires, either of rubber or some better material, will have to be constructed which will resist the disruptive action and tremendous heat of terrific speeds."

To most of us who drive automobiles, and feel as though we are flying when we travel at the rate of a mile a minute, the predictions of the famous English aviator and sportsman sound almost incredible. Yet a review of the records in racing automobiles against time from the dawn of the sport in this country up to the writing of this article endorses Sir Henry's presages. Scan the ever-mounting records at Daytona Beach, the Indianapolis Speedway, and other national and international rendezvous of racing if you doubt this.

A certain W. J. Morgan, who chaperoned the first American bicycle racing team to Europe, is really the father of automotive time-trials in these United States. Mr. Morgan gained the cooperative aid of W. K. Vanderbilt, A. F. Vanderbilt, Howard Gould, and John Jacob Astor and introduced motor racing at Ormond and Daytona Beaches, Florida. The historic Vanderbilt cup races were a



ESTABLISHING A RECORD IN 1903

Alec Winton driving the *Bullet* at the record speed of 69.18 miles per hour. This achievement, made at Daytona Beach in 1903, stimulated great interest in automobile racing

result of those early efforts to establish record speeds on "cushions of air."

Henry Ford, who was then an ambitious mechanic endowed with meager financial assets but aflame with the automobile racing urge, eventually came to Ormond with his homespun racer, notable *999*. Mr. Ford had expended most of his funds in the building and equipping of his "gasoline chariot." He was unknown in motoring circles. It was with great difficulty that he procured on credit fuel, oil, and other supplies for his racing machine. He never established any remarkable records at Daytona Beach although the story goes that in one of his speed trials, Mr. Ford equaled the one-mile time record of 39 seconds made in 1904 by Alfred Vanderbilt driving a Mercedes—a velocity equivalent to 91.8 miles an hour. In this feat, the body of *999* failed and Mr. Ford was forced temporarily from the racing game.

AN EARLY MERCEDES

With this car, Alfred K. Vanderbilt established a new record in 1904, by traveling a mile in only 39 seconds

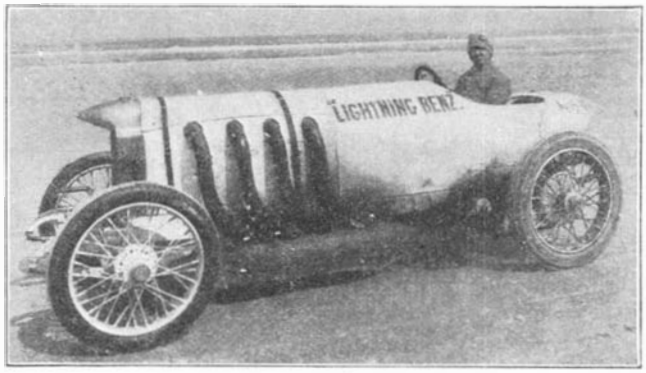
VICTOR DEMOGOET, a French driver of a Deracq car, two years later increased the Daytona speed mark to two miles a minute by covering that distance in 58 4-5 seconds. Several years later, Frank Mariott piloted his Stanley Steamer over the same course at the gait of one mile in 28 1-5 seconds.

"Speed, speed, and more speed," was the demand of the rapidly developing automobile industry. Cars were shipped from all parts of America and Europe to the Florida beaches where drivers dared death in exciting efforts to shave fractions of a second from time marks. Some of the pilots risked their lives in pre-sunrise races against time. Roaring, gas-actuated vehicles of wood and steel hurtled through space, challenging the wind's maximum velocity and the efforts of their rivals to surpass their thrilling speeds.

The beach at Daytona, composed of disintegrated coquina rock and ordinary sand, wave-rolled and water-packed, defies duplication as a natural motorway. It is so compact when the tide is out that race horses develop pavement soreness when run there. Early attempts to popularize horse-racing on that beach failed because all the equine sprinters soon became crippled due to the hard track. Rubber tires have absorbed the concussions which wrecked four-legged horsepower and as a result the endless story of speed conquests is being written in serial form.

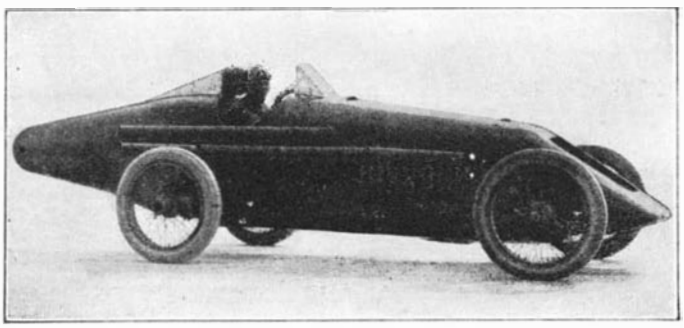
Ralph De Palma piloting a Packard in 1919 drove 10 miles in four minutes 9.31 seconds and subsequently lowered the mile mark from a standing start to 38.8 seconds. The following year, Tommy Milton driving a Duesenberg did even better by negotiating one mile in 23.07 seconds, five miles in two minutes 0.4 seconds, and one half a mile in 11.57 seconds. Milton's fastest speed was at the rate of 156.4 miles an hour. Subsequently, Joan Lacoste, a venturesome woman driver, drove a Miller at a gait of 144.65 miles per hour which still stands as the speed record established by her sex.

It was Sig Haugdahl crouched low at the wheel of his *Wisconsin Special* who ushered in the new era of speed at Daytona Beach. Haugdahl was timed in 1922 by officials of the International Motor Contest Association at the then almost unbelievable speed of 180.27 miles per hour, slightly better than



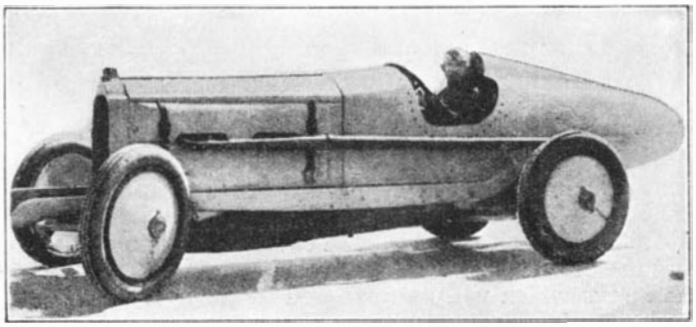
BARNEY OLDFIELD

Driving *Lightning Benz* in a competitive race with Alfred K. Vanderbilt, the famous Barney Oldfield won one of the first of his many racing victories



TOMMY MILTON IN A DUESENBERG

In 1919, Tommy Milton introduced a new era of speed, when he drove this Duesenberg 156.4 miles per hour on Daytona Beach



RALPH DE PALMA DRIVING A PACKARD

New records for various distances ranging from five to 20 miles were made in 1920 by Ralph de Palma, driving this Packard

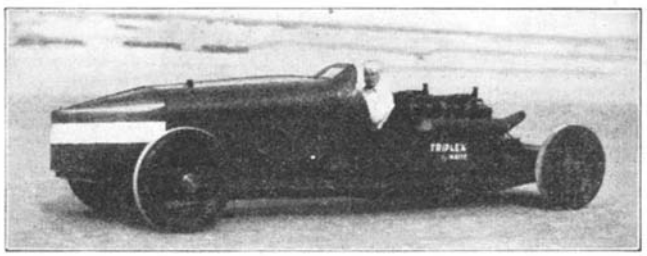
three miles a minute. A lull in racing records occurred until Major Segrave first visited Daytona Beach with his *Sunbeam Special*. A few days later, the former British birdman raced against electric timers at a speed of 203.79 miles per hour. He was the pathfinder among modern motorists who drive at velocities three times faster than express trains.

Then followed another Englishman, Captain Malcolm Campbell, winner of the Paris Grand Prix motor race over a cross-county course of 276 miles. Captain Campbell, seeking the crown worn by his countryman, unloaded his *Bluebird Special*, tried out the course and shortly shattered the record by covering a carefully measured one-mile stretch at the terrific pace of 206.95 miles an hour. Shortly afterward, Ray Keech driving the White *Triplex* increased the time trial mark to 207.55 miles an hour. During one of these trials, the tachometer in the White car showed that the machine was traveling at a velocity of 253 miles an hour. Over the same course, Frank Lockhart drove to his death. Officials estimated his speed at 235 miles an hour when his tires exploded and the car dove 15 feet into the air and 50 feet out to sea.

TIMING DEVICE

Speed trials on the beach at Daytona are clocked with this electrical timer

During the 25 years from the Alfred Vanderbilt record of 91.8 miles an hour to the acceptance of Sir Henry Segrave's mark of 231 miles an hour, the speed of the finest racing automobile has been increased 139.2 miles an hour. If this achievement is duplicated during the next quarter century, it will mean that the champion racing driver of 1954 will set a record of at least 370.2 miles an hour, better than six miles a minute. Sir Henry, who knows more about the design, operation and, driving of high-speed motor cars—both from theoretical and practical standpoints—than any other living driver, believes that a speed of approximately 400 miles or faster will be a reality within perhaps the next decade.



THE TRIPLEX

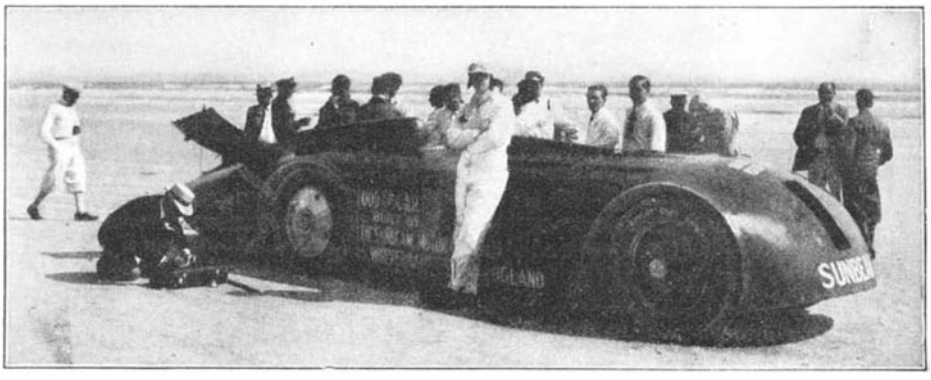
This ill-fated racer once placed the world's speed record at 207.55 miles an hour, with Ray Keech driving

SIR HENRY SEGRAVE maintains that with the eventual building of superhighways in the United States, and with future perfections of the ordinary motor car, American motorists will travel at speeds of from 100 to 150 miles an hour during their cross-country tours with as great safety as they now journey at 45 miles an hour. He says that at present there are ten makes of cars built in England which can do 100 miles an hour or better on present tracks and the finest roadways.

The motive power for potential passenger cars which in many respects will resemble the famous *Golden Arrow* is merely a matter of mathematics and is the easiest problem of all to solve in speeding up America's traffic streams. Both state and federal agencies have reacted favorably during recent months to higher speeds in the open country. California, for example, has abolished speed laws and leaves it to the individual driver to determine what speed is safe for his car and associated traffic. Research is ascertaining what special hazards are to be avoided at great vehicular speeds and thus is eliminating the dangers from future cross-country velocities of more than 100 miles an hour.

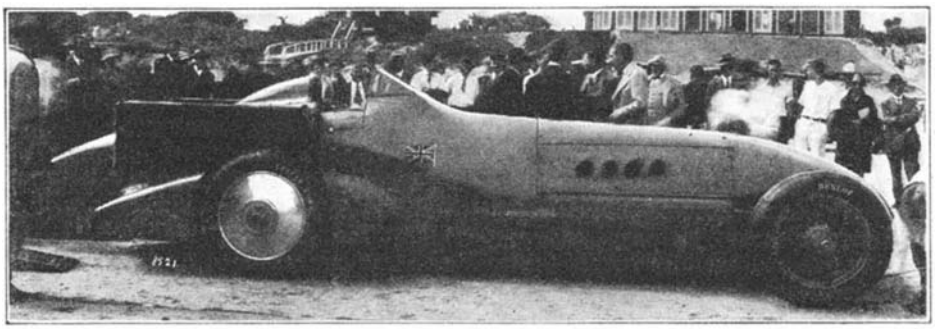
Sir Henry says that many improvements still remain to be made with regard to the aerodynamics of racing automobiles, as well as those of the passenger cars which eventually will be designed along similar lines. The future will see a much lighter-powered machine surpass the record of the *Golden Arrow* simply because experimenters will improve its aerodynamical features. Even today, the research experts of the National Advisory Committee on Aeronautics are experimenting in the wind tunnels at their Langley Field (Virginia) laboratories with velocities up to 1000 miles an hour. Their remarkable tests indicate future airplane and automobile speeds from three to five times greater than those which now prevail.

With the inevitable advances in road construction and in the mechanical perfection of automobiles, who can say what the harvest in the way of new speed records will be in the next quarter century?



SEGRAVE'S *SUNBEAM*

For his first American tests, Segrave used the *Sunbeam*, shown at the right



CAPTAIN CAMPBELL'S *BLUEBIRD*, FORMER RECORD HOLDER

For a short time, this English car held the world's speed record, at 206.95 miles per hour

OUR POINT OF VIEW

Science Awaits

WHETHER or not the general reading public is to believe that Professor Dayton C. Miller, the physicist who during several years past has been re-performing at Cleveland and Mount Wilson the famous Michelson-Morley ether-drift experiment and obtaining with uniform consistency indications of an actual ether drift and hence the existence of an ether, is out to "get" the Einstein theory of relativity which dispenses with an ether, seems to depend upon what it reads. If one could safely depend upon all he saw in the newspapers, and especially in newspaper headlines, Miller, driven by some animus, had about succeeded at last in hamstringing Einstein.

Quite a large section of the public has apparently become somewhat "steamed up" about these things and the Einstein—anti-Einstein battle has again taken on new life. We can think of no corner of science which seems to stir up as much high-pitched emotion as the Einstein theory. People for the most part are all for it or all against it; there is no middle course. It would seem that the most redoubtable defenders of the Einstein concepts come not from the ranks of the professional scientists but from the lay public; and likewise its most bitter and tenacious opponents.

One who goes habitually among professional scientists will not, however, meet with a comparable temper. There, instead of taking the matter in high gear, there is a marked disposition to take it in low. Perhaps scientists, or at least physicists and astronomers, the scientists most closely involved, realize a little more fully than others that the Einstein theory will not be settled finally one way or the other either by the research of any one man or two men, or even ten; or in one year, or two years, or ten years. Instead, a long slow pull is ahead and these men propose to take it in low gear. Animus, prejudice, personal feeling and, in short, any kind of emotion whatever is wholly contrary to the method of science. Let the layman if he wishes become overwrought about the reasonableness or unreasonableness, the demonstrability or sheer ridiculousness of bent space and similarly bizarre Einsteinian concepts; a good scientist will divest himself as completely as a Supreme Court Justice of every shred of such impediment.

Of all scientists there are two who give perhaps more clearly than any others the impression of living up to the scientific ideal—the search for truth unprejudiced—and these are Einstein and Miller. Let a world of blind admirers and enraged detesters of a theory beat the air with superheated syllables, Einstein serenely smokes his pipe and says "If Professor Miller's research is confirmed, my theory falls, that's all." And Miller, standing before his assembled peers in science, is almost apologetic about his findings but indicates that there they are. He has followed the lead of experiment, the only lead worth following. No wonder he receives a hearty handclasp from all men of science.

For misleading the public about the Einstein theory, first with regard to its alleged full acceptance by scientists and then with its alleged disproof by Miller, the popular writer is mainly to blame, for he too frequently presents snap judgments and half truths. Science itself takes neither course; it awaits. That is why this journal has published so little about the Einstein theory in recent years.

Rioting for Science

SINCE the world-famed trial of a Tennessee professor several years ago for teaching the theory of evolution, science has made great forward strides both in achievement and in the amount of serious interest it has aroused. But no one was surprised more than the scientists themselves at the scene enacted recently in the American Museum of Natural History, New York City, when a mob of 3500 to 4500 men, women, and children attempted to gain admission to a small hall in which was to be shown a moving picture concerning Einstein's theory of relativity.

Surging and seething around exhibits of the Alaskan Eskimo and the North Pacific Indian —canoes, totem poles, walrus tusk ornaments, kyaks — the swarming knowledge seekers were oblivious to these exhibits of which they already were informed and pressed on toward their objective — the higher knowledge of modern scientific theory. Theirs was no apathetic interest but a determination to learn. And while their rioting was undignified, perhaps, the mere fact that they did riot indicates that the popularization of science is now getting a stronger hold on average people. They *were* average people for they evidenced the psychology of the mob.

In the face of such facts, can skeptics continue to scoff? We think not. We believe that even the hard-shelled ones will begin to see the light, will begin to understand that despite dogma, superstition, and in-bred tradition, the appetite for scientific knowledge is becoming keener every day. SCIENTIFIC AMERICAN'S task of interpreting and popularizing science is, therefore, far from hopeless—except, of course, in the case of Voliva, dictator of Zion City, Illinois. We never hope to prove to his satisfaction that the earth is a sphere—but then, who wants to argue with him or his kind!

Bad Bargains

IN parts of the country where spring comes early, farmers and home gardeners are already buying seeds and doing their planting. In other sections, many thousands of people are poring over seed catalogs, fascinated by the size and colors of the fruits, flowers, and vegetables depicted there in all their glory.

Most of these people are experienced. For some of them, farming or gardening is a life work but for a lot of others these jobs constitute an avocation or a method of obtaining recreation and exercise. Yet despite their experience, many planters buy their seeds according to price. They are warned year after year to buy the very best seeds available and are reminded that cut prices indicate inferior seeds, the purchase of which is the poorest sort of economy. And yet many catalogs replete with alluring promises and splashes of color are published every year by unscrupulous dealers and have a wide circulation.

Therefore, for your own best interests, heed the perennial warning: "Don't buy bargain seeds!"

Increasing Game

A FEW years ago it was feared that the American buffalo, or bison, was doomed to extinction. Then the government took a hand and protected the few remaining specimens, with the result that herds are rapidly growing. Now comes the good news in an announcement of the Forest Service that large game animals, indigenous to America, are also showing an increase in numbers. To most people the figures, based on very careful estimates, will be surprising.

On December 31, 1928—the latest estimate available—deer on the broad expanses of our National Forests had shown an increase over the preceding year of 47,400, making a total of 748,000; elk increased from 74,200 to 78,-

200; and antelope from 7700 to 8500. On the date of estimate, black or brown bears totalled 52,200; grizzlies (including the Alaskan brown bear) totalled 3400; mountain goats, 19,300; and mountain sheep, 13,800.

These game animals have not been press-agented as much as our buffalo, to which a great deal of sentiment has been attached due to the important part it played in our history, but they are valuable nevertheless and certainly worth all the effort expended in their behalf. It is to the credit of the Forest Service, therefore, that it has undertaken to increase the supply of game animals—even to the extent of "planting" them in sections where they have been exterminated. And if it can devise means of increasing the number of moose, caribou, and mountain goats—the three important species which are hardly holding their own—the Forest Service will win the thanks not only of naturalists, nature lovers, and big game hunters but also of those sentimentalists who have a predilection for all early American things.

Our Limitation Conference Delegates

THE difficulties confronting the delegates attending the Conference on the Limitation of Naval Armament in session at London, are obvious to the most casual observer. It is never easy to reconcile the naturally ambitious aspirations of first-rate powers. The rôle of an envoy is always an unhappy one; if he abates too much of his country's claim he is assailed as unpatriotic; if he is too chauvinistic he prevents an international accord.

Our country has no traditional enemy or unsatisfied ambition. It is financially able to indulge in competitive naval building if that becomes necessary, but prefers to concentrate its energies in peaceful pursuits and well knows that its real interests will be furthered by an era of world peace. Nevertheless, the international situation is so complicated by the relations existing between other states, and Europe has such a heritage of conflicting ambitions, that our delegation will be taxed to find an agreement, satisfactory to all the powers, that will still safeguard our own legitimate interests.

Mr. Hoover has from the first been aware of these difficulties; his years abroad familiarized him with the unending struggle for foreign markets, scarcely suspected in some parts of our country; he knows that a desire for peace will not of itself keep a country out of war, and what he saw in Belgium under German control will not incline him to expose his country ever so remotely to such horrors. He has stated that he will not attempt to lead the world to disarmament by solitary example.

To confront and assist in overcoming these difficulties, Mr. Hoover has selected an extraordinarily strong delegation of civilians and has supplied them with able naval advisers. During the World War three of the civilian members—Mr. Stimson, Mr. Dawes, and Senator Reed—served in France in the American Expeditionary Force; Mr. Gibson served in the American Embassy at Paris; Mr. Morrow served on the Allied Maritime Transport Council. The presence of Senator Reed and Senator Robinson insures the Senate complete information on the proceedings, and the participation by Secretary Adams assures the country that the efficiency of the Department assigned to his care will not be unduly sacrificed. The following brief sketches of the personnel of the American delegation emphasize the careful selection exercised by our President, and we feel sure all Americans will wish them well in their efforts to find a proper solution to an ancient problem.

Mr. H. L. Stimson, the head of the American delegation, a New Yorker by birth, a graduate of Yale College and Harvard Law School, was a law partner of Elihu Root and, like him, served as Secretary of War before serving as Secretary of State. During the World War he served in France in the Field Artillery and earned his promotion to Colonel of the 31st Field Artillery in the field. He succeeded Leonard Wood as Governor General of the Philippines and carried on his work of rehabilitating the Philippine Government. Although a strong executive and frequently in conflict with Filipino politicians, Mr. Stimson quickly gained the confidence of the Filipino people and on his departure from Manila to become Secretary of State he was given a farewell ovation by the inhabitants of Manila.

Mr. Stimson belongs to that group of eastern Republicans most favorable to our entry into the World Court. There can be no doubt of Mr. Stimson's abilities to present America's just claims to parity; he is too wise to be imposed upon, and although this is his first large undertaking as Secretary of State, we venture the prophecy he will not let his natural desire to return home with an agreement lead him to make concessions that will be unacceptable to the Senate or the country.

Mr. Charles G. Dawes comes from the Middle West that boldly claims it represents the heart of America; he graduated in law only to become a successful banker and business man. He served on Pershing's staff during the World War and, as a member of the Liquidation Committee of the A. E. F., closed out the vast mass of unfinished business between the United States and France in one big bargain with the French in 1919. It was his spirited defense of the work of this committee before an investigating committee of Congress, that brought him nation-wide attention and added "Helenmaria" to the American vocabulary. He organized the Office of the Budget for President Harding, but soon turned over the job to General Lord and returned to his business.

But for his loyalty to Governor Lowden, he would have been a more formidable candidate for the Republican nomination for the Presidency in

(*Please turn to page* 246)

The Barjot Plan and a Greater North

TO the engineer and the practical man the Barjot power project described on page 196 will be seen to resolve itself directly into a question of economics and engineering installation. Its purely theoretical or scientific side is sound, being based on simple elementary physical laws; it takes advantage of a temperature difference. This, also, is the essence of a steam plant; heat is energy. In the Barjot scheme, however, the temperature difference is relatively small, but the volume of the "fuel" available is sufficient to compensate for it—far more than sufficient, in fact.

To some readers the apparent lowness or coldness of both of the temperatures involved in Dr. Barjot's plan, the low and the high, may seem to be an obstacle. It must, however, be remembered that the coldest arctic temperatures are not in actual fact low. What we human beings commonly think of as "low" and "high" temperatures have no such significance in science; they are merely relative to our own immediate criterion of hot and cold, the reports of our senses. Zero on our Fahrenheit scale is actually 459 degrees above zero on the absolute scale of temperature—two thirds of the way to the boiling point of water—and that is the only scale which has inherent sanction in fact. The rest are arbitrary; and misleading, also.

The Barjot plan bears close resemblance to the well known Claude-Boucherot plan for making use of the temperature difference between tropical sea water at the surface (80 degrees) and at the bottom (40 degrees). Both are fundamentally based on taking advantage of a temperature difference. Extensive application of the Claude-Boucherot plan would spread the industrial world from the temperate zones, where it is now centralized, to the tropics; the Barjot plan would spread it far toward the Arctic. In this connection one will recall the writings of the arctic explorer Stefansson, in which he has so often emphasized that the north will some day cease to be regarded as a vast arctic waste and become the object of a very active exploitation. Canadians should be especially interested in Dr. Barjot's article.

A Newspaper in the

The Solving of a Great Railroad's Smoke ing Feature in the Creation of a Huge

By ALBERT A. HOPKINS

THE MONUMENTAL BUILDING

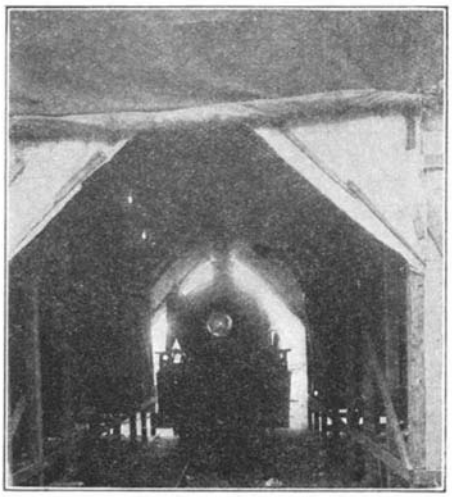
This huge building is built astride railroad terminal tracks. The smoke from the track area passes through vents into smoke chambers and is carried up a great internal chimney

CHICAGO needed to expand. That iron bound "Loop" held the business quarter in a vise. There was congestion and lack of space for growing industries. The freight tunnel helped to relieve the situation, but something more had to be done to give relief. What did Chicago do? They turned to their river, which was heretofore a hopeless nuisance upon which the city's back must be turned, and they found that it had other uses than as a receptacle for wastes and as a means of transportation of freight. The Wacker Drive development and the new Marshall Field Building on the main branch of the river, and the Union Station, the Civic Opera, and The Daily News buildings on the south branch all testify to the growing realization that the river is a civic asset of primary esthetic importance.

THE completion of the Daily News Building above the tracks of the Union Station group of roads and the rapid progress of work upon the Merchandise Mart above the Chicago & Northwestern tracks should serve to give a concrete object lesson relative to the hundreds of millions of dollars of value and income which railroad officials could produce for their stockholders by prompt action in making possible air-rights development above their terminal tracks. But what about the smoke? There did not seem to be much chance of electrification in the Chicago region, so this question became a very vital one.

The smoke problem was attacked and solved in an interesting manner by Mr. Joshua D'Esposito, a consulting engineer. Today the Daily News Building is an accomplished fact, but only because of a new departure in the handling of smoke and gas discharges from locomotives. One admires the symmetry of the beautiful building but does not realize that hidden away from general view are certain chambers, passageways, and stacks which are the agencies of the smoke control system. The construction engineers understood the value of air-rights, New York furnishing an excellent example, but there the smoke problem has been solved by electrification. Smoke-handling tests in Chicago began early in 1917 in a temporary shack in the coach yard of the Pennsylvania Railroad. The experiments involved great labor and cost much money, but they were successful in the end.

An expansion chamber was constructed above the vents in the test shack. The engineers found a valuable fact in that the smoke in the chamber expanded. Expansion decreased its density, made it practically as light as air, and consequently added a safeguard against its dropping through the entrance passageways. The system was entirely successful. The Daily News Building was accordingly built directly over the tracks and the locomotives belch smoke and gas freely. These waste products pass through vents in the roof to the roomy



THE EXPERIMENTAL SHACK

Smoke is being discharged into chambers in a shack where the problem was solved

ELIMINATING THE SMOKE

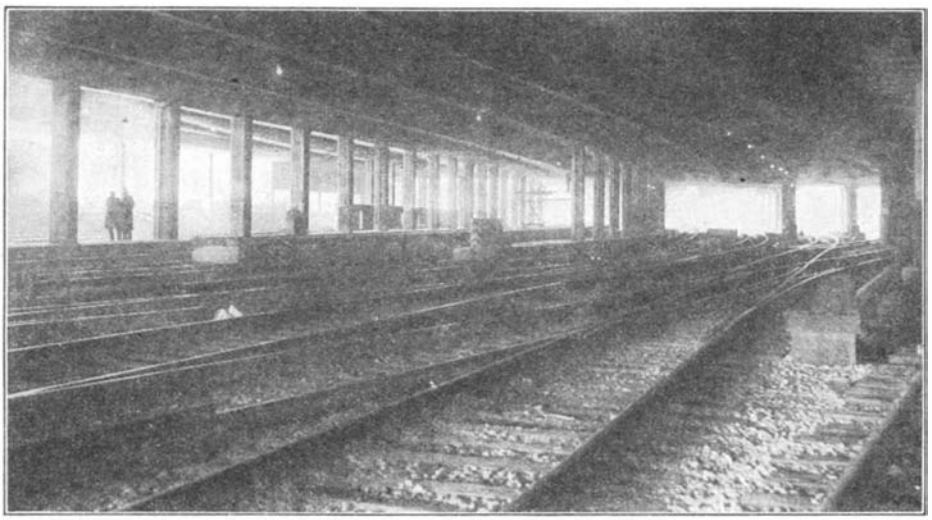
The smoke is drawn from the expansion chambers into a smokestack that mounts through the 25 stories to the open air. The great bulk of the solids is stopped in smoke chambers

Making

Problem Was a Strik- Newspaper Plant

smoke chamber which is as wide and as long as the track area. To be precise, this chamber consists of several divisions, as partitions have been built in it. The smoke is drawn from the expansion rooms into smokestacks that mount, through the 25 stories of the building, to the open air. The great bulk of the solids in the smoke are stopped and remain in the smoke chamber, to be removed later. Smoke emitted 25 stories up is as nothing compared with the same smoke emitted at or near street levels.

We need say little of the architecture of the building itself; it really has to be seen to be appreciated. It is one of the finest buildings in America and directly across the river and facing it is the new Civic Opera House illustrated in our February issue. The plaza, the bridge, the clocktower are all beautiful features. A fleet of speed boats take the visitor or the commuter via the river to the Wrigley Building on Michigan Boulevard in a few minutes.



MAKING AIR-RIGHTS POSSIBLE

The Chicago Daily News Plaza viewed from below. The grooves in the ceiling are the smoke vents which allow the smoke from the C. M. & St. P. engines to pass into the numerous smoke chambers directly over the track area, an excellent utilization of air-rights

The *Chicago Daily News* is one of America's great dailies, and while visiting the building the writer was so struck with the newness and efficiency of the great plant that it was determined to make the latter part of this article a brief description of the work involved in turning out a newspaper.

The *Chicago Daily News* was built up by Melville E. Stone and Vincent F. Lawson. Mr. Stone was for many years manager of the Associated Press and with Mr. Lawson as president

THE NEWSROOM AT WORK

In the foreground are the rewrite men. The city desk is shown at the right center and in the background are still other desks

THE BUSY "COPY" DESK

Reports of the doings of the teeming world, received by wire and written by the reportorial staff are all edited and head lined

WAITING FOR THE LAST LINE

The markets have closed and the editors have finished their work on the "Red Streak" edition. In a few seconds the closing quotations will be in type and then to press and the street. As this is an afternoon newspaper, great speed is necessary in handling financial news

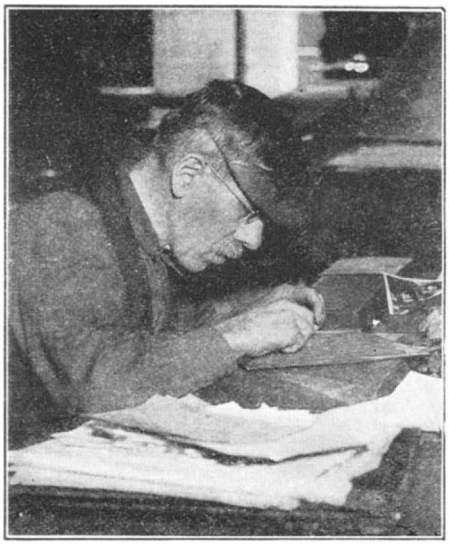
they helped to develop this great co-operative news gathering and distributing agency. A newspaper has been well defined as an organism with a synthetic soul. While habitually giving reliable information in the fullest measure, it must endeavor consistently to teach a sound philosophy of life. It must be fair, avoiding prejudice and prejudicial practices. In the broadest sense it must be a force on the side of human progress. The *Chicago Daily News* has always held public confidence. This is probably the reason why it has such a splendid building.

The old building at 15 North Wells Street was a ramshackle affair endeared to all those who were brought up in its atmosphere. For many years the talk of a new building had been the subject of many a joke. Site after site was considered and rejected. The

"WANT" ADS BY TELEPHONE
These alert girls take in "want" ads over the telephone for the classified advertising

development away from the "Loop," the construction of Wacker Drive, and the river straightening project all seemed to point to the necessity for a location where considerable space was available, yet one which was central enough for the receiving of news and for distribution of the printed newspapers. Therefore the site over the tracks next to the Union Station was finally selected.

A newspaper is an exceedingly complicated organization, particularly in the editorial end, and it requires great co-ordination. It will have besides the



AN EXPERT TOUCH
The foreman engraver has been putting finishing touches on plates since 1887

managing editor, an associate editor, news editor, art editor, editorial writer, literary editor, foreign news editor, the make-up editors, and special editors for sports, automobiles, aviation, financial, et cetera. These clever craftsmen all have their offices, but they lack the atmosphere of the newsroom, where are arranged the 45 desks of the city editor, the copy editor, telegraph and picture editors, the rewrite staff, and the reporters. A feature of the room is the specially designed copy desk which provides space for 10 copy

seconds elapse from the time the copy is written until it reaches the battery of linotype machines.

The composing room is 200 feet long and 80 feet wide. Here is installed a battery of 54 latest model linotype machines, besides other composing equipment. The composing room includes an engraving department and a matrix department, to name only a few of them. The room where the market reports are compiled is the scene of a daily fight against time. The quotations are hand set by

THE "HI-LO" ROOM
Priceless seconds are saved by putting market quotations directly into type. The girls read aloud from the unwinding tape and the compositors set type by hand. It is a mad rush

editors and their chief. Of course there is ample telephone service as well as pneumatic tubes for routing communications. Copy boys, the descendants of the printer's devils of yore, are arranged along the north wall of the news room, where they can respond quickly to the calls of editors and reporters. Directly in front of their station is a slot in the floor through which copy is dropped to the composing room so that only a few compositors receiving the dictation of girls who watch the swiftly moving tape. The entire composing room is floored with wooden blocks placed on end which rest rather than tire the feet. The ceiling is covered with sound-proof material which eliminates sharp and metallic noises.

The photo-engraving department allows for speedy production of both line and half-tone cuts. The newspapers are printed from curved stereo-

PHOTO-ENGRAVING
Photo-engravings, both line and half-tone, are important to the newspaper. Here the men are photographing, etching, and finishing. Newspaper cuts are made with incredible speed

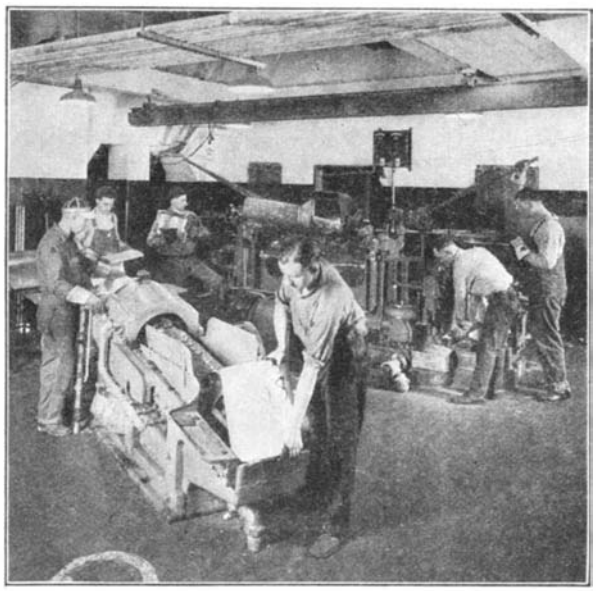
type plates which are made in the stereotype foundry. These plates go to the great presses which are of very special design. One would hardly expect any sentiment to prevail in the pressroom, but when the order for new presses was placed by the publisher, Mr. Walter A. Strong, he suggested that the old metal be used. Carrying out his wishes, R. Hoe and Company, builders of the new units, melted down the old iron castings and used the metal for the new presses and folders. The presses consist of 70 units. Each unit has a capacity of eight pages, and units may be made up in tandems of from two to 10, depending on the size of the paper to be printed. Presses are carefully insulated to avoid vibration. They are floated on a mat of cork which is laid on a concrete base and up the sides of the press pits.

A crane moves the rolls of paper from the hold of the vessel on which they are delivered and places them on a conveyor system which operates down a mammoth shaft to a point 40 feet below the surface of the river. As the paper reaches the bottom of the vertical shaft, it is rolled off on horizontal conveyors and travels under the Union Station property and the Chicago, Milwaukee & Pacific Railroad tracks until it is beneath the Daily News Building. Then it is automatically rolled off to a vertical lift where it ascends to storage space, or directly to the presses.

The paper in roll form is fastened on a roll in the press, its open end is smeared with glue, and as it is swung into place the open end flips over to the paper web going from the press and is automatically glued to it. The web from the old roll is broken and the new roll takes its place. It speeds through the press, being printed on both sides, and comes out on a folding machine where the individual papers are automatically cut apart, stacked and placed on the conveyor which brings them automatically to the binding machine which counts and binds them with wire into bundles of 25 or 50, depending on the size of the issues.

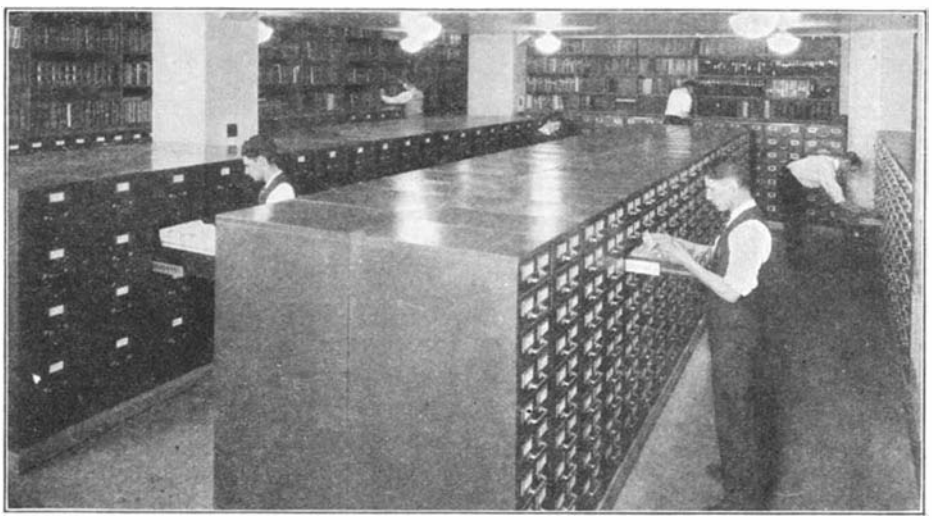
Some of the figures relating to the pressroom may be found interesting. The mechanical equipment cost approximately 3,000,000 dollars. For an 80-page paper, 2000 plates of type are cast in multiples for speed. Nine thousand pounds of ink are used daily and more than 100,000 pounds of melted metal are required each day.

Many of our pictures are self-explanatory, such as the morgue, receiving of classified advertising, et cetera. The *Daily News* equipment includes two airplanes and a fully equipped broadcasting studio, station WMAQ.



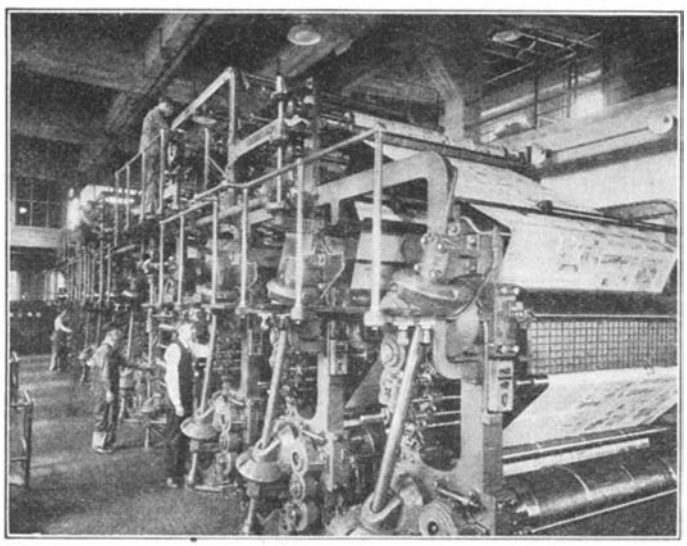
THE STEREOTYPE FOUNDRY ➤

Here the semicircular plates for the great presses are cast in wonderful automatic machines



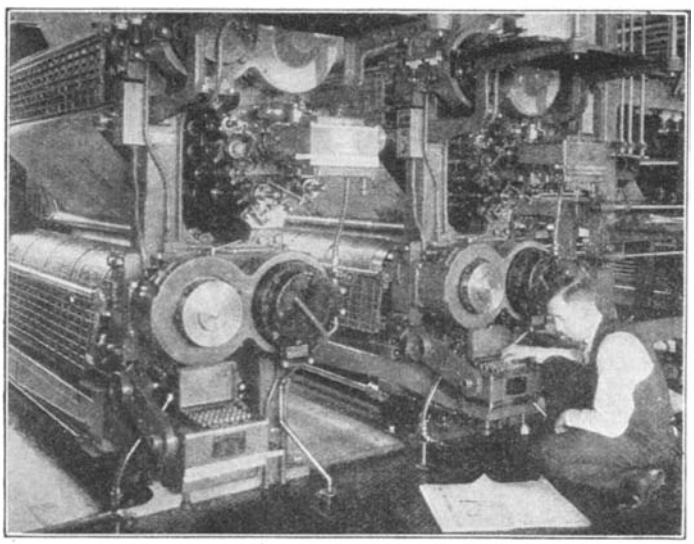
THE "MORGUE"

A million photographs, a million clippings, one hundred thousand negatives, form a part of the "morgue." It is easy to "look it up" here with such splendid modern equipment



CLICKING OFF THE "HOME" EDITION

The nine great presses have a capacity of 300,000 papers hourly. The complex machinery daily turns 300 tons of white paper into printed newspapers. They are the last word in printing machinery



A QUESTION OF INK

The proper distribution of ink is important. The superintendent of the pressroom is operating the ink-fountain supply regulator with a press-sheet before him to ensure even color distribution

Cameras, Airplanes, and a New Industry

The Story of an Inventor Who Developed a Hobby Into a Commercial Enterprise of International Standing

By MILTON WRIGHT

IN the history of American invention there are the names of plenty of poor boys who struggled over seemingly insurmountable obstacles to places of prominence. It almost would seem that lack of resources is one of the essentials of success.

Once in a great while, however, we find a man who lacks the advantage of having been born in humble circumstances, and who, in spite of that fact, makes an invention that founds a new industry. And when we do find such a man we have found one whose career it will be well worth while to study.

Consider Sherman Mills Fairchild. At 33 years of age he is one of the dominant figures in the aviation industry, being president of the Fairchild Aviation Corporation and a half-dozen subsidiary corporations, all bearing his name, as well as vice-president of the 200,000,000 dollar Aviation Corporation which he helped to organize. His companies control two airplane factories, one of which is said to be the largest exporter of cabin planes in America. Another of his companies makes all of the aerial cameras used by six governments, including our own. Another engages in making aerial photographs and surveys. And these, remember, are not enterprises that he bought an interest in, but enterprises that he founded himself and built up by hard work, business acumen, and perseverance.

"How did you come to start this gigantic business?" we asked him one day.

"IT probably was largely a matter of natural perversity," he replied. "My relations and friends thought I was just wasting my time on what they considered merely a hobby, so I just had to show them they were wrong."

"But how did you come to take up aircraft?"

"Oh, that was a matter of evolution. One thing led logically to another. Of course, we had to have our eyes open to see opportunites when they appeared, but then the aviation industry is full of opportunities."

"You started in aviation in the war, didn't you?"

"No, not exactly; let's say at the time of the war."

Elsewhere we learned that Fairchild had adopted several hobbies. One was interior decorating. Another was playing the piano. Today he has two pianos in his New York apartment and two in his country home at Centre Island. His favorite form of relaxation is playing duets with a certain well known composer and music publisher.

The one hobby that has determined his career—and affected, too, the development of aviation—is photography. Cameras are a means of achieving artistic effects, and Fairchild is artistic. Their use involves niceties and intricacies of mechanical operation, and Fairchild is mechanically inclined; in fact, he is a mechanical engineer.

When America entered the World War, he hurried to a recruiting office. However, the army surgeons who gave him a physical examination refused to let him into the army. They even told him that if he expected to be of any use to anybody, himself included, he had better start living in a high, dry climate. So Fairchild went to Arizona, while all the other fellows his age—he was 21 then—went to Europe.

But you know what Emerson said about building a better mousetrap and the world beating a path to your door through the wilderness. Fairchild, in Arizona getting back his health, worked away with photography. More and more the war news featured airplanes. Not only were planes fighting one another and raiding enemy positions, but, what was more important, they were the eyes of the army.

Here was where Fairchild could help—aerial eyes for armies—cameras for use in airplanes. And cameras were his hobby. He went to work and soon obtained some remarkable effects in clear, sharp, long-range photographs. They came to the attention of army officials in Washington.

FAIRCHILD was getting results that the army couldn't get with the apparatus they were using, so they ordered him to Rochester, where the facilities of the Eastman laboratories were available. He evolved a camera that the army found ideally suited to its purpose. Today Fairchild cameras are standard equipment of the United States Army and Navy Air Corps, the Royal Canadian Air Forces, the Brazilian Navy, the Argentine Navy, and the Japanese Imperial Army Air Service. Our own Army Air Corps specifies that substantially all airplanes now being built must provide for the installation of Fairchild cameras.

MAPPING THE EARTH FROM THE SKY

Typical aerial survey map, useful for realty development, taxation, and similar purposes. *In the oval:* Sherman M. Fairchild

"Just what did you do to perfect cameras for aerial use?" we asked Mr. Fairchild.

"Worked out the between-the-lens shutter," he replied. "If you will recall almost any picture of racing automobiles that you've looked at, you may remember how distorted the objects were and how uneven the illumination was. Those defects were due to the design of the shutter; you don't have them if the shutter is of the between-the-lens type, such as those used by the army.

"This kind of shutter, as we use it today, is adjustable to speeds of 1/50, 1/100, and 1/150 of a second. It is mounted in a metal cone attached to the camera body. The retard mechanism for varying the shutter speeds has to be positive in action and unaffected by changes in climate, for the army takes its pictures at high altitudes where the temperature is far below zero. We obtained a high efficiency

in opening and closing the shutter by having the retard mechanism function only when the shutter leaves are wide open; it is released before the leaves begin to close."

"But how did you step from cameras to airplanes?"

"The planes came later. The army wanted cameras, and so we started making them. We're still making them, developing new models, of course, all the time, for the art of photography is one of constant progress and development. Some remarkable results are being obtained. Only recently Captain Stevens of the army took pictures at a distance of 227 miles. [See page 127, February.]

"RECENTLY we received an order from the army for a machine gun camera; it looks and is operated exactly like a Browning machine gun, only instead of shooting cartridges, it snaps pictures which show the accuracy of the aerial marksmen. [See page 482, December 1929. Editor.]

"To develop aerial cameras we had to use them, and, using them, we came to see what a wonderful field aerial photography was for commercial and industrial uses. Towns could be surveyed for tax purposes, geological formations could be studied for the location of oil wells or gold mines, power sites could be laid out, real-estate developments planned, and the like. The hardest thing in connection with this was educating the public. Nobody had ever used aerial photographic maps and it was an uphill job to put them over.

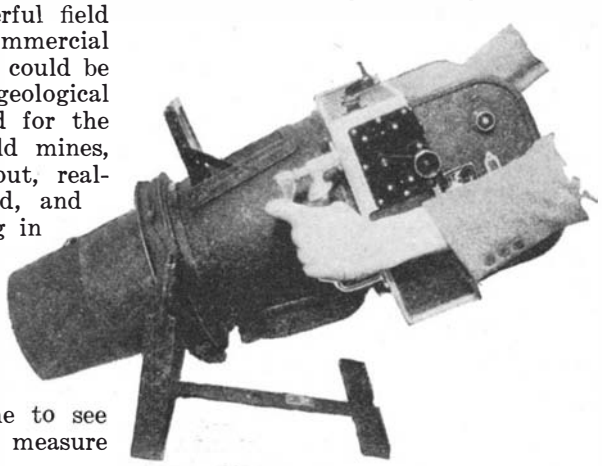
"As we did more and more aerial survey work we came to see that results depended in a measure upon the kind of airplane we used. A plane for photographic work ought to be stable and steady, comfortable, fast, and easily maneuverable. There was no plane that we considered ideal.

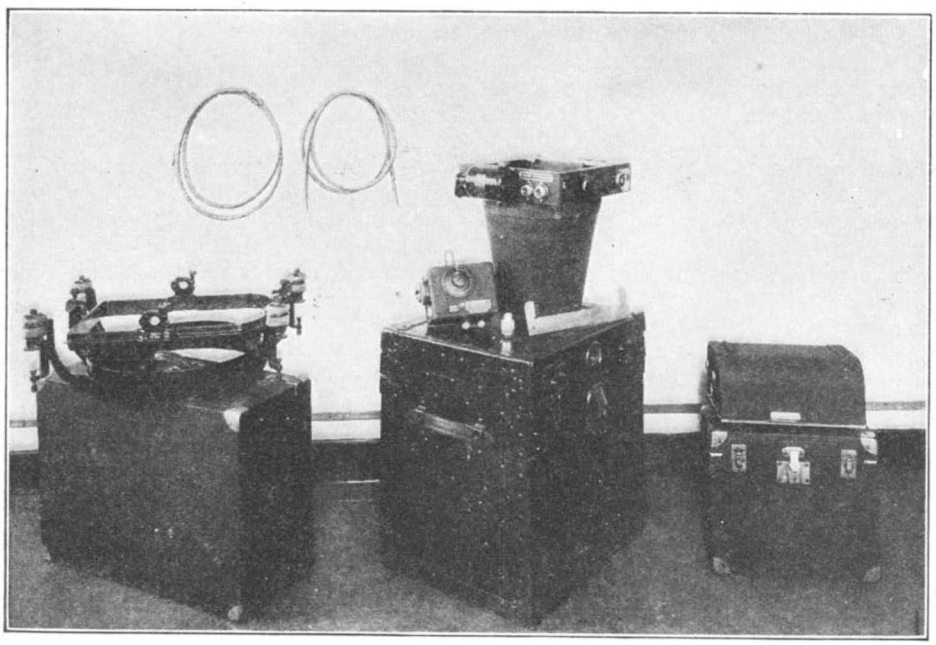
"We were down at Rio Janeiro equipping the Brazilian Navy with aerial cameras, when their officials asked us to get them a plane. This was our opportunity. We would sell them one that would incorporate our own ideas. We had another manufacturer make it for us. The Brazilian Navy liked it, but we could have done better if we had made it ourselves.

"We designed a new ship and built it. We entered it in the Ford reliability tour and it outperformed other ships in its class. Within a year we had sold several planes of that design to other companies who were engaged in the operation of aircraft or were manufacturing exclusively for the government."

"But how did you get a factory?"

"At first we rented the old Sperry Gyroscope plant at Farmingdale, Long Island. Later, as we grew, we bought land and began putting up factory buildings of our own. As business developed we kept adding to them."





EQUIPMENT FOR MAKING AERIAL SURVEYS

Aerial camera outfit, with swivel mount, intervalometer, and magazine containing 75 feet of film. *Above:* Camera assembled on swivel mount in position for mapping from high altitudes

MAKING AERIAL PHOTOGRAPHS

Photographic mapping from the cockpit of an airplane, with the camera in position

"But how did you come to go into a big combination of airplane companies?"

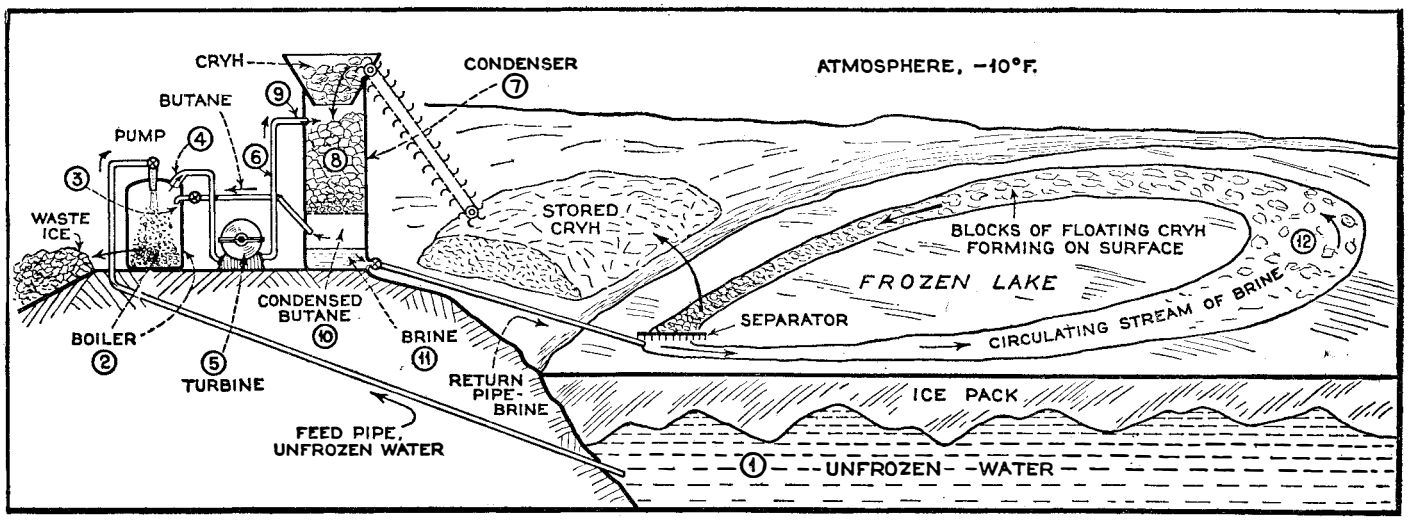
"This is the day of big combinations; especially is this true of the aviation industry. It is all very well for an inventor to start out in a small way and keep going by himself, but only up to a certain point.

"WITH the camera we had exclusive patent rights and the capital investment required was not enormous. When we got into airplane manufacturing, a small group of men was enough to provide all the funds necessary. Later, as we expanded, we enlarged our group of owners. Then came the day when we saw the need for a sort of 'General Motors' of the air. We organized the 200,000,000 dollar Aviation Corporation, with the Fairchild Aviation Corporation as its manufacturing unit. Other combinations were forming, and we had to do it, too, not only as a defensive measure, but as a means of contributing to the advancement of aviation."

"Do you still do much inventing yourself?"

"Not a great deal now; there are too many other things to do. I probably have had 50 or 60 patents issued in my name, but nowadays the design of airplanes and engines has become so highly specialized that we retain the best engineering talent we can find. The inventor may be all right for supplying fundamental ideas, but in a highly technical field like aerodynamics you want a highly trained specialist—a scientist.

"Then, too, you must remember that after you reach a certain stage of development, your job is not alone one of inventing, nor even of manufacturing. You must know the whole field in which you are operating, you must read in the activity of today the developments of tomorrow, and you must organize your forces accordingly."



A DIAGRAMMATIC LAYOUT OF THE PROJECTED INSTALLATION

The numbered details are listed in the text and will be better understood if left until their description is reached. It would be well, however, to take note of the main features, the feed pipe and the source of its supply beneath the ice, also the return pipe above it

Power from the Heat of Arctic Waters*

Energy Outrivaling That of the Niagaras May Be Recovered in the Far North. Will the Frozen Wastes Become an Unlimited Source of Wealth?

By DR. H. BARJOT, H.M.R., University of Bordeaux.†

POWER is synonymous with progress and civilization. History proves this assertion. The white man leads the world today because, through invention and the possession of a scientific mind, he has been able to harness coal, water power, and other sources of energy, and thus to adapt the forces of Nature to his own ends. Other races, unable to do the same thing, remain in a backward social condition.

Slavery was due to the lack of power. The Roman mill could be kept turning only by a human motor—by a slave who might even be blinded in order to increase the efficiency of that engine. The same cause, the lack of power, will account for the social inequality of the Middle Ages; only a comparatively small privileged class could live on the luxuries provided by the labors of all the common herd.

The invention of the steam engine, more than any other factor, has changed this situation, liberating man through the products of the machinery it drives, and enabling more people to devote time to intellectual and spiritual pursuits. The discovery of a new source of energy, more than any other fact or social theory, brings about human progress.

In the final analysis, power, whether it be provided by animals or engines, has its origin in the sun's heat. But heat can not be turned into power at will. True, the greatest law of thermodynamics, Carnot's Law, tells us that power is generated by a thermal machine only by a drop in temperature from high to low, just as water turns a wheel only when falling from a high level to a lower one. In more common language, "cold," a relative degree of cold, is as necessary as warmth for getting mechanical energy from heat.

WE now obtain most of our power from coal and petroleum, because their combustion gives very large differences of temperature. But several centuries hence when our reckless consumption of coal has totally depleted our fuel reserves, and no more heat is available through combustion, we shall have only natural differences in temperature left to use. The hoped-for release of "intra-atomic" energy now appears to be quite impossible, or at least difficult. So the problem of finding new sources of power amounts to finding temperature differences in nature, no matter how small they may be, provided the respective hot and cold sources have large enough values to make up in quantity what they lack in quality. That possibilities of this kind are more important than was previously suspected has been demonstrated by the well-known scientist Georges Claude who recently showed that a 100-horsepower turbine could be kept running with a temperature difference of only 18 degrees Fahrenheit, at Ougrée in Belgium. Thus this project has already entered on practical possibilities.

Such natural sources are rather rare but such a source, outstanding in total magnitude, exists throughout the year both in the arctic and the antarctic; it also occurs in sub-arctic regions in winter time. These immense sources of energy are the basis of our power process. This process has already been outlined before the French Academy of Sciences.

We think of the arctic primarily as cold, but this is only because we customarily deal there with the atmosphere, its temperature being very low—about 40 degrees below zero. But by comparison with the atmosphere the big bodies of water in the arctic—the sea, rivers, and lakes—under the ice remain always unfrozen and their temperature is therefore above 32 degrees. This, when compared with the arctic atmosphere, is warm. The anomaly is due to one of the physical properties of ice—it is a splendid insulator of heat. Thus it prevents the leakage of heat from the water beneath it to the much colder atmosphere; provided, of course, it is thick enough. One recalls the "igloo" of the Eskimo where, under cover of ice walls, comfortable refuge can be taken from the most intense cold.

The heat thus retained in unfrozen water is enormous; it corresponds, in fact, to the latent heat of solidification,

* See editorial on page 189
† See "Among Our Contributors," page 181

and thus one cubic meter of water when freezing can liberate the same amount of heat as the combustion of two gallons of petroleum. Such a form of heat can be utilized in the arctic because the atmosphere is cold enough and because this cold makes available an immense amount of potential energy which can be utilized to generate power. It has been proved, in fact, that with a thermodynamic efficiency of only 4 percent —although theory allows double that amount for an atmospheric temperature of five degrees below the Fahrenheit zero—a volume of water obtained from beneath the ice pack can produce the same amount of mechanical power as an equal volume of water falling from more than 4000 feet. There is no Niagara which is as powerful as this one, and it is available in the arctic on the shore of any river or any lake. Since the energy can also be generated from sea water, power in this form appears to be as unlimited as the oceans.

THE invention which we have had in mind during years, like all inventions, has required much developmental work. It has now reached the stage where it is suitable for practical application, through a simple and economical process. The apparatus will employ cold brine as a condenser, taking advantage of a well known property of a solution; namely, that when common salt is added to water the freezing point is considerably lowered, and the salted ice thus obtained—the so-called cryohydrate or "cryh"—is an effective refrigerating agent because its melting point is five degrees below the Fahrenheit zero. This substance, cryohydrate, is easily obtained in the arctic, simply by causing brine to freeze solid under normal weather conditions. It might therefore be said that the brine serves to collect the "cold" and concentrate it in tangible form.

Thus we would have the two differences in temperature required to generate power: First, the warm source, consisting of ordinary water, which freezes at 32 degrees. Second, the cold source, consisting of cryh which melts at a temperature of five degrees below zero. This standardized difference of temperature would bring about a flow of heat between the two sources, and a temperature difference is the fundamental and essential basis of a power plant.

A plant will preferably be installed on the shore of a lake or river, or by the sea. Unfrozen water, 1, (see diagram), pumped up through the ice pack will be directed into a boiler, 2, in same diagram. Here it will be mixed with a volatile liquid, 3. This volatile liquid, having low boiling point, will be caused to boil because it takes up the heat in the water. The volatile substance thus to be vaporized is one of the "light ends" produced in refining petroleum. These hydrocarbons of low boiling point possess the great advantage of being wholly insoluble in water, thus they can be mixed directly with it. This simple device provides an instant transfer of heat and permits the use of a simple and economical boiler. Normal butane, which boils at 30 degrees Fahrenheit under a pressure of 25 inches of mercury, would be particularly suitable for such a purpose. Because it would be condensed and used over and over again its cost would not be a large factor, especially since this petroleum by-product is very cheap, being wasted at present for lack of a market.

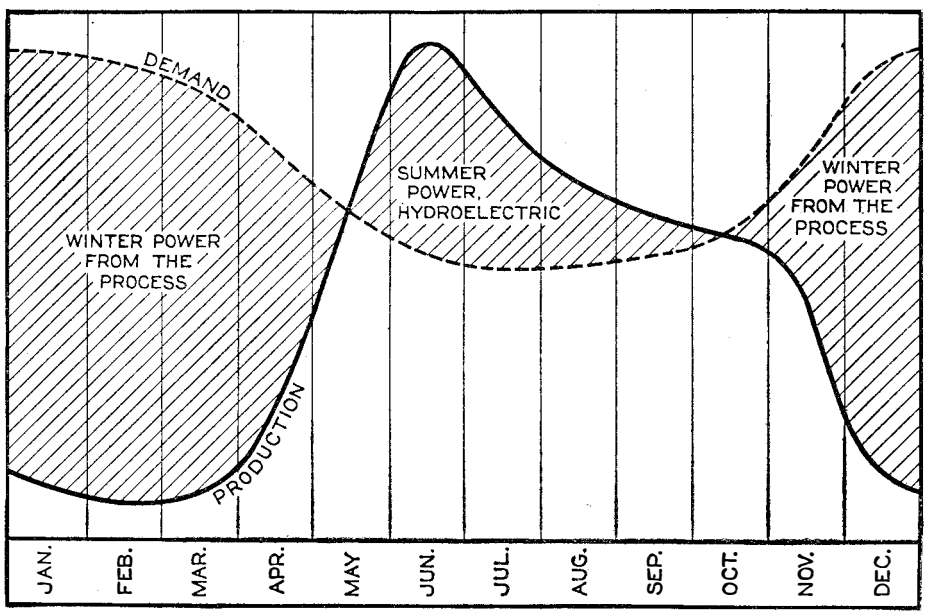
The butane vapor, 4, obtained as described, passes through standard low-pressure turbines, 5, and is exhausted, 6, into a condenser, 7. The condenser contains salt water ice ("cryh," 8) whose temperature is always below zero. The arriving vapor, 9, comes in contact with this sub-zero ice and is rapidly condensed or liquefied at low pressure (about 10 inches of mercury), meanwhile melting the ice.

The condensed butane, 10, and the melted brine, 11, collect at the bottom and since these two do not mix they are easily separated on a basis of their differing density. Both are used over and over again; the butane is sent back to the boiler, and the brine is caused to resolidify or freeze, 12, by action of the extreme cold of the arctic atmosphere.

If we look at the matter broadly we see that the production of power by a transfer of heat energy from unfrozen water to a chill atmosphere is theoretically unlimited, but that in practice it depends upon the capacity of the transfer agent employed. The price of that material is consequently the crucial matter, and this is why the use of cheap brine is extremely advantageous. Common salt is a very cheap material, but here is does not even have to be purchased, for a brine can easily be produced in the arctic from sea water. For example, this would be the case were a plant to be built near the shore of Hudson Bay. Repeated freezings acting on an isolated quantity of sea water will, as is well known to arctic explorers, concentrate it as efficiently as evaporation. Pure water freezes first and automatically separates from the remaining liquid, and a concentrated brine is finally yielded. This operation would be carried on automatically in the boiler of the plant if it were fed with sea water. Here the large amounts of brine needed would be obtained as a by-product.

THE manufacture of cryh from brine is equally a simple operation, requiring no very special plant. Since the plant is working on the shore of a lake, for example, the natural ice sheet on that lake offers a ready-made smooth surface of large area over which the brine is poured. This liquid will spread over an immense area, will thus be brought into contact with the cold atmosphere, and will freeze rapidly. Mechanical scrapers moving on tracks will automatically clear up the brine and regularly supply the plant with cryh.

The capacity of the plant depends only upon the area of the cold surface just described; the use of brine as a medium permits the employment of an immense surface at low cost. A system of tubes to accomplish the same purpose would prove to be highly expensive; it has been proved by actual test that a simple tank having a volume of only 400 cubic feet, filled with cryh, would be equivalent to 300,000 lineal feet of one-inch tubing. Furthermore



WINTER POWER WOULD COMPLEMENT EXISTING SUMMER POWER

In the north, stream-flow in winter shrinks to a very low minimum. Hydro-electric plants are based on that minimum rather than a maximum. Winter power would compensate this

the use of an open-air ice sheet would provide a better condensing process because there would be no added surfaces to delay the exchange of temperature.

Another great advantage of this cryh condensing process is the ease of obtaining a storage plant. The production of power is practical and economical only when that production is regular, and particularly when the peak load is being supplied. In our process an accumulation of cryh is equivalent to an accumulation of power. Let us suppose, for example, that a lake of brine having an area of one square mile is frozen to a depth of six inches; such an amount of cryh will enable a 75,000-horsepower plant to run during 24 hours at a 100-percent load factor. Thus the cryh, more easily produced in large amounts during the coldest spells and particularly at night time, has only to be stored up against the peak load and the occasional warm days that occur in the arctic, even in mid-winter. The storage would require no very special construction—nothing like the expensive dams of a hydro-electric storage plant.

THE NEW NORTH

The black region is suitable for the Barjot power plan. It has many lakes and streams

IN general, plants which utilize the process described will be very economical, having no elaborate costly construction comparable to the big dams required where the energy in falling water is recovered. The "boiler" and "condenser" are simply rooms in a concrete building; the turbines are standard low-pressure turbines; pumping unfrozen water from beneath the ice presents no difficulties; the brine is cheap and can be produced at the site for many plants. The capital investment will be low; an estimate for a large plant gave less than 35 dollars per horsepower installed, while hydro-electric plants involve a cost of about 200 dollars per horsepower.

The practical advantages will be obvious if we draw a comparison with the Claude process of harnessing the temperature variations of the oceans. The expensive pipe 3000 feet in length there required for obtaining cold water from the depths of the sea is not required in the type of plant at present under discussion. Here water has merely to be pumped up through an ice pack ten feet in maximum thickness. Furthermore this process makes use of the latent heat of freezing which, for the same mass of water, is 80 times as great as the specific heat used in the other process.

The region in Canada extending from Labrador to Alaska, all along the arctic coast and around Hudson Bay, is known as "the richest repository of base and precious metal in the world." The "pre-Cambrian Shield" or "Canadian Shield," more than 2,000,000 square miles in area, contains a wide range of minerals. Its southern extension in the United States, less than 5 percent of the total, has provided the Lake Superior iron mines and the Michigan copper mines which have played so large a part in America's pre-eminence in the mining industry. The largest part of the minerals of the Canadian Shield lie in the Great North, in that great region long regarded as a frozen waste. Among the potentialities of greatest known importance are the enormous deposits of native copper in the Coppermine River basin, situated under the Arctic Circle and recently estimated as a billion tons, and that fabulous reserve of iron ore at the recently discovered Belcher Islands in Hudson Bay.

AN extreme degree of cold and the lack of power have thus far prevented the exploitation of this wealth. A hard winter lasting about nine months freezes the streams, which can not therefore be harnessed hydro-electrically to advantage. These lands may now be regarded in a new light—as the lands of power. Fiords, rivers, and lakes are innumerable in that region and the process can therefore be carried out virtually anywhere. The present trend of settlement northward will be accelerated and a new part of the world opened to exploitation. Cheap metals should become available, due to a great industry wholly contingent on the vast new source of energy.

The process would be applicable not merely to the far northern fringe of Canada but to areas much to the south of this. It is well known that the great hydro-electric plants of central Canada are seriously hampered by the severe winters, and that most of them are reduced to a low capacity. The Saskatchewan Power Commission recently decided on the impossibility of making profitable use of the existing power, because in this province "the variation in the flow of the river is as much as 100 times greater in summer when the demand is light than in winter when the demand is heavy, the variation being all the way between the maximum flow of 188,546 cubic feet per second to a minimum of only 850 cubic feet per second." (reports Sask. Power Com., *Power Age*, January, 1929). This is due to the fact that water is immobilized in solid form in winter.

Unfortunately this shrinkage occurs during the very season of the greatest demand and requires the provision of steam stand-by plants. It is, however, illogical to burn coal when so much heat is already contained in any nearby lake or river. Again let us remember that unfrozen water can give more power in freezing than if falling through a head of 4000 feet. This "winter white coal" is largely available in central Canada because of its intense cold, and therefore the winter power plants utilizing the process at times of peak will fit admirably into the existing seasonal "valley," supplementing the hydro-electric installations.

The energy obtained during the cold months would be so abundant and cheap that it could even be used economically for electric heating purposes. What a curious paradox: the colder the winter the more efficient the process and the more heat! King Zero will be forced to destroy himself. The present handicap to the settlement of the arctic will be removed. The American continent, granted by the accidents of Nature a Far North which it now turns out is really a land of power, will become a center of civilization.

THE CANADIAN SHIELD

This area of pre-Cambrian rocks is a rich source of metals, but much power is needed

Finally, mankind has now the safe assurance that there is in the polar regions a source of power which will never be depleted; and which, incidentally, it will no doubt become steadily easier to transmit to greater and greater distances because the distance to which electrical energy can be transmitted is increasing every day.

High-Speed Tickers to Serve Brokers

MUCH of the chaos—and many of the losses—incident to the recent stock crash was due to the tardiness of the stock ticker, the type used having been in service for 10 to 15 years. Trading off "the floor" was largely guess-work for brokers dependent upon the tickers, because by the time quotations reached them, many wild fluctuations had taken place.

The recent announcement by the Western Union Telegraph Company that they are beginning installation of new high-speed stock tickers throughout the country will, to a large extent, prevent a recurrence of this situation in the future. Design and development of this high-speed ticker occupied practically three years' time and was a result of the combined efforts of ticker and printing telegraph engineers of the Western Union, the New York Stock Exchange, and the Teletype Corporation of Chicago.

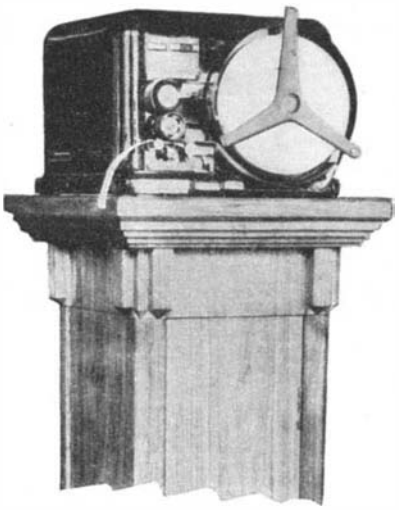
WHILE this new ticker is a cumulative result of developments and improvements rather than any startling new invention, it is based upon principles which enable it to operate at practically twice the speed of the old tickers. It requires only one main line wire instead of two as formerly used.

With the old style ticker a considerable amount of power must be supplied over the telegraph signal wires and a considerable time is required to rotate the typewheel from one printing position to another, since the alternating current impulses which control this rotation cannot be sent at a speed greater than ordinary automatic signaling speed. The new high-speed ticker development, therefore, took place along the lines of reducing the operation to one-wire control, reducing the amount of signaling current required, furnishing a local source of power at the ticker, and a change of code which would not require so many transmitted impulses to control the position of the typewheel.

The new ticker operates on a start-stop principle similar to the well-known Simplex printers which are coming into general use as a part of telegraph equipment. A local source of power is supplied by having a small electric motor which furnishes the driving means for rotating all the moving elements in the ticker and performing the operations of shifting, printing, rotating the typewheel, et cetera.

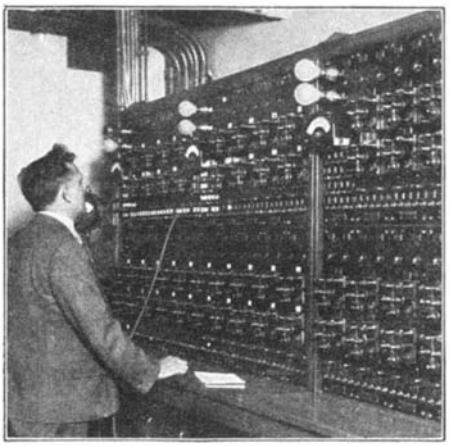
Instead of the step-by-step code which averaged 16 current units for each character printed, a permutation code is used which, with start and stop impulses added for each character, makes a total of eight current unit impulses for each character. There is only one magnet in the new ticker whereas there are four in the old. One important feature in the design is the fact that one character is really "stored" in the ticker mechanism and is being printed while the selection impulses for the next following character are being received and stored.

The 4,500,000-dollar program involving nationwide installation of the high speed stock tickers required construction of 5000 miles of new city-to-city wires, mapping of numerous curcuit changes and wire installations in 350 cities all over the country and in parts of Canada, and an enormous amount of other preparatory work. To prevent discrimination, the new tickers will be operated at the same speed as the old ones until all the old tickers in the country have been replaced. Some 3000 new tickers will be installed on Western Union circuits in New York City, in about four months. At least six months more will be necessary to rush work to completion in the balance of the country.



NO LONGER A DOME

The old familiar dome of the stock ticker is going out of style. This is the new one

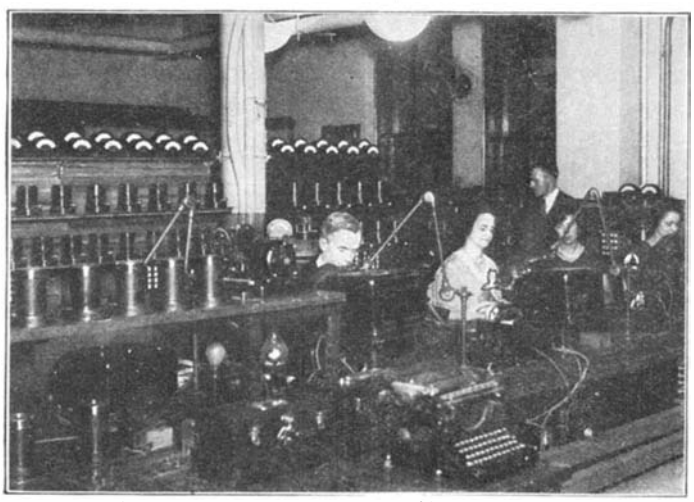


TICKER CIRCUIT BOARD

A section of the ticker circuit board controlling ticker circuits serving New York

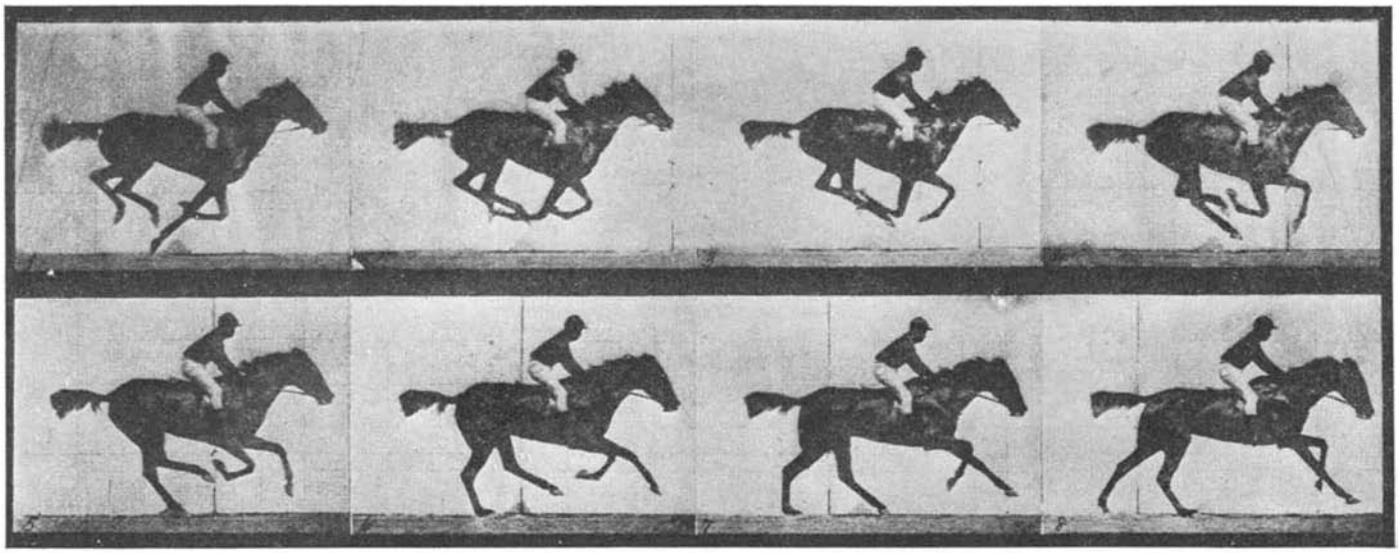
QUOTATIONS BY WIRE

An operator sending quotations from the new high-speed ticker sending station of Western Union at 40 Broad Street, New York



SERVING THE COUNTRY'S BROKERS

General view of the sending apparatus. In background a man watches a distributor receive impulses from the operating table



THE FIRST "MOVING PICTURES," REPRODUCED FROM THE ORIGINAL

"Animal Locomotion" is the title of the large volume in the possession of the editor, from which this page was reproduced. The same work is described on the fly leaf as "An Electro-photographic Investigation of Consecutive Phases of Animal Locomotion, 1872-1885, by Eadweard Muybridge, Published under the Auspices of the University of Pennsylvania," in 1887. See the text of the article

Our Eyes and the Movies

How the Laboratory Psychologist Explains by Means of Physiological Optics Some of the Phenomena of Moving Pictures

By DONALD A. LAIRD, Ph.D., Sc.D.
Director, Colgate Psychological Laboratory

AN argument that could not be answered, and a rich man's natural inquisitiveness marked the birth of the movies. Now one out of five in the United States is a movie addict, according to compilations made by the industry, public schools are using movies for educational purposes, salesman are using them to supplement their sales talks, and when Walter Gifford, president of the American Telephone and Telegraph Company, cannot be at a banquet to make a speech in person, he makes a "talkie" of himself appropriate for the occasion and is represented in proxy by an operator of a projecting machine.

All this resulted from the bet of a wealthy sportsman and philanthropist 50 years ago, and on the application of some dry-as-dust discoveries and laws scientists unearthed nearly a century ago. Out of these origins has come the celluloid ribbon which claims 25,000,000 of us as well-nigh incurable movie addicts and touches closely the lives of as many more.

Science has accomplished so much that concerns moving pictures in the last century that we have developed a nonchalant, matter-of-fact attitude toward these achievements. We are content simply to enjoy the beauty or amusement rather than trying inquisitively to find out "what makes it go."

While hundreds of men who labored through two centuries have made essential contributions to the development of the motion picture, it is generally recognized that the first actual pictures were taken at Palo Alto, California, on the stock farm of Leland Stanford, in 1878 and 1879. Stanford turned his vast resources and ingenuity to settling some arguments on which wagers had been laid about how horses ran.

Eadweard J. Muybridge, sometimes known as Edward James Muggeridge, and John D. Isaacs, worked with Mr. Stanford in arranging a battery of 24 cameras so that a moving object, such as a racehorse or a human being walking, would expose each plate in serial order and would leave behind a photographic record of each of 24 closely timed phases of his movements.

WHILE the investigation was planned primarily to settle arguments about racehorses, the developed negatives upset many conventional ideas about pole vaulting, sprinting, and even pleasure walking; the human brain and eye, apparently, had not in the past really analyzed motion itself but had reacted to a composite, and at best a rather hazy, picture. From this crude start, experimental work continued.

When we see, the light which enters the eye produces the sensations of vision by changing the chemical constitution of the sensitive retinal coating of the inner surface of the eyeball. The chemical changes do not cease immediately when the light is cut off. Everyone has seen the after-effects of this persistent chemical reaction when looking at the light in his bedroom just before turning it off for the night. The light is extinguished, but a weak image of it persists in the eye and remains, no matter what direction the eye turns. The same after-image is seen when riding at night and looking directly into the headlights of an approaching automobile; after the automobile has passed, the persistent image which is caused by the lag of the chemical reaction is seen dancing around like a firefly.

When a very strong light is used, these after-images last longest. So in experiments to reduce the flicker in movies it was found that, by substituting an arc light for the old carbon-filament bulb, the pictures could be made bright enough so that the chemical change of the first picture persisted in the eye while the cut-off blade of the shutter was hiding the second picture which was being jerked into place. But that was not all. Flicker still persisted and movies in the early professional exhibition hall flickered much as the blades of an electric fan do as they are coming to a stop. Of course it was not the blades or the pictures on the screen that flickered, but the overlapping chemical changes in the retina of the eye.

Ordinary visual impressions last in

the retina for about three thousandths of a second after they are cut off. The stronger impressions from a bright movie screen will last longer, but not enough to eliminate flicker. So "Talbot's Law" was called upon. This is a law from pure science but it solved the critical problem of movie projection.

Talbot's Law states that in rotating a disk made up of sectors of black and white, flicker decreases as the speed of rotation increases, with the intensity of illumination, and with the number of interruptions. The speed of films could not be increased practically and economically and the intensity of lighting of the pictures had been increased as far as seemed possible. So why not interrupt the light more? That is what they did. One shutter had to be used to hide the motion of the new picture being hauled into place, so another, and usually smaller, blade was added. Its function was to pass its shadow across the screen while the picture was being shown. Adding this second shadow diminished the flicker. Instead of interrupting the light on the screen just once for each picture, a second and sometimes a third interruption is now added. Paradoxical as it may seem, flicker disappears. Doubling or tripling the number of times the light is broken lessens the brightness of the picture seen by the eye, as predicted by Talbot's Law, but substitutes steady fusion of after-images and does away with flicker. Only when the machine is running too slowly or when the light is momentarily weakened does flicker appear.

IN the home projection of movies flicker may appear, due to several causes. If the home projector is moved a distance from the screen so that the size of the picture is increased, the intensity of illumination of the screen is decreased and may be reduced to a point where the after-images are too weak to carry over the darkened intervals on the screen. The motor may also be running slowly, due to lack of oiling. If the room is not darkened flicker will be difficult to avoid because the after-images fuse most readily when the general illumination is least.

While the home projector should be placed as close to the screen as possible in order to obtain the brightest picture that is consistent with adequate size, the spectators should sit as far from the screen as possible. When the spectators sit at a considerable distance from the screen the image of the picture is focused on the central region of the retina, but if they sit close to the screen the corners of the picture are focused on the peripheral or marginal portions of the retina. This marginal retina is especially sensitive to flicker. Thus, by sitting close to the screen one sees the central part of the picture fusing perfectly but the corners of the picture present an annoying amount of flicker.

When a common cotton screen is used the spectators should sit directly in front of the screen, because it reflects the maximum light directly backward. In moving picture theaters mirror or ribbed screens are used which reflect the rays to the spectators at the sides of the stage. Most screens used for home projection do not do this.

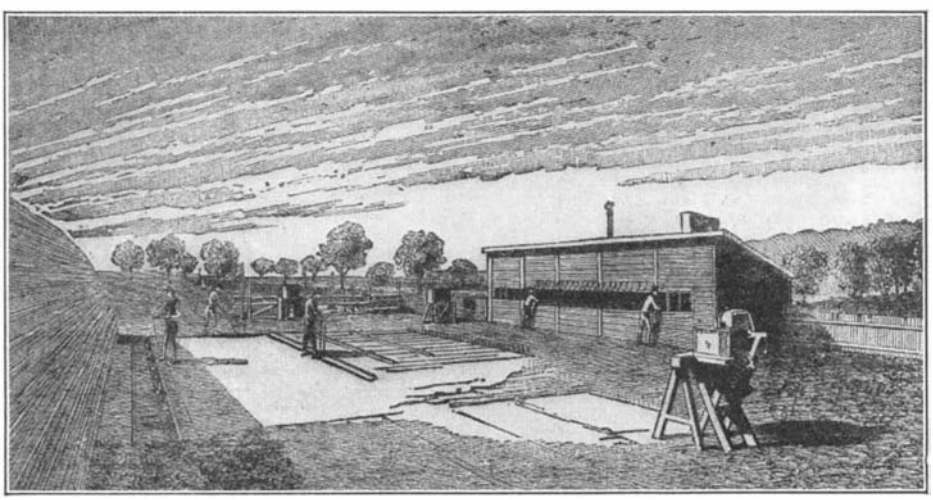
There are always a few persons whose eyes are irritated by the movies. This is due to individual peculiarities in the critical flicker threshold, and is not a defect of movie projection but a human idiosyncracy.

The fusion replaces flicker quickest when the predominating color is bluish, but the light of the carbon arc or incandescent bulb used in projecting the pictures has an excess of red and yellow rays and a deficiency of blue rays. In some professional machines lenses are used having a bluish cast. These filter out the excess of red and yellow and consequently give a smoother picture with the best fusion in the intermittent images. Some of the patented ribbed and mirror screens are so constructed that reds and yellows are absorbed to some extent, thus giving the screen and the picture it reflects a slight bluish cast. In home projection it will help if the cotton screen is thoroughly blued by the laundress. In the more skillfully designed moving picture theaters the lights that are kept on in the auditorium during the projection of a picture have bluish reflectors or filters in order to give this color help to fusion.

Do movies harm the eyes? Many people think so. A few years ago a responsible public health official made this prediction: "Motion pictures will be extinct in ten years. The public realization that they are ruining eyesight will lead to a demand that they be abolished. Within ten years I predict that there will be no more motion picture shows in America. By that time they will be barred as a pernicious evil to health."

Some people undoubtedly do experience eye strain at the movies, but this is usually the result of their eyes having defects which they have not discovered and had corrected. Or they may habitually sit too close to the screen or too far to one side. As a matter of fact actual measurements have shown that viewing a movie projected with ordinary care is less fatiguing to the eyes than ordinary reading for the same length of time. Theoretically the movies should be fatiguing, but practically they are not. There is one type of scene, however, which may readily be very fatiguing to the eyes. This is where counter-motion is shown, as in a parade where trained marchers are in military formation and the jerky movements of their legs are in the immediate foreground. This produces jerky and irritating sensations.

MOVIES seem to be peculiarly a human institution, animals indicating little, if any, interest in them. Not only household pets but primates which have been experimented upon show no interest in movies and are more likely to look away from the screen than at the screen. This is likely due to the eyes of animals not having the photochemical changes that make it possible to fuse the pictures. Dogs are interested in their own images in mirrors and in lithographic sheets portraying other dogs, but they do not look at dogs in movies. Probably this is because the movie screen looks to them as the slowly whirling blades of an electric fan look to us. It has been experimentally demonstrated that some animals, such as the parrot, do have after-images, but it would appear that their after-images do not follow the same time course that ours do.



THE EQUIPMENT USED BY EADWEARD MUYBRIDGE

From the SCIENTIFIC AMERICAN Supplement, February 5, 1887. "On the left," reads the legend, "is the reflecting screen against which the animal appeared *en silhouette*. On the right is the series of photographic apparatus of which each one took an image of the animal"

The Romance of Steel

Most of Us Take the Metal Iron Too Often for Granted. Were Iron Newly Discovered, Its Unusual Qualities Would Cause It to be Regarded as a Remarkable Element

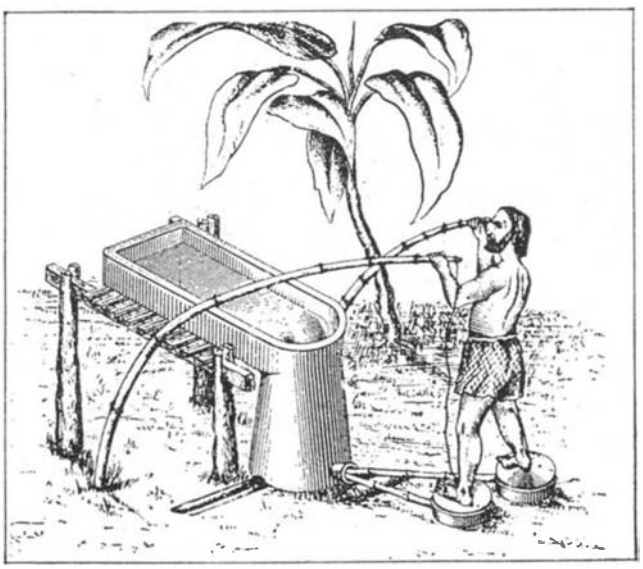
By MARTIN MEYER, Ph.D.
Assistant Professor of Chemistry, College of the City of New York

MANY thousands of years ago men were savage aborigines roaming about clothed in the skins of animals than which they were little better. Their chief cause of concern and object in life was to secure food enough to prolong their miserable existence. Surrounded by beasts of a ferocity unknown in modern times, their only weapons were crudely fabricated from wood, stone, bone, and later bronze and the softer metals. Then one day one of their comrades discovered that a rusty earth could be treated with fire to produce a material, iron, which could be fashioned into implements of an efficiency immeasurably greater than those of the time. It was one of the most important discoveries that the human race has ever made, ranking second only to the discovery of fire itself; so important, in fact, that the subsequent period is known as the Iron Age.

THE Iron Age endured from this dim dawn of humanity down to only 80 years ago, when mankind entered another epoch which might quite as rightfully be designated the Age of Steel. The date is fixed by the discovery of the Bessemer process for the manufacture of steel in 1855, and the importance by the events that have since transpired. As great an improvement over wood and stone as is iron, just so much greater is steel over all other metals.

The manufacture of steel is based upon the fact that iron possesses the peculiar and almost unique property of dissolving the element carbon, and thereby acquires some startling new properties which are further enhanced by the addition of other materials. While this was known long before 1855 and the perfection of Bessemer's process, it was not until then that steel began to be produced in the quantities that it is today.

The metals form an interesting group of elements. They are all relatively hard, strong, heavy materials, usually (except copper and gold) of a silvery appearance, and have what is commonly called a "metallic luster." They have an infinite number of uses, many of which are familiar to everyone. Copper is used for electric wires because of the cheaper metals it is the best electrical conductor, nickel for plating because it takes a high polish, aluminum for airships because it is light and strong—each metal has uses which depend upon its properties. This is what makes steel the valuable material that it is. Cheapest of all metals, composed mainly of iron to an extent always greater than 90 percent by weight, it is nevertheless not one metal, but many, because the nature and the amount of the other 10 per-



PRIMITIVE IRON SMELTING

The bellows are worked by the artisan's feet. The discovery of iron smelting was made in Africa by the negro

cent makes an infinite difference in the material.

As steel, iron is the Proteus of the metals. Considering iron only from the standpoint of the carbon it contains, one finds at least three different and easily distinguishable varieties. When it has about 4 percent of carbon, which is about all it will hold, down to 2 percent it goes by the name of cast iron. This metal is hard, easily cast in molds since, like water, it expands on solidifying (a most unusual property) and takes a sharp impression of the mold. But it is quite brittle, so that it may be shattered easily, even by a blow from a hammer. Stoves are made of cast iron and one frequently breaks parts simply by dropping them.

When iron is given from 2 percent to 0.2 percent of carbon we have steel with somewhat contrasting properties. Not as hard as cast iron it is infinitely stronger, though normally it does not cast as well. Steel can be made with a tensile strength of more than 200,000 pounds per square inch; that is, so strong that a rope of only one such strand would suffice to lift a locomotive.

With less than 0.2 percent of carbon iron is called wrought iron, a material which is still softer than steel but quite tenacious and has many uses.

It is, however, the strength of steel which is proverbial and which makes the modern world the land of miracles that it is. Without steel there would be no railroads, no large bridges, no Woolworth and no Chrysler Building, and practically none of the wonderful machinery by which manufacturing operations are conducted.

THAT, however, would not be a great loss, for without steel there would not be nearly as much to manufacture, to say nothing of the countless smaller but equally indispensable things which are dependent upon this interesting material.

But the properties of steel may be still further and more widely modified by the addition of smaller amounts of other substances. Normally iron is magnetic but loses its magnetism slowly, and strongly resists attempts to change the polarity of its magnetization rapidly. After the addition of tungsten and small amounts of chromium it may be magnetized and will retain the magnetism practically forever, the so-called "permanent magnets," while on the other hand, if it contains silicon it may be magnetized in one direction, demagnetized, and magnetized in the opposite direction a hundred times a second with only a very slight loss, known as hysteresis or magnetic lag. Ordinarily steel rusts quite readily, but by the addition of silicon in large quantities one obtains Duriron which resists corrosion of even the strongest acids, while the addition of chromium

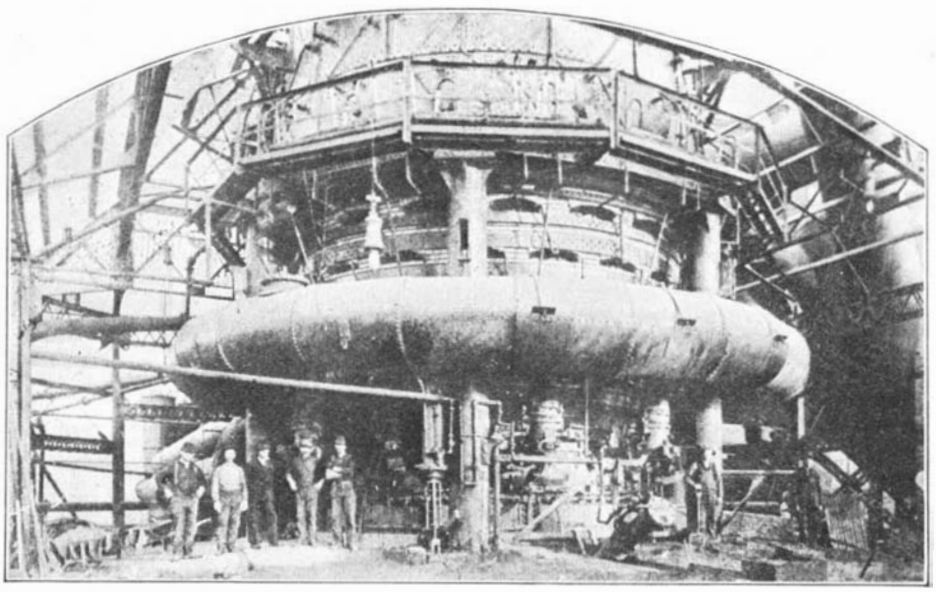
yields the "stainless steels" which are used in cutlery.

For all these reasons and many more, our modern civilization is dependent upon steel, and to call this the Age of Steel is merely stating a fact.

From whence comes this interesting material? Like the other metals it is derived from ores or earthy materials found in the ground, of which there are extensive deposits in the United States on the shores of the Great Lakes and in other places, in Spain, Germany, France, Russia, and in other countries. A new deposit has been found at Koolan Island in the Yampi Sound, a little dot in the wastes of the Southern Pacific Ocean. It is said to consist of more than 100,000,000 tons of the highest grade ore, with more under the ocean bed, and this will doubtless influence the future of the British Empire. Large deposits have also only recently been discovered at Kursk in Russia.

The most desired ores of iron are three in number—limonite, haematite, and magnetite. The last is the most valuable but also the rarest of the three, for it contains when pure about 75 percent of iron. It is the "lodestone" of the ancients, of which one rock was said to be so highly magnetic that it drew the nails from passing ships and unfortunate sailors had to swim for their lives. Like the report of Mark Twain's death, this is doubtless considerably exaggerated, but magnetite is highly magnetic for a nonmetal, or even a metal other than iron itself.

THE ores are oxides, that is, compounds of iron and oxygen, and to obtain the iron one must remove the oxygen. The first operation in the manufacture of steel is smelting. This is conducted in a blast furnace and results in the production of cast iron. A blast furnace is a huge circular building about 100 feet high and 30 feet in diameter, having the general shape of two truncated cones placed base to base. Ore, coke, and limestone are charged into the top of the blast furnace, air is blown in to burn the coke, which removes the oxygen from the ore, and liquid iron at a temperature of 2200°, Fahrenheit, is tapped out of the furnace every few hours. If the ore were pure oxide of iron, only carbon would be necessary to remove the oxygen, but as would be expected of a material dug from the earth, it may also contain sand or limestone, although nearly always it does contain sand. This would clog up the furnace and make difficulty in the smelting operations. So lime is added as a flux, and it combines with the sand to form an easily melted slag that is also tapped off from the bottom of the furnace. This slag is very similar in appearance to a poor grade of glass, and when ground finds some application as an abrasive or cutting or polishing material.



THE BASE OF A MODERN BLAST FURNACE

Such a furnace is charged with ore, coke, and limestone (as flux) and is kept running continuously for years. Air under pressure enters from the large horizontal, circular tube

The design, operation, and improvements of blast furnaces form interesting stories in themselves. Today they are almost always entirely mechanical in operation. Years ago they had to be charged by hand. Men climbed to the top of the structure, opened the door of the fiery inferno to drop in the charge, then jumped back to avoid the rush of flame which always followed. Sometimes they did not jump quickly enough and paid for their lack of agility with their lives.

The iron from the blast furnace has been made in contact with coke which is almost pure carbon, and therefore contains about all the carbon it can hold, about 4 percent. It is "pig iron" and the problem of making steel is that of reducing this carbon content to the desired 2 percent or less. The oldest method of accomplishing this purpose is by the open hearth process, which consists simply in melting the pig iron in large shallow beds lined with iron ore. The oxygen in the ore combines with the carbon of the iron and we get more iron out of the furnace than we actually put in.

Pig iron, however, also contains all of the impurities which were present in the original coke and ore—usually silicon, manganese, phosphorus, and sulfur—and these, especially the last two, give a steel with undesirable properties as it is likely to be brittle either when hot or when cold. During the World War this became a very serious problem, for it was found that the amount of sulfur in the coke which was being made was increasing. Special precautions must be taken at this point to remove them, and the furnace is always lined with either a basic or an acid lining, depending upon the chemical nature of the impurities. The lining usually takes the form of a sand or limestone layer. This is slowly eaten away in successive operations and has to be replaced at intervals. Finally the furnace is tapped and the liquid steel runs in thick fiery streams into ladles where alloying materials are added if special steels are required. More than 17 other metals are added to steel to confer upon it different properties for particular purposes.

From the ladles the steel may be cast into ingots which, in turn, go to the rolling mills to be rolled, hammered, cut, slotted, and shaped into rails, sheets, beams, and an almost infinite number of other things. By perfect marvels of mechanical ingenuity this tough and hard material is handled as easily as one may fashion butter.

ABOUT 1854 it occurred to Henry Bessemer that, since the problem of making steel from cast iron was simply one of removing carbon, this could be done most simply by burning it out with the oxygen of the air. He built a large egg-shaped machine into which he placed molten pig iron and proceeded to blow air through it. The idea worked so well that it failed. As the carbon is removed from the iron its melting point rises. In this case the air removed the carbon so rapidly that the temperature could not keep the iron liquid. It solidified and ruined the expensive machine. But eventually Bessemer solved the problem by blowing the air upon the iron instead of through it.

The idea was really conceived by Kelly, while Mushet and others improved it, but chiefly it was Bessemer who made it practicable. It was certainly he who received the rewards, for probably no great invention was so quickly and largely rewarded. It is

estimated that before his death in 1898 Bessemer had received upwards of 5,000,000 dollars as the proceeds of this one discovery. Although he made other inventions in his life, none was of any importance in comparison with this.

The idea eventually revolutionized the steel industry. At first it resulted in the production of steel at a price with which no other method could compete. Now when the price differential has been largely overcome, it still holds this advantage: large Bessemer "converters," as they are called, hold only 25 tons of steel, while an open hearth furnace may hold 200, but the latter takes eight hours for one run while a "converter" turns out its charge every 15 minutes. It furnishes a better feed for a rolling mill for it is cheaper to handle a steady small stream of material than a large quantity at infrequent intervals. In a large modern mill the ore is never allowed to cool down from the time it enters the blast furnace until it comes out as the product.

A DESCRIPTION of each step in the process reads like an ovel, and no one who has had the privilege of visiting a steel plant will ever forget the experience. The magnitude of the operations, the temperature of the furnaces and the molten metal, the noise of the mills, and the bare-shouldered workmen, like gnomes, controlling the work, combine to form a spectacle as impressive in its way as a Niagara or a Mammoth Cave. For many purposes, steel is manufactured in other ways, by the Duplex and Triplex processes, in crucible furnaces, and day by day more is being made by electricity.

Since Bessemer's invention the industry has grown by leaps and bounds until it is the most important in the world. Today it controls even matters of a political nature, for the principal problem in Europe's political tangle is no longer to maintain a "balance of power" but to maintain that which today is, from a national standpoint, infinitely more important, a "balance of steel." The world's production has risen from only a few thousand tons in Bessemer's day to over 76,000,000 in 1913 and around 100,000,000 today, valued at current market prices at about 36 dollars per ton.

From the figures of cast iron and steel production and cost, students of business foresee the course of commerce and stock speculators forecast the trend of the market. Quite remarkable correlations have been shown between carefully prepared analyses and actual subsequent facts.

It is more than an interesting comment on the effect of modern science on modern life to trace the influence of steel production upon the course of current history. The greatest body of

IRON MEANS POWER

The iron ores between the present boundary (1) and the old one (2) have passed from German hands to the French

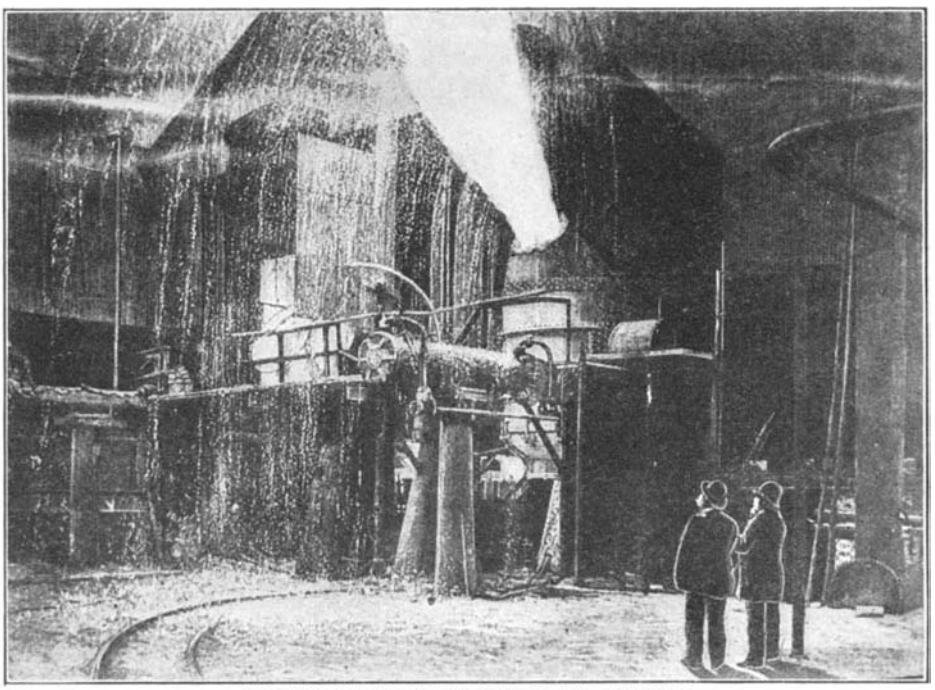
iron ore in Europe was shared prior to the war by France, Germany, and Luxemburg, and before the war Germany produced more steel than did the other three great steel producing nations of the old world, England, France, and Belgium combined, while the United States produced about the same total quantity, around 40 percent of the world's annual supply.

In the modern world steel production is the keystone to all else; steel means power and commercial preeminence. To it Germany owed her commercial supremacy and to her commercial supremacy she owed the war. By the Versailles Treaty France hoped to destroy that supremacy forever, for she thereby got Lorraine and the main portion of Germany's western ore deposits. But that has not solved the problem nor won the economic battle for France, even though she has won the war, for she did not win the coal.

In the natural course of economic events ore must go to coal to be smelted and not the reverse, as we see in our own country. Our great deposits of iron ore are on the banks of the Great Lakes but the center of the steel industry is with the coal in Pennsylvania. Coal is light and bulky, and expensive to ship, while ore is heavy and compact. France did not get the Ruhr coal deposits, and only a small part of the Sarre, although she has made heroic efforts to maintain control of them, so the actual ownership of the ore means little. Realizing the economics of the situation it is doubtful whether England could be brought to look with any degree of sympathy upon French desires for these coal deposits regardless of the other issues which might be raised to enhance the French ambition, and this is the problem which will remain for solution for some time to come. The recent formation of the European steel *cartel* or trust will write a new chapter and perhaps a whole volume in this story. In the meantime our own production has been mounting. Since 1916 we have produced more than 50 percent of the supply of the entire world. For us from that standpoint the future seems secure.

What Is Your Opinion?

This article is one of a series. All are elementary and deal largely with the romance of chemistry. Whether several more articles of this series will be published or not will depend entirely on the number of votes received from individual readers. A post card will suffice. —The Editor.



A BESSEMER CONVERTER IN ACTION

To make steel from iron, some of the carbon is burned out, either in the Bessemer converter or by the "open hearth" process. Today about three fourths of the steel is made by the latter process yielding a better product, and one fourth is made by the Bessemer process

An Experiment in Suspended Gravitation

We May Reason Out One Kind of an Answer to a Question in Physics and Arrive at an Opposite Answer By Actual Experiment. Experiment Wins

By R. W. WOOD, LL.D.
Professor of Experimental Physics at Johns Hopkins University
Corresponding Editor, SCIENTIFIC AMERICAN

IF a bottle of water is allowed to fall, and a large air bubble is released at the moment at which the bottle is dropped, will the bubble rise in the water?

Having received an incorrect answer in a surprisingly large number of cases, it seemed of interest to devise an experiment which would demonstrate the abolition of hydrostatic pressure in falling water, and the consequent disappearance of buoyancy.

Everyone is familiar with the circumstance that in an elevator a suitcase held in the hand feels much lighter at the moment at which the cage commences to descend, and much heavier at the moment at which the descent is being arrested. If the supporting cable breaks and the car falls freely the suitcase weighs nothing at all and feels as light as a feather—although this observation has not been put on record, so far as I know, by the victim of any elevator accident. The experiment can be tried on a smaller scale by jumping from a height of five or six feet.

THIS suspension of gravitation occurs also within the interior of bodies shot up into the air, and the error made by Jules Verne in his "Trip to the Moon," in having gravitation disappear within the projectile *only* at the moment when it passed the center of gravity of the earth-moon system, has surprised many of his readers.

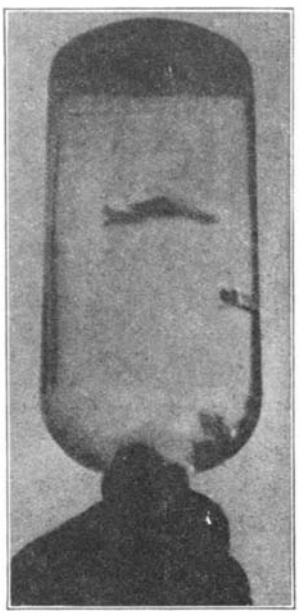
From these considerations it is clear that the hydrostatic pressure of water, which obviously depends upon its weight, disappears also when the mass of water is rising or falling freely in the air (neglecting a small effect due to air resistance, which prevents a "free fall").

A parachute jumper could try some amusing experiments with a corked bottle of water containing a small quantity of air. If at the moment of jumping he inverted the bottle, the air bubble would remain for a few seconds at the bottom, and then rise slowly as the air resistance reduced his acceleration. As soon as he reached his final "terminal velocity," which is something like 120 miles an hour for the human body in a horizontal position and in air, there would be no further acceleration, and his velocity would remain constant until he opened his parachute. During the time of fall at constant velocity the air bubble would rise with its customary velocity.

Possibly some of our air service men who think nothing of dropping a thousand feet or so before opening their parachutes may be willing to try the experiment and report on it. I should also like to suggest that a moving picture of the earth, taken with the machine pointing straight down, during a free fall of several thousand feet, would be of considerable interest. It could easily be done with one of the lighter cameras operated by a spring drive, or perhaps even with a standard machine, although the latter might give more trouble later, in making the landing.

THE EXPERIMENT

Above is the bubble almost stationary in the falling bottle and virtually spherical in form. Below is a bubble made by simply inverting the bottle in the hands. Note its rather peculiar mushroom shape



The stationary bubble in the bottle can be observed, however, in a far less hazardous manner. After giving some thought to the problem of how to drop a bottle and release an air bubble at the bottom at the same moment, it occurred to me to toss the bottle into the air. After some little practice I learned how to do this in such a way as to bring the bubble to the center of the bottle at the moment at which it could most clearly be seen, namely, at the top of its flight when it is moving slowly.

If the bottle is properly thrown to a height of a foot or two above the head, we see the large silvery bubble poised at the center, almost spherical in form. If, however, we invert the bottle by a quick turn of the wrist, the bubble rises rapidly in a much flattened form having a mushroom shape. The two conditions are illustrated by photographs, taken with a shutter speed of 1-500 second with the sky as a background. The bottle was tossed up with one hand and the shutter sprung with the other.

THE best method of observing the suspended bubble is to stand facing the light, holding the bottle, cork down, loosely in the palm of the right hand at an angle of about 45 degrees, the arm hanging by the side. The bubble should be about the size of a peanut.

The bottle is now tossed up by a free upward swing of the arm, in such a way that it turns slowly and assumes an upright position at the top of its flight. The first attempt will probably result in a double somersault, but with a little practice the toss can be properly made. The best result is obtained by letting the bottle slide off the palm of its own accord, by straightening the fingers at the proper moment. If the bubble rises rather rapidly, as is sometimes the case, it is due to currents set up in the bottle by an incorrect release. However, a little actual practice will have more value than many words.

An Archeologist-Detective at Work

With Only a Vague Clue as a Starting Point, Queen Meryet-Amun's Tomb Was Unearthed

THE annual report of the Metropolitan Museum's excavations at Thebes is, as usual, written by Mr. Herbert E. Winlock, who has that rare ability of making archeology real and vibrant to the lay reader. It will be remembered that the stories of the expeditions in the last two years, presented in the SCIENTIFIC AMERICAN, have been very largely devoted to an account of the discovery of statues and sphinxes broken up and buried near Deir el Bahri. We have already related how Queen Hat-shepsut usurped the throne during the youth of King Thut-mose III and built a temple to justify her usurpation. When she died in 1479 B.C. the young king tried to expunge all memory of her by destroying inscriptions, statues, et cetera. Mr. Winlock says:

"To finish clearing away what still remained of Naville's debris [See SCIENTIFIC AMERICAN for June, 1929, page 522] and to expose the rest of the quarry was the task on which we spent the first part of the past season. Meantime, while the men were digging, we went back to the slow, laborious grind of sorting out and fitting together the fragments found during the previous years."

All photographs courtesy Metropolitan Museum of Art

Detective work by the expedition, on statues and sphinxes found at Deir el Bahri before the discovery of the tomb of Queen Meryet-Amun, brought other surprising results. The torso of one statue dug up by the expedition only a year or two ago at Deir el Bahri was found to fit a head taken by German Egyptologists to Berlin in 1843-45. The same situation existed in regard to a granite sphinx. The Metropolitan's expedition also discovered fragments of a statue of Queen Hat-shepsut, the torso of which was taken to Holland in 1869 by Prince Henry, High Admiral of the Netherlands Fleet. Negotiations are now afoot for the reuniting of these statues.

The next interesting feature which Mr. Winlock describes is the Osiride statue of Hat-shepsut referred to in our issue of June, 1929, page 524. Mr. Winlock continues:

"For another piece of architectural sculpture—this time of gigantic size—the problem of location was solved last season and the actual reconstruction is now practically completed. We have unearthed fragments of two enormous Osiride statues and had been able to demonstrate that they had originally stood at the far ends of the two lowest porches of the temple."

The great story in the report on the 1928-1929 Egyptian Expedition is the finding of the tomb of Queen Meryet-Amun. After the search for statue fragments in the quarry and in the hole filled up by Thut-mose III, there was left only one more place where the archeologists believed that there was any likelihood of finds. On the hillside to the north of the temple there was a postern gate through which all sorts of rubbish and sweepings had been carried out in ancient times and dumped on the hillside. On it they noticed two chip heaps weathered during centuries and almost hidden by drift sand and fallen rock. Mr. Winlock says:

"We could see that the chip was shale from the lowest strata of the cliff and that it lay much higher up the slope than any natural agency could have carried it. Of course it was possible that we were dealing with heaps of shale dug out in leveling the temple courts below, but it was hard to see why the quarry chip from there should have been carried so far uphill—and across a ravine, at that. On the other hand it was equally possible that what we had were heaps of chip from the tunneling of some undiscovered tomb or tombs in the shale strata, and it was on this that we pinned our hopes.

"Naville had started to dig just outside of the temple wall—we had an old photograph showing some of his men working there—but he soon abandoned the place and covered the lower part of the slope with one of his inevitable dumps.

"AMONG the commonest questions put by the layman to the excavator is 'And how do you know where to dig?' If these words chance to fall under the eye of anyone who has wondered about it, an answer has been given for a typical case. In fact, the digging which took up the second half of our season involved finding the answers to so many of the everyday problems of excavation that it may be worth while telling the tale as we lived it on the spot. It had the usual delays and disappointments, the invariable surprise when the find was actually made, the laborious groping after the explanation of what had been found, and finally the arrival at a conclusion that seemed to fit the facts discovered. If the reader finds the tale involved in the telling he will get a very fair idea of the way things generally happen in the field."

THE SPHINX'S HEAD IS FOUND

The head was found in Berlin and the body was found in Egypt. They were pieced together; result, a perfect statue

The remainder of Mr. Winlock's story must be somewhat abridged, although we shall not depart from his own words.

"The gang of workmen was started at the foot of the hill. On February 23—six weeks after we had started—the men found a rough hole in the rock. They cleared out an irregular, jagged opening, and, when they were about waist deep, brought to light some rather carelessly laid brickwork. As a matter of routine we put guards on the spot.

"The bricks were merely stuffed into the mouths of an opening and were only held in place with a little clay smeared along the top. The pit itself was filled with dirt, rags, bits of a large white coffin, and the lids of straw baskets. Then we took out a couple of bricks and flashed an electric torch inside.

"IT was only then that we had our first hint that our tomb was not so simple and uninteresting. A jumble of white shawabti boxes and a headless Osiris figure could be seen just inside the opening. Beyond were several big round baskets to which the lids in the pit seemed to belong, piled against the wall of the corridor. Those big baskets were the kind usually associated with Eighteenth Dynasty tombs. Once our first surprise was over, we began re-adjusting our ideas. We jumped to the conclusion that we had found the tomb of another of Hat-Shepsut's courtiers.

"That night the tomb was sealed up again and heavily guarded. Then we started to remove the brickwork. One fact was soon established. Originally the corridor had been closed with a carefully built brick wall. All but the bottom courses of this wall had been broken down, and the tomb entered a second time, after which it had been reclosed with bricks and stones. Later all but three courses of this second blocking had been removed and the tomb entered a third time.

"The last people in the tomb had made a path along the corridor by pushing everything over to one side. On March 3rd I crawled in and gingerly followed in their footsteps. The passage was clear almost to the end, but there my way was blocked by a yellow, varnished coffin. Its lid was missing and inside it there lay a mummy with bandages absolutely intact and with garlands over its face and a wig at its head. Beyond it the lid of a large outer coffin was propped up on its side in a doorway leading to the right, and just beyond the doorway lay the empty outer coffin, the missing lid of the outer coffin, and the cover which belonged over the mummy itself. Here was a most surprising state of affairs. These coffins seemed to be lying just as they had been dropped by a burial party when something had interrupted them—and another flash of the torch showed what that something was. I was on the brink of a deep well that made an absolutely impassable gulf across the corridor. The real crypt of the tomb must lie beyond, and in the far left-hand corner across the well I could see a passage leading off to the left.

GIGANTIC

The problem of location being solved, masons "assembled" the statue of the usurping queen

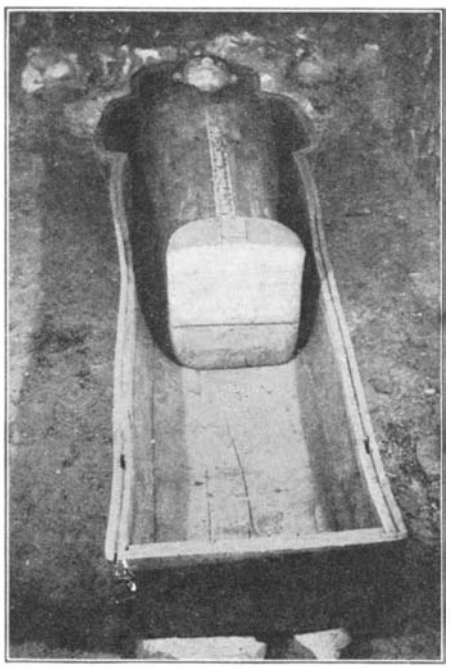
"FOR the time we were completely balked. The Osiris figure bore the name of 'the House Mistress, the Chantress of Amen-Re, the King's Daughter of his body, his Beloved, Entiu-ny,' and the same name appeared on the shawabti figures in the boxes. From the style of the coffins we could safely conclude that we had discovered another daughter of Paynudjem, named Entiu-ny, who died and was buried probably in the years just preceding 1000 B.C. When Entiu-ny died, somebody had known of the existence of this tomb. The pit was dug out, the blocking broken through, and the heavy outer coffin and the three lids were started down the passage. As soon as the first bearers had turned the corner at the end of the corridor, they found themselves on the brink of the well, and dropped their burdens. The bearers crowding from behind with the body had to drop it. Probably a discussion followed, which ended with some of the party leaving the others while they went off to look for a beam to bridge the well. Some were left out of sight among the coffins long enough to chop the gilded faces off all three lids. We could picture them hiding their plunder under their clothes when they heard that no beams could be found. Bricks had been hastily stuffed into the entrance, leaving the Princess Entiu-ny lying just where she had been dropped on the brink of the abyss.

"It was the morning of March 11 before the well could be crossed. We brought down a light beam and worked it across the deep well to the doorsill on the opposite side. On the first we slid a second beam, and on the two, a board. I crawled across on my hands and knees, tingling with curiosity.

"From the doorway on the other side there was one step down, and then inky blackness. I turned on my torch and flashed it around. I was in a chamber just high enough to stand up in, seemingly interminably long in the gloom—and blankly empty. For a moment the bottom seemed to have fallen out of everything, and then my light shone on a narrow doorway at the far end. I came to a standstill just within the doorway beside three little empty saucers and a dried and shrivelled bundle of leaves lying at the foot of an enormous recumbent figure. My light flickered along it, and came to rest on a great placid face staring fixedly upward

THE BRINK OF THE WELL

Here the empty outer coffin was dropped on the brink of the mysterious well



THE HUGE COFFIN

The inner wooden coffin of Meryet-Amun in the big outer coffin after removal of lid

in the deathly silence of the dark crypt. Then it flickered back and followed down a column of hieroglyphs announcing that 'the King gives a boon to Osiris, the Great God, Lord of Abydos, that he may cause to come forth at the call, bread and beer, beef and fowl, bandages, incense and unguents, and all things good and pure on which a god lives, and the sweet north wind, for the spirit of the King's Daughter and Sister, the God's Wife, the King's Great Wife, joined to the Crown of Upper Egypt, the Mistress of the Two Lands, Meryet-Amun, true of voice with Osiris.'

"On the 15th we raised the gigantic coffin lid and exposed a disproportionately small coffin inside. That was open, and we were looking at a slender little mummy, simply wrapped, and festooned with garlands still fresh enough to show the colors of their flowers. The inner coffin, while much smaller, had been almost as lavishly decorated. On the head we found a tenon hole which had once held the golden vulture head of a queen's crown, and all over the body were rows of nail holes showing that within and without the entire coffin had been encased in sheets of gold. None of this richness was left, however. In place of the vulture head on the brow a uræus had been painted; the wig was colored blue and the face yellow; a blue and yellow collar had been daubed over the breast; down the front was painted a copy of the inscription on the big coffin.

"WITH obvious signs of forcible opening on both coffins, we have a pretty clear story. At some time in antiquity, the tomb of Meyret-Amun had been robbed, and on the discovery of the outrage all that was possible had been done to cover up the damage. The date had been recorded in a docket; that second blocking of the doorway must have been done in 1049 B.C. by the necropolis officials who restored Meryet-Amun's mummy. So far we were still leaning toward our first idea that this tomb had originally belonged to Hat-Shepsut's courtiers. It was only when we had cleared the last of the rubbish out of the tomb that we changed our minds. A pile of rags had been thrown into the unfinished corridor to the left of the well. They turned out to be bandages ripped off a mummy, and among them we found one marked 'The God's Wife, the King's Wife, Meryet-Amun, beloved Amun. May she live!' These, then, were obviously the original bandages torn off Meryet-Amun's mummy by the thieves.

"Among other fragments of funeral furniture were bits of an enormous wooden coffin plastered over with white gesso. It had been actually big enough to hold the great coffin of Meryet-Amun. Here was the third outermost coffin of Meryet-Amun so completely wrecked by the thieves it had simply been swept out of sight at the time of the restoration. It followed that Meryet-Amun had been robbed here in this tomb. Thus we arrived at the conclusion that we had discovered the tomb of Queen Meryet-Amun.

"In the first corridor two things gave us a very good idea of the period when the tomb was constructed. That corridor passed obliquely under the north portico of the temple so close that the under side of the temple foundations was actually exposed in one place in the corridor roof, hanging precariously over our heads. Now it is possible to dig under foundations once they are set, and even to expose them without necessarily bringing them down, but it is absolutely impossible to lay heavy stones unsupported across a void. Thus the tomb must have been made after the middle of the Eighteenth Dynasty, when the temple was built. Therefore, we felt safe in dating the tomb of Meryet-Amun to the second half of the Eighteenth Dynasty, and her coffins confirmed this date absolutely. Meryet-Amun could not have been buried earlier than 1480 B.C., when the temple was finished, and probably not much later than about 1440 B.C. The only question that remained was to settle the identity of Meryet-Amun herself. Two queens of that name were known, but our queen could be neither. There remained a Princess Meryet-Amun—'the King's Daughter, the King's Sister, the God's Wife and Hand (-maiden?), sweet in love, living like Re'—portrayed in the Shrine of Hat-Hor erected at Deir el Bahri by Thut-mose III. This Meryet-Amun was the ranking daughter of Thut-mose III and of his Great Wife, Meryet-Re'. The Princess Meryet-Amun, the daughter of Thut-mose III, must have been the wife of his heir and successor, Amen-hotep II. Since Amen-hotep II succeeded in 1447 B.C., and as we already had evidence to place our Queen's death somewhere between 1480 and 1440 B.C., we felt convinced that the two Queens Meryet-Amun were one and the same person. During her father's lifetime she had been 'the King's Daughter.' After his death she had become 'the King's Great Wife.' But the last title—'the King's Mother'—had never been hers. She must have died soon after the coronation, for Queen Ti-'o occupied the position during most of Amen-hotep's reign. Of Meryet-Amun, no recognized trace existed until we found her tomb.

ORIGINALLY GOLD COVERED
Once of a richness comparable to the coffin of Tutankhamen, but vandals have completely stripped off the decorations

"KNOWING now, with fair assurance, who Queen Meryet-Amun was, we can complete the story of the tomb. Work was begun on it at least as early as her coronation but it was still unfinished when she died soon afterward. There was no time to hew out an actual burial crypt and her gigantic white outermost coffin was installed in the last of the unfinished passages beyond the well. On the day of her funeral came the enormous coffin overlaid with gold and brilliant with incrustations, the little innermost coffin just large enough to hold the mummy, and the mummy itself heavy with jewelry within its bandages. The coffins were closed, the richest of the tomb furniture was placed nearby, the bridge across the well was removed, and the baskets full of the less valuable clothing and food were stacked in the outer corridors. Then the entrance was carefully bricked up and the pit filled in—and Meryet-Amun lay in peace for the next four centuries."

Submarine Safety Advances

The "S-29" Is Now a Floating Laboratory for Testing Sub-Sea Safety Devices

SINCE 1923, eight United States submarines have been in serious accidents. Only three of these resulted in death to members of the crews but the great hazard of submarines to which all these disasters pointed served to accentuate the widespread insistence that safety measures be taken and safety apparatus be devised to protect, and save in case of trouble, the lives of submarine crews.

Loss of the *S-51*, on September 25, 1925, with five officers and 31 men was appalling enough but when the *S-4* was rammed and lost on December 18, 1927, with her entire crew, matters were brought to a head. The government renewed its submarine safety efforts in earnest. Thousands of ideas were submitted by scientists, engineers, inventors, and laymen. Most of these were quickly discarded but others were considered further; some have been worked out and tested, and a few are still being experimented with.

PERHAPS the most valuable device recently developed in this country is the Momsen "lung," an illustration of which is shown on this page. Named after its inventor, a lieutenant in the United States Navy, this lung is, in effect, a miniature diving apparatus which, when worn, permits the wearer to rise safely from a sunken submarine without danger of suffocating or drowning. This and the other devices shown here are installed on the submarine *S-29* which recently arrived in San Diego Harbor equipped with all the latest rescue and salvage devices. These devices will be tested this winter and early spring.

It has been asserted that submarine design and construction in the United States has been far in advance of that of other nations and our accidents fewer than in any other comparable navy. Not content with this high place, government experts are continually working to devise new safety apparatus and to improve the old.

LIFTING EYE

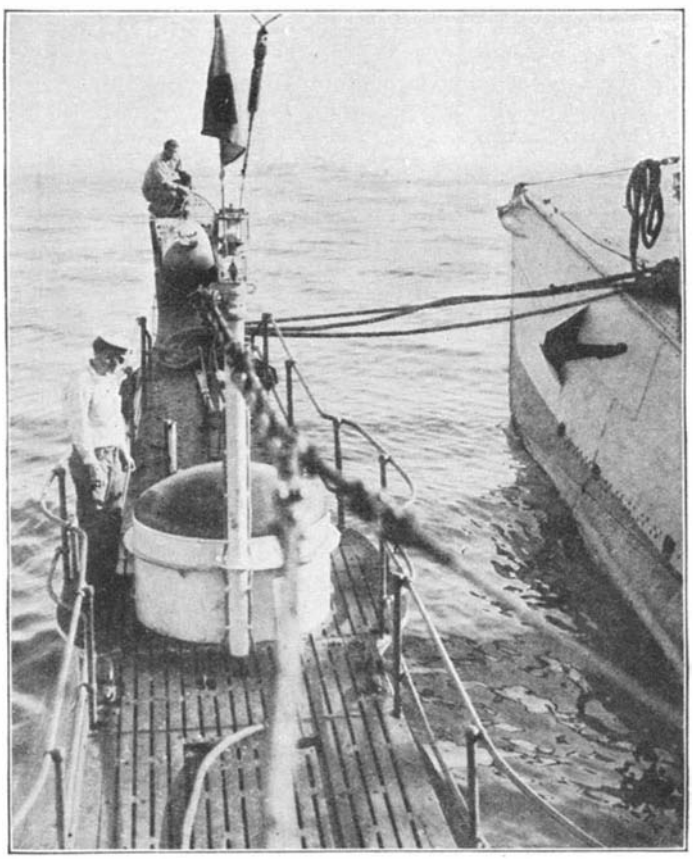
The eye on the hull of a submarine for attaching a pontoon

MOMSEN "LUNG"

The breathing mask which men will use to escape sunken submarines

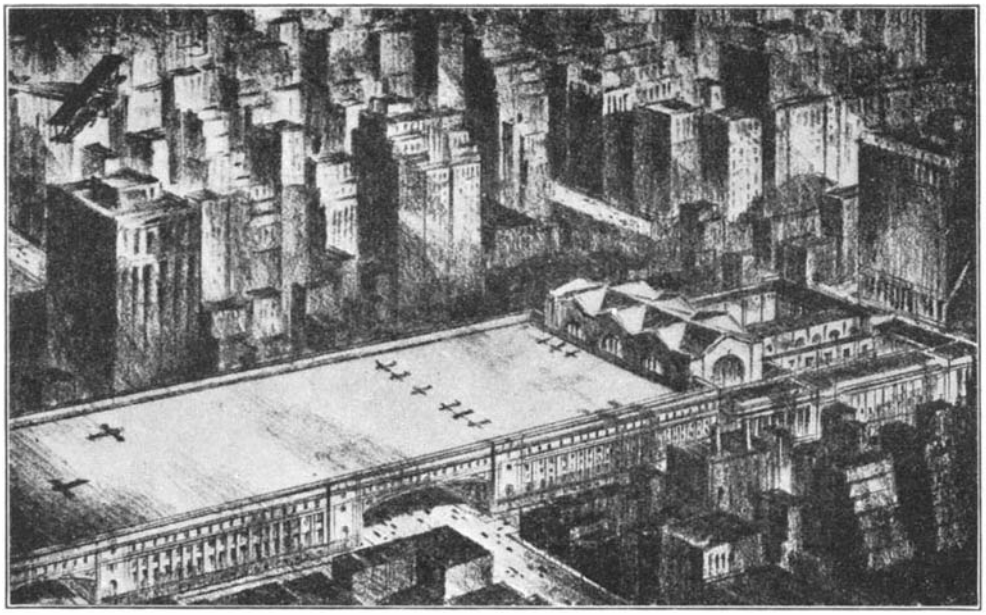
UNDERSEA COMMUNICATION

A member of the crew of the submarine *S-29* demonstrating the use of buoy telephones for talking with a sunken submarine



THE ESCAPE HATCH

This view taken from the conning tower shows an escape hatch and the buoy which carries a telephone line to the surface



IN THE HEART OF THE CITY

Planes landing on this platform "field" over the Pennsylvania Railroad tracks in New York City, conceived by Francis Keally, could discharge their passengers directly in the city while their mail could be shot directly to the branch post offices in the city by pneumatic tubes

Faster Airmail Terminal Service

Pneumatic Tubes Like Those in Cities Between Branch Post Offices Would Speed Airmail Between Post Offices and Airports

By HAMILTON M. WRIGHT

PNEUMATIC tube service for airmail from outlying airports into the post offices of large cities has been urged by a number of architects, engineers, aviators, post office officials, and others who, in the past two years, have given thought to the problems of aviation and particularly to the expedition of the airmail. Since the dispatch of airmail is the backbone of commercial aviation in this country, and since the airmail is constantly assuming larger proportions, any means which will improve this new branch of the postal service is worthy of careful analysis. The present importance of airmail is illustrated by the fact that the scheduled daily mileage of mail pilots in June 1929 was 38,689 miles! But this is only a beginning. Important postal officials have predicted that in a very few years *all* first-class mail will be carried by air.

Unfortunately for aviation, obstacles dangerous to fliers exist in the vicinity of large cities so that mail-contract airports are necessarily located at some distance from post offices and commercial centers. These suburban locations place air terminals at a disadvantage as compared with railway terminals which are much nearer the post offices.

A pneumatic tube for carrying mail between airports and post offices would, however, offer safe, economical, uninterrupted, and rapid service. It is, of course, essentially adapted to large cities where the amount of mail is vast and where the airport is, generally speaking, six to 15 miles distant from congested centers. Other means to overcome the handicap of airports have been suggested, such as dropping the mail from parachutes into nets, building landing stages on the roofs of tall city buildings, or constructing elevated landing platforms above switching yards or wharves in cities adjacent to commercial centers. All these, however, are inherently more or less uncertain or dangerous, and even a helicopter plane, it is said, would not find the proximity of large city buildings conducive to complete safety.

THERE is a great inconsistency between the 100-mile-per-hour, or more, rate of fliers to carry the airmail on time and the slow truck traffic to the distributing centers. It takes a bus 45 minutes to run between the Newark airport and the Hotel Pennsylvania opposite the main New York Post Office.

This sort of delay, to a greater or less degree, but always to an important extent, will occur where trucks must be employed to carry mail between airports and post offices through congested areas of great cities. The red stop light traffic signal is no respecter of vehicles, not even of mail trucks.

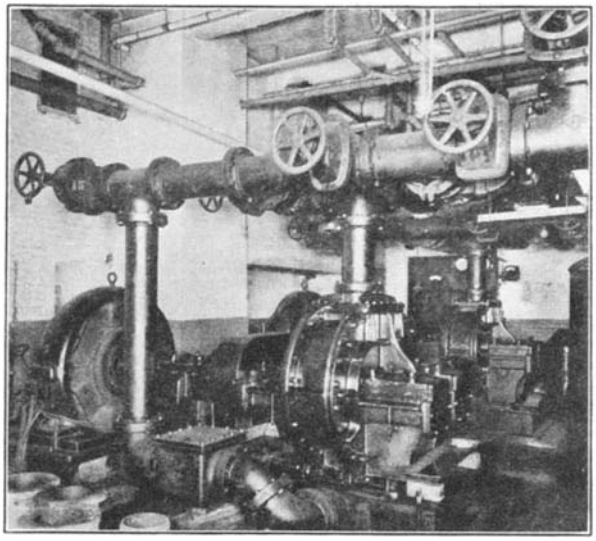
The Joint Commission on Postal Service which from 1921 until 1924 made an exhaustive study of the postal system, reported to Congress that on one day that was studied 27,166 mail containers with a capacity of 10,846,400 letters were dispatched through the pneumatic tubes in New York City, and that, for each letter delayed by the tubes, 3915 letters were delayed by the motor vehicle service. They also said that the operation of the tubes and the reduction of the motor vehicles service would reduce the number of accidents in congested streets of New York which, in 10 months, resulted in seven cases of fatal injury and 99 cases of other injuries caused by government-owned vehicles.

Other points were that the pneumatic tubes as a means of transmittal of the mails are secure and reliable; that the delivery of letters is expedited from two to four hours or more by utilization of the tubes, and that the speed of transportation by tube is 30 miles per hour, whereas the speed of transportation by motor vehicle in New York is but 7½ to 10 miles per hour; that approximately half a million letters a day would be advanced in delivery by means of the tubes; and that the tubes have a value apart from speeding the mail, in that they stand ready at all emergencies and are not subject to the

irregularities experienced by the motor vehicle service.

Largely as a result of this report, the pneumatic mail-tube service was resumed in New York and has given excellent results. Letters are now carried more than 140,000 carrier-miles per day beneath the streets of New York, equal to a daily journey of five and two thirds times around the world. The "petit bleu" pneumatic tube service for special delivery mail in Paris is too well known to any experienced visitor there to require any description. Pneumatic tube service also exists in London, Liverpool, Berlin, Vienna, and other cities.

In New York City the pneumatic tube system consists of 27½ miles of double tube extending between the Battery and 125th Street on both sides of the city, and across the Brooklyn Bridge to the Brooklyn Post Office. There are between four and five miles of double tube in Brooklyn.

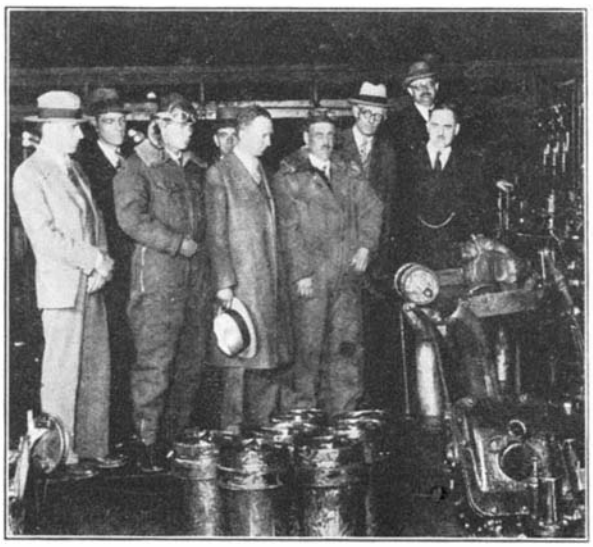


BROOKLYN AIR POWER STATION

Electrically driven compressors and rotary blowers which supply air to the tube system in Brooklyn

IN New York the operation has reached a remarkably high stage of efficiency. The efficiency of service for several years has averaged better than 99 percent. Interpreting the figure 99.9661 percent for 1928—a typical year—we see that the pneumatic mail-tube service in New York City was within one twenty-fifth of 1 percent of perfect operation. The saving in time in the arrival of mail at its post office destination to reach early mail carriers and for outgoing mail to reach departing trains is one of the outstanding advantages of the system. This advantage could as readily be transferred to the dispatch and receipt of airmail.

The cost of constructing a pneumatic tube system similar to that in New York is estimated at approximately 19,500 dollars per mile. It would cost, therefore, approximately 195,000 dollars to install the system between Barren Island, New York City's new municipal airport, and the Brooklyn Post Office. But the tube would pass five post offices en route and give important factory districts the same mail service that Wall Street now enjoys. Installation of smaller sized tubes like those used in Berlin—for example about 2¼ inch—would cost less for less important airports. The tube system in New York is privately owned, the owners contracting with the government for the handling of mail. According to the majority report of the Town-send Congressional Committee, their use effected a saving as compared to mail trucks.



TUBE MACHINERY

Clarence Chamberlin, consulting engineer for the Barren Island airport, who advocates a mail tube system between the port and New York City, inspecting the pneumatic tube machinery at the General Post Office, New York City

Just a word as to construction of the tubes. They are made of sections of cast-iron pipe approximately 12 feet long, bored out to an inside diameter of 8⅛ inches—designated as 8-inch tubes—and joined together with bell and spigot joints caulked with lead or other suitable material. Change of direction in the tube is accomplished by sections of tube bent to a long radius at true curvatures to permit the containers to slide along without reduction in speed.

The tubes are laid approximately four feet underground between stations.

The containers in which the mail is packed are steel cylinders, 7 inches in diameter and 21 inches long (inside dimensions), and weigh approximately 20 pounds each when empty. The front end of the container is solid and is equipped with a leather buffer designed to absorb the impact when the container is brought to rest. The rear end of the container is a hinged cover, which is opened for the insertion of mail and which, after being closed, is locked by means of an eccentric lever connecting with inside bolts which engage the rim of the cylinder in suitably designed slots. When the cover is unlocked this lever projects beyond the edge of the outside periphery of the cover, thus preventing the container being placed in the tube until the cover is properly locked.

The shell of the container is kept from contact with the tube by means of two bearing or packing rings located near the ends of the container, composed of cotton, duck, and vulcanized rubber, and held in place by keeper rings brazed to the shell of the container. The container slides in the tube on these packing rings, and the tubes are lubricated from time to time to facilitate the passage of the container. The power which propels the containers through the tubes is a current of air which is maintained constantly through the tube at a pressure of from four to eight pounds per square inch, according to the length of the line, by electrically driven air compressors and rotary blowers.

Each station on a pneumatic-tube line is equipped with a receiving and sending apparatus, commonly called a "receiver" and a "transmitter," and the containers are relayed at each station on the line until they reach the station of delivery.

DIFFERENT types of "receivers" and "transmitters" are used, the receivers being divided into two general types—the "open" and the "closed." With the open receiver, the container is brought to rest by the friction created in its travel around a circular table or trough formed of a half longitudinal section of tube bent to the desired radius. With the closed receiver the container is brought to rest by the compression of air in the dead end of the tube forming an air cushion which, in turn, opens a valve and ejects the container. The "transmitter" most commonly used is of the gravity type, set in the floor at an angle.

The container is dispatched by placing it in a scoop or trough with its front end resting against the upper gate. This gate opens at the interval of time fixed by a time clock, allowing the container to drop into the air chamber. Air pressure is then brought behind the container, forcing it through the lower gate and into the tube, where the current of air carries it to the next station. The system is similar to a stream of water into which floating objects are dropped at stated intervals.

What's In the Sun?

Not Only What Elements Exist in the Sun's Atmosphere, But Now Their Percentages, Have Been Worked Out by Improved Analysis

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

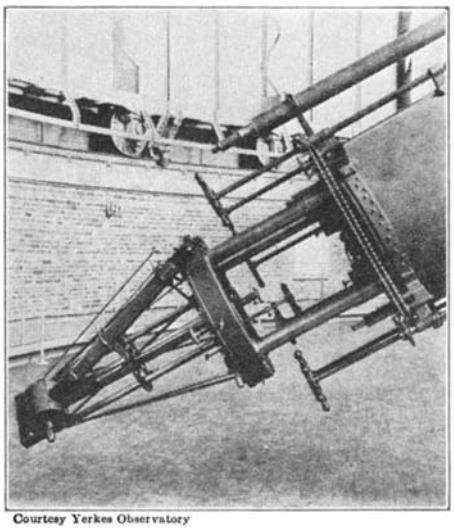
WE told last month how, by measuring the width of lines in the solar spectrum, it is possible to find how many atoms are at work above a given area (say a square centimeter) of the sun's surface in absorbing each particular line. Many readers doubtless realize the possibility of using this method for an improved analysis of the composition of the solar atmospheres. The older method which depended merely upon the identification of solar lines told us only what elements were present there. It was like the qualitative analysis with which the student of chemistry begins—very like it indeed, for these tests in the laboratory give the student an idea whether a given metal is present in large quantities, small quantities, or mere traces, and the same can be concluded from the presence of strong lines, weak ones, or very faint ones in the sun.

But the chemist will not be satisfied with this information. He devises schemes for quantitative analysis which end by telling him the exact percentage composition of the substance he had studied. To do the same for the sun and perhaps also for the stars has long been one of the dreams of the astronomer. Now the dream is coming true.

FIRST steps were taken by Professor Milne (now at Oxford) who devised ways by which the composition of different stars could be compared, even though some were hotter than others. Miss Payne, working at Harvard by this method, found that the numerous stars which she studied were "remarkably similar" in composition, and obtained good estimates of the relative abundance of a considerable number of the more important elements. Now the analysis has been carried further and applied to all the 57 elements which have been detected in the sun's atmosphere.

At first sight the problem looks simple enough. If we can measure the width (technically speaking, the "contour") of one line and calculate how many atoms are at work making it we can do so for all the 20,000 lines in the solar spectrum. Then, adding together the results for all the lines of iron (for example) we have the amount of iron in the sun's atmosphere.

But it is not really quite so easy. In the first place the finer lines are so narrow that even our greatest spectroscopes lack the defining power to show them perfectly; they make them look wider and less black in the middle than they really are. Moreover, influences in the sun's atmosphere may widen the lines slightly—not enough to count for a strong line but quite enough to upset our calculations on a weak one. Fortunately there is an easy way to get around this difficulty. There are hundreds of groups of lines—"multiplets"—in the spectrum for each of which we can calculate theoretically the relative number of atoms at work. For example, twice as many calcium atoms are "doing" the K line as are at work on the H line. In other cases the rate runs up to 100 or even 1000.



Courtesy Yerkes Observatory

SOLAR SPECTROSCOPE

Attached to the great 40-inch refractor at Yerkes Observatory. A more or less "typical" instrument for work on the sun

BY utilizing the rich material thus available it is obviously possible, and was not very difficult when it was tried, to find the relative numbers of atoms which were required to produce lines of different intensities on the arbitrary scale which Rowland used in the great tables of the solar spectrum. We already have, thanks to Unsöld, determinations of the actual numbers of atoms at work on a dozen or so of the stronger lines. With this starting point we can now find it for all the rest.

For the lines which Rowland described as of "intensity 0," that is, those which were just strong enough on his photographs to measure easily, the number of atoms at work comes out at 6,000,000,000,000 (6×10^{12}) above every square centimeter. This looks startlingly big, but a layer of ordinary air 1/1000th of an inch thick contains 6×10^{12} as many molecules per square centimeter. So we reach the amazing conclusion that to produce one of these faint solar lines would require only a layer of gas 10,000 times thinner than air and a thousandth part of an inch thick, provided of course that all the atoms of this gas were at work on the line. Remarkable as this is, it is fully credible to anyone who knows the extraordinary delicacy of the spectroscopic method of analysis, which habitually reveals traces far too small to be detected by ordinary chemical means.

THE general run of the strong lines of the spectrum for which Rowland's intensity numbers range from 7 or 8 up to 40 demand for their production from 1000 to 20,000 times as many atoms; the H and K lines, which are vastly stronger than any other, about a million times. For the faintest line (of intensity -1 to -3) the number varies from 30 percent to 2 percent of the standard.

We have now overcome this obstacle and can calculate with some confidence how many atoms produced each line. We should be near our goal if the whole extent of the sun's spectrum could be observed.

But this, though it might be possible if we could set up an observatory on the moon, is out of the question for us who dwell on the earth. The atmosphere above our heads, although reasonably transparent to the kind of light which our eyes can see, obstructs the passage of most others. Not very far beyond the range of ordinary observation in the violet, and hardly at all beyond the limit to which the human eye can see under favorable circumstances, the air becomes opaque. For waves of light shorter than about 3000 Angstrom units (the ordinary violet is at 4000) our air transmits not the faintest trace of the rays, which we have no doubt at all that the sun emits and emits strongly.

We know what is to blame—a small proportion of ozone in the upper atmosphere higher than any aircraft or even a pilot balloon may hope to rise. Beyond the wavelength

limit mentioned, down through the whole range of shorter light waves, all direct knowledge of the radiation of the sun and stars is permanently denied us.

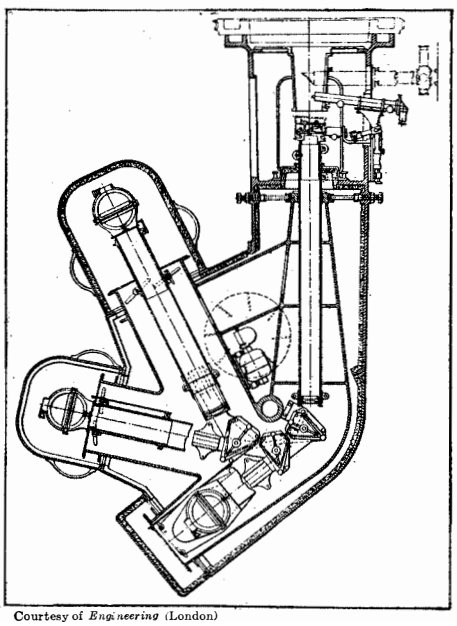
Beyond the red end of the spectrum things are not quite so bad, but there are wide and heavy bands of absorption, due mainly to water vapor, which cut off great regions of the spectrum, and the rest can be observed only by heat-recording devices which, sensitive as they are, are vastly inferior to the eye or the photographic plate. Only the portion of the spectrum between 3000 and 11,000 Angstrom units is accessible to precise astrophysical study.

If, then, an element has practically all its strong lines in this accessible region we will obtain a correct determination of the amount of it in the sun's atmosphere. But if not, our estimate will be too low and may be altogether vitiated.

A few years ago, before the structure of the more complex spectra was understood, this difficulty would have been insurmountable. But now we know for a large majority of the spectra not merely what sort of atom produces the lines but in what state the atom has been to absorb any given line. Some are given by neutral atoms, others by ionized atoms which have lost an electron. Some are produced by atoms in their normal state, others only by atoms which have been "excited," that is, loaded up with an additional store of energy and so raised to one or the other of a large number of additional states. The great majority of the atoms of any one element at any instant will be in the normal state, but a certain proportion will be in each of the excited states. This proportion can be calculated if we know how hot the sun's atmosphere is—which fortunately we do pretty well. For some of the metals such as iron and titanium the strongest lines absorbed, both by the normal state and several of the excited states, are accessible. We can then find the number of atoms in each of these states and the results check with the theoretical calculations closely enough to indicate that it is really safe to apply the theory (which was devised under the assumption of simple idealized conditions) to the actual atmosphere.

THE "abundance," that is, the number of atoms above a square centimeter of the sun's surface, may then be found for a large number of the metals. For some of the others, such as magnesium, the lines absorbed from the normal state are practically all in the ultra-violet and inaccessible, but the lines of the excited atoms remain to work with, and having tested our method we can calculate the whole number of atoms with confidence. Indeed we can get a good idea how strong the principal lines of these elements would appear if we could get outside the earth's atmosphere and look at them. There is a great line of magnesium, for example, at λ2852 (just inaccessible) which must be even stronger than the H and K lines.

So far we have really been talking only about the arc lines, those of the neutral atoms. The ionized atoms must be handled separately but can be treated quite in the same way. In most cases the "ultimate" lines absorbed by the ions in their normal state are quite out of reach, but there are several elements—calcium, titanium, and so forth—for which we can get at them. In these cases we can find the whole number of ionized atoms, as well as that of the neutral atoms. Now the latter of these two depends not only on the temperature of the sun's atmosphere but also on the average pressure; and also, of course, upon the ease of ionizing atoms of each sort. It thus enables us to calculate this average pressure. The results, calculated independently from five different elements, agree satisfactorily.



Courtesy of *Engineering* (London)

A TYPICAL SPECTROGRAPH

Made by Hilger for the new 36-inch reflector for Edinburgh Observatory. Cross-section shows heat-insulated case, motor-driven fan for even air distribution, three prisms, and three cameras. Note hole for main pivot. This permits moving any camera to any part of spectrum

We can now handle one more situation which previously was intractable. Sodium, for example, is very easily ionized, but the principal lines of the ionized atoms are far out in the inaccessible region, and so the amount of ionized sodium can not be found by our spectroscopic analysis. Knowing, however, the average pressure, we can calculate it, and it comes out 1600 times as great as that of the neutral element. The familiar D lines of sodium in the yellow, then, although they are strongest in this part of the spectrum, must be mere wraiths of what we would see if the sun's atmosphere were cooler and the ionization much smaller.

Working step by step it has finally been possible to obtain a complete quantitative analysis of the sun's atmosphere with respect to the metallic elements.

The non-metals are much harder to handle, for their ultimate lines are utterly out of reach, and the only lines we can get at are produced by highly excited atoms. Theoretically, at the sun's temperature not one atom in a million should get into such a state. Various factors of which it is not yet practicable to take exact numerical account may, however, operate to modify this number. The fact that these high excitation lines are present at all in the sun, although faint, shows that the corresponding elements, oxygen, carbon, sulfur, and so on, must be very abundant, but only the roughest numerical estimates can be made. Hydrogen is remarkable, for its lines, although absorbed only by very highly excited atoms, are among the strongest in the whole solar spectrum. There can be no doubt that it is much more abundant than any other element—if we count atoms by number, and light as its atoms are, their total weight probably exceeds that of those of any other sort.

AN investigation recently completed by the writer leads to the following estimated composition of the sun's atmosphere:

	Parts by Volume	Parts by Weight
Hydrogen	60	60
Helium	2?	8?
Oxygen	2	32
Metallic vapors	1	32
Free electrons	0.8	0.0005

The numerical values just given may be considerably changed by future work, but the hydrogen flavored with oxygen and metallic vapors seems likely to stand.

The amounts of the various metals can be stated with much more confidence. Expressed in grams per square meter of the sun's surface the amount of the principal metals are:

Sodium	40	Scandium	0.02	Cobalt	2.5
Magnesium	150	Titanium	0.8	Nickel	4.
Aluminum	6	Vanadium	0.5	Copper	0.6
Silicon*	60	Chromium	2.5	Zinc	0.5
Potassium	25	Manganese	4	Strontium	0.015
Calcium	20	Iron	100	Barium	0.025

No other metal reaches as much as 0.01.

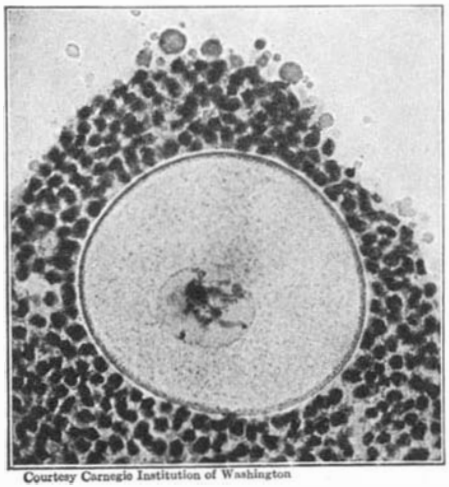
Many conclusions might be drawn from this table but there is no space to speak of them now.—*Florence, Italy, Nov. 3, 1929.*

*Silicon behaves spectroscopically like a metal.

How Large Is the Human Egg?

Some of the Findings of Recent Research Upon the Eggs of the Human Species, and Those of Other Mammals

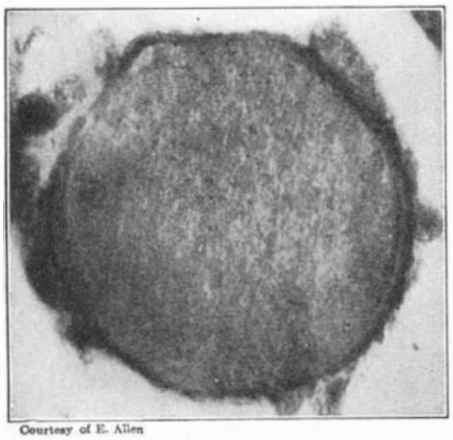
By CARL G. HARTMAN, Ph.D.
Research Associate, Department of Embryology, Carnegie Institution of Washington
Carnegie Laboratory of Embryology at Johns Hopkins Medical School



Courtesy Carnegie Institution of Washington

A HUMAN EGG

The egg is surrounded by nurse cells in the ovary. The view is a cross-section



Courtesy of E. Allen

YOUNGEST HUMAN EGG

The youngest human egg yet discovered. Unfortunately this egg was not fertilized

THAT there is such an object as an egg, wherein every human being has his origin, no longer astonishes the layman. Few people, however, realize the minuteness of this all-important microcosm, which is pretty near the borders of unaided human vision. To gain a concrete notion of the size of a human egg, scatter a pinch of sea sand over a sheet of black paper and find the smallest visible grain. This is of the order of magnitude of a human egg. Yet this egg is larger, by a fraction, than most mammalian eggs—it is about double the size of those of the mouse or the rat, which are the smallest, and larger than that of the horse or the cow. But such differences are not significant.

It is no wonder, therefore, that the egg of mammals should remain undiscovered so long, for it was not until the year 1827 that von Baer, a Russian biologist working in Germany, was able to point out the egg of mammals and to tell us something of its size and where in the ovary it was to be found. This marked an epoch in the study of human and animal life.

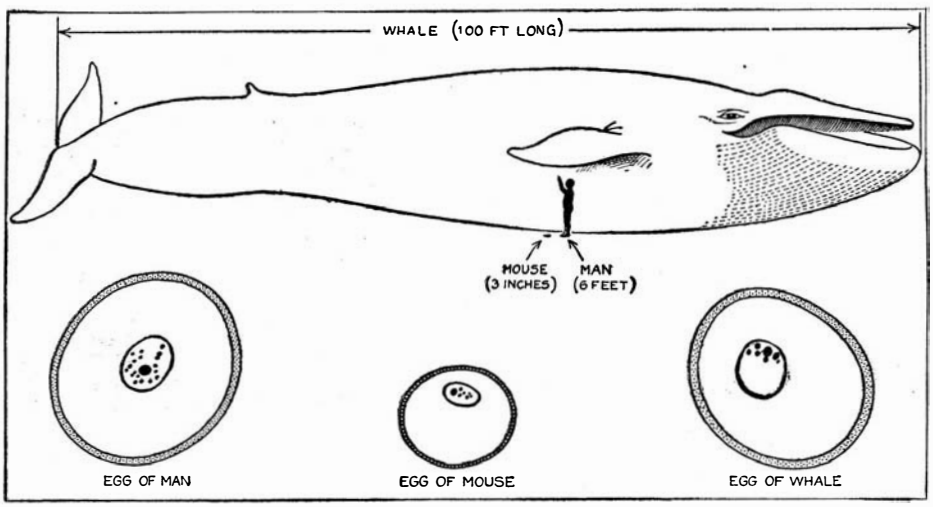
Throughout the hundred years following, many mammals were studied, rabbit eggs being especially singled out. This was for biological reasons and not because of the traditional activity of the Easter Bunny—the legend of Mother Rabbit is older than any scientific studies upon her. Rat, mouse, dog, cat, pig, and other species have yielded eggs in greater or lesser abundance, according to the difficulty of finding the eggs in any given animal species, and depending upon the perseverance and ingenuity of the investigator.

As a result, we know pretty well what happens during the first few days after conception in a half dozen species of animals; indeed, it has been possible to record in motion pictures the changes of the rabbit egg during the first five days of its development.

Until last year no one had ever succeeded in finding a freshly shed human egg, although a year and a century had passed since von Baer first saw the human egg in the ovary. The fact remains, however, that, except by analogy with animals, we know almost nothing about the development of a human being during the first 12 days of embryonic life. This hiatus in our knowledge bids fair to be filled within the next few years.

THE small size of the mammalian egg demands an explanation. It is the smallest egg of all the vertebrates, yet mammals are among the largest animals that ever walked the earth or swam the seas. By way of contrast, the ostrich egg measures six inches in length and holds a quart of food for the ostrich chick; a certain man-eating shark has an egg eight and one half inches in diameter; the eggs of snakes and turtles, fishes and frogs, possess yolk and egg-white to nourish the developing embryos, so that upon hatching they can survive in a new environment. The mammal embryo, however, and even the egg before the appearance of the embryo, has learned to parasitize the mother directly. Not content to consume the food which the mother's organs place into the egg (as is the case in the bird, for example), the mammalian embryo "digs in" and lives at the expense of the mother's body. It effects its purpose by growing a system of blood vessels and laying them down next to those of the mother's womb. There food and waste substances are exchanged, and there the embryo may remain during a variable length of time until birth.

There are some exceptions to this rule for mammals—links, as it were, in the evolutionary chain. There are, for example, the curious monotremes of Australia, that land of biological surprises—two genera: *Ornithorhynchus*, or the duck-billed platypus, and



WHALE EGG, HUMAN EGG, MOUSE EGG—ALL ABOUT EQUAL SIZE

All the mammals have eggs of approximately equal size. The whale, largest mass of flesh controlled by a single brain, originates in an egg little larger than that of a mouse

THE author of the accompanying article modestly has made little or no direct mention of his own part in the newer research on the living egg of the mammal. The especially interested student will find a technical study of the subject, with further bibliography, by the same author, in the *Quarterly Review of Biology* (Baltimore) Vol. IV, No. 3—*The Editor.*

Echidna, the Australian ant-eater. These mammals actually lay eggs: the ant-eater deposits an egg into a brood pouch on her abdomen; the duck-bill lays a pair of eggs in its nest where it incubates them like a hen. Comes a time for the young to hatch. These wiggle about the milk glands of the mother, setting up an irritation that results in the milk oozing out. This the babies lap up, for these mothers have no nipples. Since they have mammae, or milk glands, it must be admitted that they are mammals, but the mammae have only just "arrived."

Next in the evolutionary series are the marsupials, which, as the name implies, have abdominal brood pouches like the *Echidna*. Our American curiosity, the opossum, is our only marsupial; the others, like the kangaroo, all live in Australia. The marsupials no longer lay eggs; their eggs are reduced in size like those of other mammals, but are provided with eggwhite and a shell membrane. These increase the size of the egg so that only 50 can be laid in a row to make an inch, instead of 170 without the envelopes. Of the full-sized eggs with the envelopes, a thimble would hold no more than 15,000. The opossum eggs are beautifully transparent things when well illuminated under the microscope. Magnified, they look like delicate soap bubbles or spheres of blown glass.

The opossum embryo develops in the mother's womb for only a short time—it is not yet an expert in parasitism. After only 12 or 13 days the babies must be born; tiny bits that they are, 18 of them will just comfortably fill a teaspoon. But Nature has its compensations; it has provided a brood pouch on the mother's belly around the tiny udders. Here food, warmth, and shelter for two months bring the babies to where their eyes are open and their legs are strong.

A PEG higher in the scale come the rabbits. Their eggs have no shell membrane, but they still possess a large amount of egg white, like their contemporary ancestors, the marsupials. All other mammalian eggs, including the human, have lost the egg white and are tiny spheroids of protoplasm. They have become much alike. There are minor differences: the opossum egg has more fat, the dog egg is opaque, while those of the mouse and rat are very transparent. Fundamental differences doubtless exist but they are not discoverable by present means. All rabbit eggs look alike, yet if you take the eggs from a black rabbit and place them in a white mother, the offspring will all be black.

Perhaps the differences between a mouse egg and a whale egg are as great as between adult mice and whales, but size is not one of the characteristics wherein they differ. From the Greeks to the moderns, philosophers have theorized on this point, but their theories are of historic interest and belong to the realm of metaphysics, not biology.

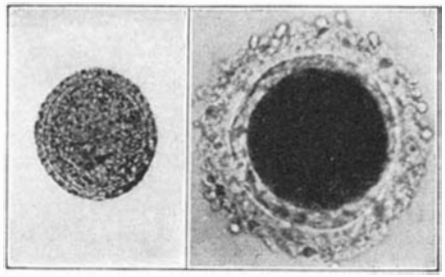
To visualize still better the minuteness of the eggs of mammiferous quadrupeds, let us single out the human egg and make another comparison. Let us assume that the entire human race comprises in the aggregate two billion individuals. Suppose one could assemble in one place all of the eggs from which will arise the next generation of mankind—2,000,000,000 eggs. How much space would they occupy? Would they amount to a houseful, or a roomful, or a hatful?

The last guess is right—a derby hat would suffice. The largest egg known to science is that of the recently extinct Madagascar bird, the *aepyornis*—an egg over a foot in length. This largest of vertebrate eggs will hold 2,000,000,000 of the minute eggs of mammals. The largest mass of animal flesh that ever lived as an individual, controlled by a single brain, is the whale; yet the eggs of mouse, man, and whale are approximately of equal size.

NOW each human egg, before it can develop, must be "fertilized" by a male cell or spermatozoon. Male sex cells are tremendously smaller than the eggs: the 2,000,000,000 of them necessary to fertilize the eggs from which will come the next generation of mankind would easily go into an elliptical vessel the size of a capital letter "O" on the text page of this magazine.

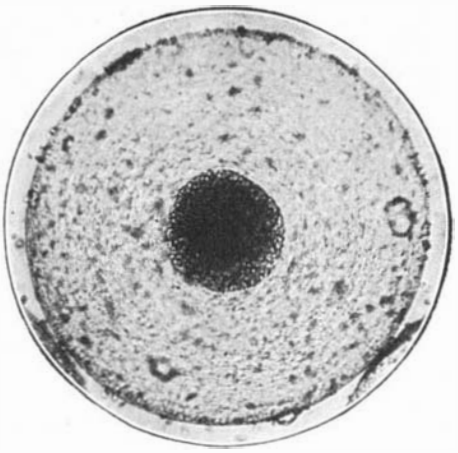
What a microcosm is such a fertilized egg, carrying as it does all the hereditary qualities from both parents that make the individual, into whom it develops, what he is! It is an entity in size somewhere near half way between the electrons and "corpuscles" of which matter is composed and the vastness of space known to the astronomer. Yet in the fertilized egg is bound up the capacity to develop into the complex mechanism of the human body; it has represented in it, perhaps by actual molecules capable of infinite and eternal multiplication, all the characters which the individual inherits from his parents, his grandparents, his ancestors back through the vistas of time, racial and familial—color of skin, hair, and eyes; stature and constitution; temperament and character. These myriads of factors are, moreover, represented, not in the whole egg but only in its tiny nucleus, which, in its turn, contains those self-perpetuating molecules, the genes, that determine at fertilization what each individual shall be.

Truly the unfolding of an individual from the egg is the most marvelous phenomenon in Nature. The evolution of organic forms through eons of time pales beside what we can witness daily, superficially at least, in the development of the individual from the egg.



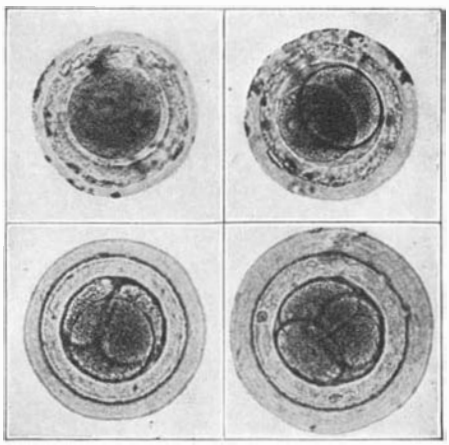
EGGS OF MOUSE AND DOG

The mouse egg (left) is rather transparent, while the egg of the dog is opaque



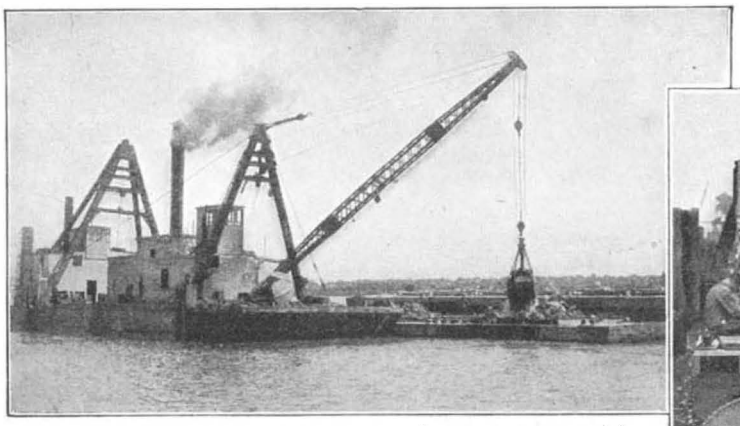
CLOSE-UP OF OPOSSUM EGG

All of the pictures on this page are photomicrographs of actual living eggs



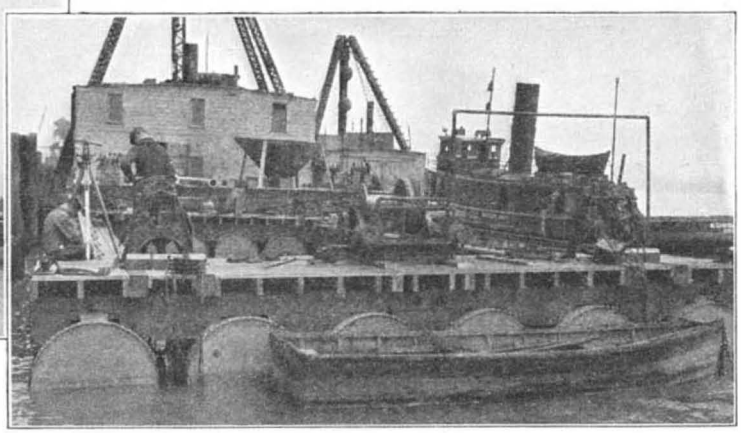
DIVIDING RABBIT'S EGGS

These have been fertilized and are developing. Note one, two, three, and four-celled stages of cellular development



THE "JUPITER"

The floating dredge which excavated the half mile long river-bottom trench for the tunnel sections, which were sunk in place



THE "NONE-SUCH"

Specially designed craft from which a steel grillage was dragged to level off the sand and gravel bed of the trench for the tubes

Detroit Digs Under to Canada

Vehicular Tunnel Under Detroit River, Soon to be Completed, Will be Important International Highway Connection

By HARVEY KLEMMER

A PRODIGIOUS step in Man's never-ending conquest of natural barriers is being taken at Detroit, where engineers are constructing the world's first international vehicular tunnel between that city and the Canadian municipalities across the river. It is particularly fitting that Detroit, the automobile capital of the world, thus should blaze a new trail for the automobile. Crossing the Detroit River always has been a tedious ferry process; the Detroit and Canada tunnel will bring the downtown districts of Detroit and Windsor, Ontario—the Canadian terminus—within three minutes of each other, supplying at the same time a transportation link of importance to all of Michigan and the Ontario Peninsula.

The tunnel has been under construction for the past two years, with the official opening scheduled for this summer. The tube is approximately one mile long, will cost 25,000,000 dollars, and terminates in the heart of the business district at each end. The traffic capacity will be 1000 vehicles per hour in each direction.

This is the third sub-aqueous roadway to be constructed in the United States, and the first to be constructed internationally. The other two vehicular tunnels in the United States are the Holland Tunnel connecting New York City with Jersey City, and the George A. Posey Tunnel under the estuary at Alameda, California.

Construction of the new tunnel is being accomplished by three separate and distinct methods. Some of the engineering processes are similar to those employed on previously-constructed tunnels; others offer new and distinct departures from any methods of construction previously used on an undertaking of this kind.

The work has been divided into five sections in accordance with the methods of construction. The five sections in turn fall into three general classifications. Sections 1 and 5 are the usual box type of subway, with steel bents and concrete jack arches, and are being constructed by the "open cut method." This method of construction is being used on both of these sections up to a depth of 53 feet below street level. Sections 2 and 4 are being constructed by the "tunneling shield method" and extend from the open-cut operation approximately to the harbor line at each end of the tube. Section 3—the river operation—is being constructed by the "trench and tremie method," embodying the sinking of previously-constructed tubes in a trench dug across the bottom of the river.

BY far the most spectacular of all the tunnel operations is the construction of section 3. This is composed of nine steel tubes, all built on dry land, launched like ships, floated into position, and then sunk merely through the weight of interior and exterior concrete. Several engineering departures are involved.

Most land-built tunnel sections heretofore have been sunk through the addition of water or sand to the interior. If they were concreted, that operation generally was performed after the tube was in its river-bottom resting place. Tubes for the Detroit River tunnel, on the other hand, were fully concreted inside and out while on the surface and then sunk without admission of any foreign material to the interior. So accurately was the weight of the concrete computed that each tube thus far has been made to sink practically of its own weight, the addition of a few concrete blocks being sufficient ballast in each case.

The tubes, varying in length from 220 to 248 feet with an over-all diameter of 35 feet, were constructed on a launching way at the plant of the Canadian Bridge Company at Ojibway, Ontario.

As each segment was completed, it was fitted with heavy, water-tight bulkheads and sent down the ways. The interior and some of the exterior concrete then was applied, and the tube was ready for its five-mile journey to Detroit.

Each tube when launched weighed about 500 tons. When partially concreted for towing upstream, its weight had increased to some 4000 tons. When fully concreted the tube became an 8000-ton monster of steel and concrete.

The final concreting was accomplished at an anchorage constructed in the river several hundred feet from shore. As the tube gradually sank beneath the river surface, a large buoyancy scow was placed over each end and the tube suspended from lines

attached to winches aboard the scows. The whole outfit then was moved into position over the previously-excavated trench and, moored to anchorages in all directions, the tube was gently lowered into place. Specially-designed flanges permitted locking of the tubes together under water by the three divers kept constantly on the job.

Exact alignment of the tubes was accomplished through the use of tall masts attached to each tube as sunk. When the tube came to rest on its bed of sand and gravel, the tips of the alignment masts were used for exceptionally accurate lining-up. The nine tunnel tubes must be projected across the river bottom to meet the Canadian shield-driven section with an error of less than one inch!

Photographs courtesy Goodwin, Inc.

SANDHOGS USING POWER KNIVES

Note consistency of clay, a slice of which is held by one of the men. The knife is a cable-pulled sharp ring

THE irregular bottom left in the trench by the dredging operation was smoothed over by means of a special contrivance designed for the tunnel job. This strange craft, christened the *None Such* by the men, consisted of a huge pontoon arrangement supporting a carriage on tracks. From the carriage was suspended a steel grillage approximately the width of the trench. Sand and gravel were poured into the trench and leveled off by dragging the grillage back and forth over the area to be prepared.

The tunnel shield used for the excavation of sections 2 and 4 is the largest in North America and when designed, was the second largest ever built. The Holland Tunnel, which consists of two tubes, each smaller in diameter than the Detroit tunnel, required smaller shields. The shield has an outside diameter of 32 feet 3 inches, and is 15 feet long. The outside diameter of the steel tunnel lining measures 31 feet 8 inches. The inside diameter throughout will be 28 feet. A 22-foot roadway will allow one lane of traffic in each direction, with an extra lane for emergency purposes.

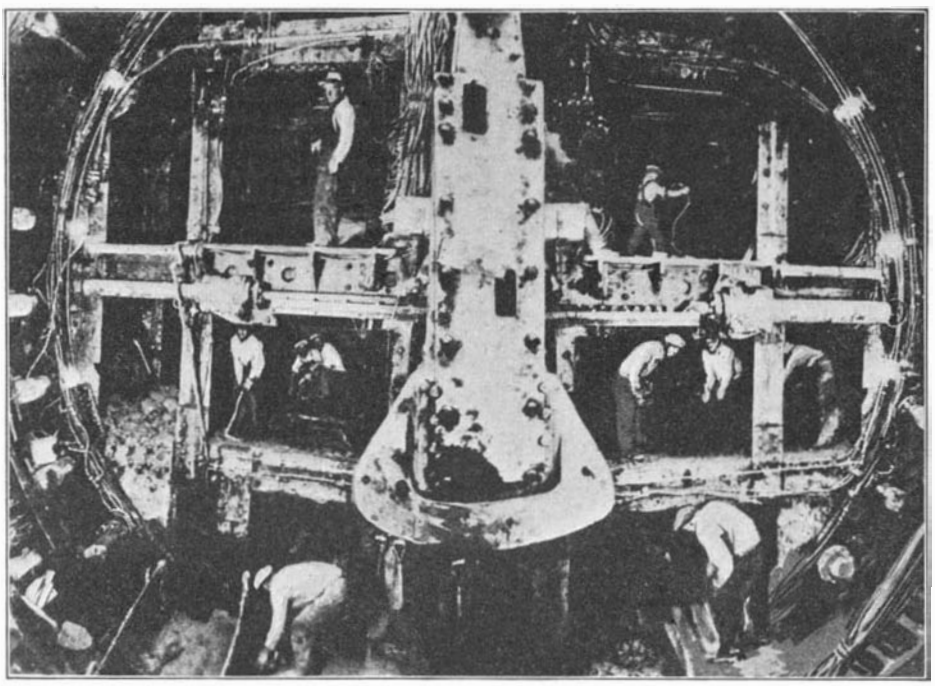
Progression of the shield-driven section of the tunnel resembles the operations of a giant mole. A gang of workmen known as "muckers," or "sandhogs," digs ahead of the shield, slicing away the earth with power-operated knives. When they have excavated a few feet in advance of the equipment, the shield is forced ahead 30 inches to occupy the space thus won. This is known as the "shove."

Thirty hydraulic jacks, each capable of exerting a pressure of 150 tons, push the shield ahead. The jacks are operated with water from the city mains, forced into an accumulator at pressures up to 6000 pounds per square inch, and fed to the jacks at constant pressure.

After each shove, a hydraulically-operated erector arm picks up segments of lining and swings them into position. When a complete "ring," 30 inches wide, has been placed, the muckers have again advanced and the shield is ready for another shove.

Another innovation of the Detroit tunnel job is the use of steel lining for the shield-driven section. Heretofore cast iron or wooden lining has been used. In this tunnel the lining is made of stamped, electrically-welded steel plates. The steel plates, surprisingly enough, represent an actual economy as well as a structural improvement over the older forms. The weight of the steel lining is about 2.3 tons per lineal foot of tunnel, while the same unit in cast iron would weigh about eight tons per lineal foot.

Each segment of lining is 30 inches wide, 10 inches deep, and nine feet long, weighing approximately 1000 pounds. Eleven segments and a key comprise a complete ring of lining. As the shield progresses, the segments are erected and bolted in place, the joints between each segment and between successive rings being waterproofed.



LARGEST SHIELD IN NORTH AMERICA

The muckers work in front of this huge apparatus, digging out the clay with power knives and passing it back through the shield to others who remove it to the dump. Note great size

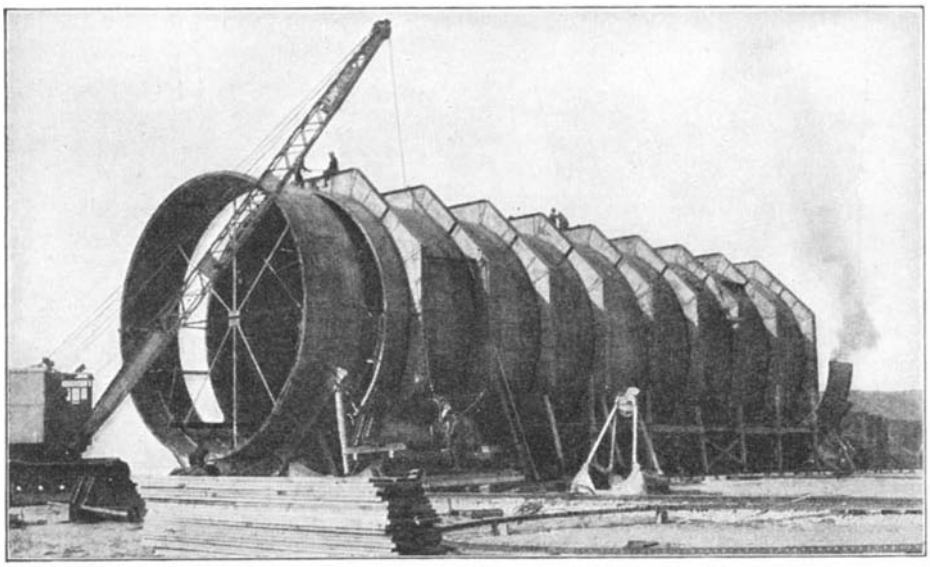
A TOTAL of 466 feet was excavated at the American end of the tunnel by this method, after which the shield was knocked down, hoisted to the surface, and transferred across the river. About 1243 feet are to be excavated in this fashion on the Canadian side. As this is written several hundred feet have been completed and the shield is making progress of 12.6 feet a working day. The Canadian shield is expected to reach the harbor line early in the spring, in time to join the last tube when it comes up the river from Ojibway.

As soon as the shield is removed, interior concreting is begun. Steel forms running on tracks are used in pouring the concrete. The whole structure of forms is run forward 25 feet at a time, concreted, then pushed ahead for another lap.

Sections 1 and 5—the box-type subways—offer no unusual features of construction or design. Steel sheet piling is driven on each side of the open cut and the material taken out with subway shovels and clam buckets. The shoring follows immediately behind the excavation. A three-inch slab of concrete is poured at the invert, upon which four-ply membrane waterproof-

ing is placed. The structural steel frame is erected, the invert, side walls, air ducts, and roof are concreted and backfilled, and the street surface restored. Connecting the portal of the box section and the terminals at each end is a short stretch of open approach, reinforced concrete invert, and concrete retaining walls.

Spacious terminals have been provided at each end of the tunnel, the American terminal plaza being two acres in extent. Traffic at the American end will spiral in coming to the surface, while the Canadian roadway, being farther back from the river, comes to surface level in a straight line.



BUILT LIKE A SHIP

A partially completed tunnel tube on the launching way at the plant at Ojibway, Canada. These tubes were fully concreted inside and out before final sinking to the bottom of the river

Ventilation of the tunnel will follow closely the design worked out for the Holland Tunnel and found extremely successful in practice. There will be two ventilation towers, one at each end of the tube. The equipment for each tower consists of 12 motor-driven fans, six for fresh air and six for exhaust, arranged in successive tiers in different stories and with direct connections to the subway ducts.

THE amount of fresh air that can be pumped into the tunnel will be 1,500,000 cubic feet a minute, giving a complete change of air in the longitudinal ducts every 90 seconds. The fresh air will go into the roadway through curved apertures near the curb line; the vitiated air will be drawn off through two rows of openings located at frequent intervals in the ceiling.

The air in the tunnel, according to the engineers, will be purer than the air in the street outside during rush hours. The power layout is so arranged that any part of the equipment can be operated from either the American or the Canadian side.

Many interesting articles have been brought to light in the various excavations of the Detroit and Canada Tunnel, the engineers report. One of the most interesting is an old Indian sling, with a cord of bark fiber still attached. Other finds include several firearms, a goodly number of bottles of beer and liquor, the remains of two small boats, automobile parts, and three human bodies.

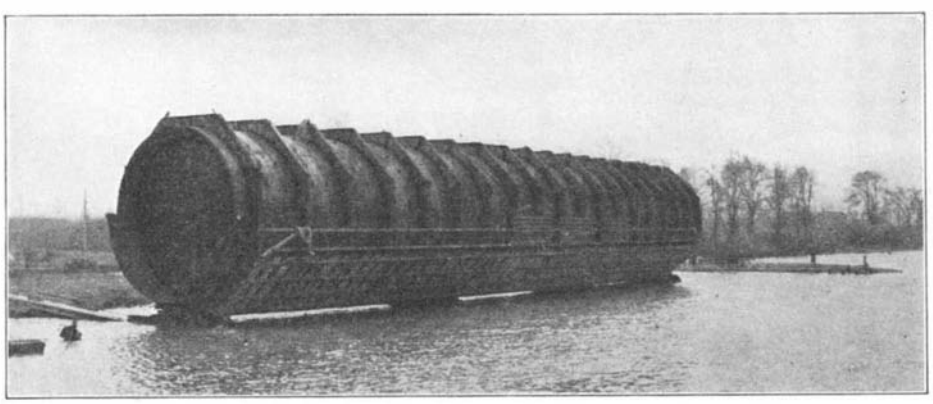
Two of the bodies were found by the river crew engaged in sinking the tunnel tubes; the other was brought up by the dredge *Jupiter* in a clamful of mud. The *Jupiter* also brought up the liquor, the firearms, the boat remains, and the Indian relic. The automobile parts were encountered by the shield in its excavation at the American end of the tube.

The terminal gang also made a find. Their contribution to the tunnel museum was a goodly amount of old wooden water pipe, placed beneath the streets of Detroit almost a century ago and still in good shape when unearthed.

THE tunnel will be operated jointly by the Detroit and Canada Tunnel Company and a Canadian subsidiary. Policing, regulation of traffic, and enforcement of customs and immigration regulations will be undertaken by the American and Canadian governments, officers of each nation looking after that portion of the tube lying within their domain. Completion of the tunnel is expected to result in an international interchange of visitors such as rarely, if ever, seen anywhere in the world, according to Judson Bradway, president of the tunnel company.

Figures compiled by the Border Cities Chamber of Commerce show that 25,000,000 persons are crossing the river annually at Detroit now. As many as 70,000 automobile passengers have been carried by the ferries over a single week-end, without taking into account the many casual visitors who cross on the ferries without cars for business and pleasure.

Because of the 15,000 commuters who make the daily crossing; because of the 3,000,000 tourists who cross each summer, many bound across country and more headed for the Canadian wonderlands in Quebec and the Georgian Bay country; because of the large number of shoppers and casual visitors; and because of the growing popularity of the Canadian resorts around Lake Erie and Lake St. Clair—because of all these things the Detroit and Canada tunnel is being rushed to completion with a future of singular promise.

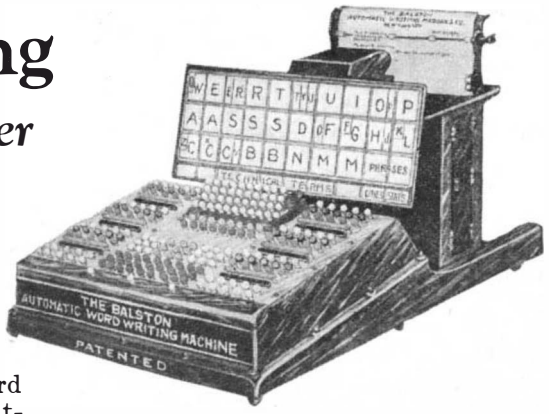


LAUNCHED LIKE A SHIP

Two views of a launched tube just after leaving the ways. With ends bulkheaded, tubes were towed to the floating concreting plant, concreted, and then sunk to the bottom

Automatic Word Writing

Departures From Familiar Typewriter Found in Word Writing Machine



WORD WRITING MACHINE

Although less than twice the size of a common typewriter, this machine does the work of many

MODERN business, in its restless search for the ultimate in operating efficiency, is always finding new short-cuts. Of these, an interesting one is a recently patented word and phrase writing machine for use in offices. Although it includes many of the essential features of the typewriter, this device differs radically from equipment now in use.

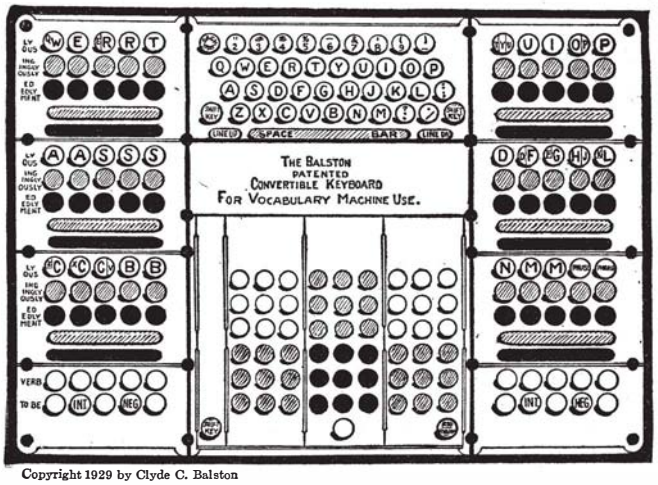
Mr. Clyde C. Balston, the inventor, based his research on the conclusion that there is no justification for the present "unit method" of typewriting. He challenged the prevalent conception that every word written mechanically must be first decomposed into its individual letters and then re-assembled as words on the paper. He decided that it should be possible to perfect a machine which would collect and print the letters of a word automatically, without requiring a separate movement to produce every letter and space. This led to the conclusion that there are a number of common phrases which are used innumerable times each day in office correspondence, which might just as well be impressed on the paper as if the phrase were one word.

Before working out the mechanical details of the machine, Mr. Balston spent some years on an exhaustive study of words to determine the relative frequency of their use. It was found that about 100 words comprise more than 50 percent of all words used in business. Less than 400 words represent more than 90 percent of those we use and about 1000 words constitute slightly more than 98 percent of all business correspondence. For these words, stenographers use "word signs" or symbols, rather than attempting to record the individual letters of each word.

In operating the word and phrase writing machine, there is no need for the typist to use the usual lightning-like movements, because the world's fastest typist cannot compete with a machine that prints a whole word or phrase while a typist using the unit system would be writing the first two letters. With much more deliberation, the operator presses two keys, one representing the initial letter of the word or phrase to be written and the other a selector. The use of the keys is guided by a chart which shows the grouping of the words, and the relative position of the selector keys. As with the "standard" keyboard, the operator may become so familiar with the position of the keys that no time is lost hunting for the right one.

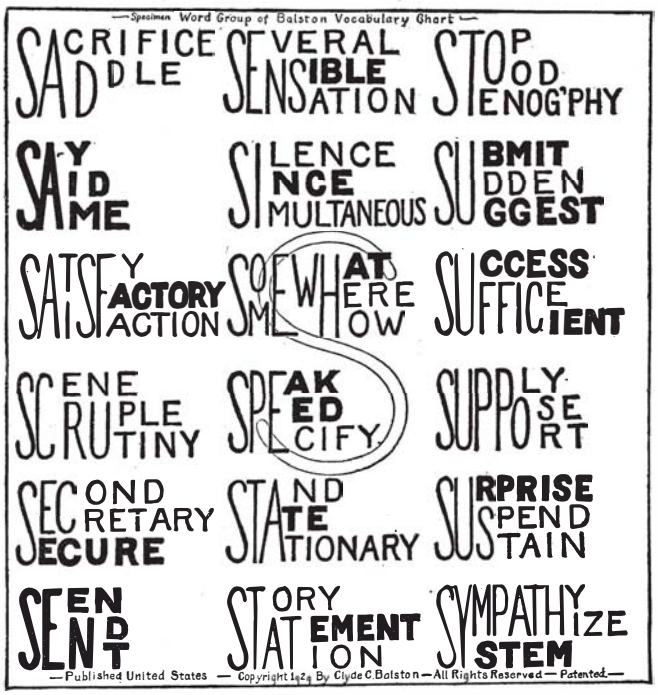
THE machine automatically assembles the letters and impresses the word or phrase on the paper, with the requisite spacing and punctuation. The type is mounted on an assembly of revolving disks somewhat reminiscent of the mileage recorder of a speedometer. A series of interchangeable combs with movable teeth, operated by the selector keys in accordance with the chart, automatically catch the various disks and hold them in the proper position for impressing the word chosen by the operator. As soon as the word is impressed, the disks are released and spring back into a neutral position ready for the next word.

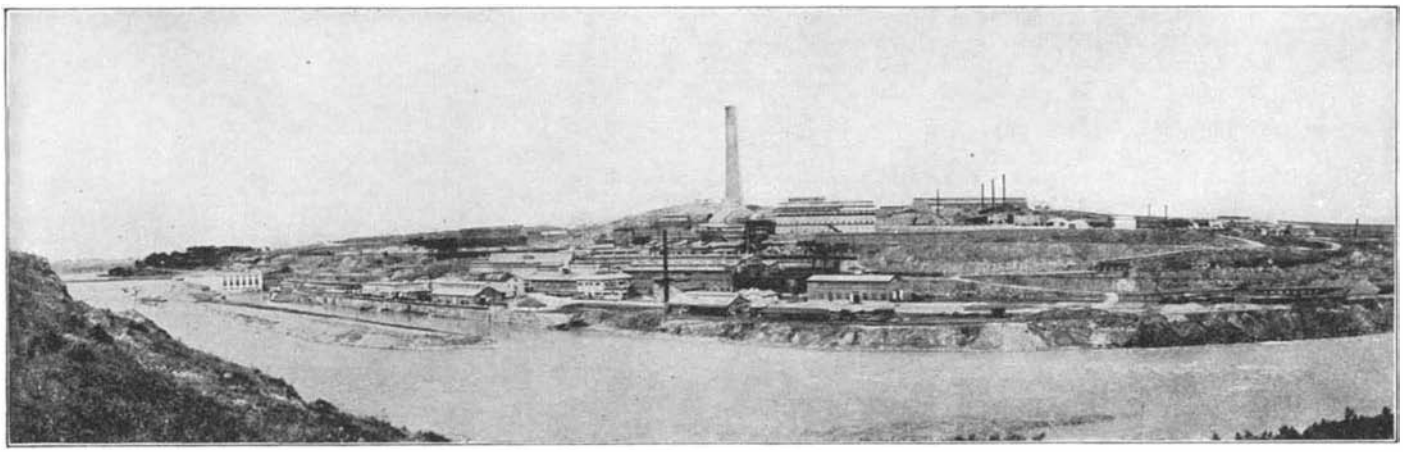
The mechanical writing speed of the machine, according to Mr. Balston, is more than 1000 words per minute, and the operative writing speed is over 300 words per minute, when writing single words. When writing phrases, the number of words per minute is greatly increased. It is significant that the Balston machine retains the standard typewriter keyboard, in addition to the special keyboard governing common words, word-endings, place-names and phrases. The more familiar keyboard provides an efficient means of writing (by the unit system) words seldom used, variously spelled proper names, and other words or phrases infrequently used in business correspondence. The machine has been adapted for use by telephone companies in posting and billing toll charges.



SOMETHING NEW IN KEYBOARDS

Above: Keyboard of the Balston machine, showing arrangement and grouping of keys. Note the standard typewriter keyboard, which has been retained for writing variously spelled words and names. The three 18-key panels are operated according to the groupings of words on a chart mounted within view of the operator of the machine. *Right:* Specimen square of the chart, showing alphabetic arrangement of words used most commonly in business correspondence. Capitalization and terminal forms may be included





GREAT FALLS REDUCTION DEPARTMENT OF THE ANACONDA COPPER MINING COMPANY

Situated on the upper Missouri River in Montana, in the heart of one of America's great hydro-electric developments, the Great Falls Reduction Department includes the largest electrolytic zinc plant in the world, an electrolytic copper refinery, and a copper rod and wire mill

Refining Metals by Electrolysis

Production of Refined Zinc and Copper by the Electrolytic Process in the World's Largest Metal Reduction Plant

By HENRY W. HOUGH

"WHITE COAL" was responsible for the selection of the site for the Anaconda Copper Mining Company's electrolytic zinc reduction plant near Great Falls, Montana. The importance of an ample supply of cheap electric power is easily understood, for the plant sometimes demands as much as 64,000 kilowatts, or 85,000 horsepower. The total connected motor load of the 600 alternating- and 182 direct-current motors in service, including the rotary converters and motor-generators, is 102,000 horsepower. In addition to the zinc plant, which is the largest of its kind in the world, the properties include also a large electrolytic copper refinery and a mill for making copper rod and wire.

TRANSMISSION lines carrying 110,000 volts transport power from the hydro-electric stations of the Montana Power Company at the Great falls and the Rainbow falls, in the upper Missouri River, supplemented by four 6600-volt transmission lines from the Black Eagle falls station adjacent to the plant. A fourth large hydro-electric plant is now being constructed in the vicinity, at Morony Dam. The most distant of these power sources, at the Great falls, is only seven miles from the plant.

Although the mining region centering at Butte, Montana, has been famous for 25 years as the greatest copper producer of the world, it had its inception as a placer gold mining camp, when gold was discovered in the sands of Silver Bow Creek in 1864. Silver soon became the most sought-for mineral, for valuable silver ores were found in the oxidized parts of quartz veins prominently traceable on the hillsides. The claims staked on these lodes later proved to be enormous producers of copper, as the diggings were carried farther beneath the surface. In 1887 about 290 stamp mills were working the silver ores of the Butte district, but the industry reacted sharply to the sudden drop of silver prices in 1902.

However, the copper industry had already reached its full stride. From 1870 to 1879 claims had been staked covering most of the valuable copper deposits, although many of them, like the Anaconda claims, were located for silver ore. The copper ore was originally hauled to Corrine, Utah, on the Union Pacific Railroad. After this 400-mile haul, it was transported to eastern plants for treatment. Some of the chalcocite was shipped to Swansea, in Wales.

IN 1879 the first successful smelter in Butte was built by the Colorado Smelting Company, greatly stimulating the local production. Several other smelters were constructed within a short time, including the Parrot, Montana Copper, Bell, and Clark's Colusa. The Montana Copper Company established its smelter at Great Falls, 180 miles from Butte, in 1892, under the name Boston and Montana Consolidated Copper and Silver Mining Company. The smelter at Anaconda, about 15 miles from Butte, was started by the Anaconda Copper Mining Company in 1883. In 1902 the "new works" was built across the valley. This plant, the largest non-ferrous smelter in the world, treats about one fourth of all the copper produced in the United States.

Our Basic Industries

DESPITE rumors of business recession as a result of the sharp decline in stock valuations, the foundations of our prosperity are secure. Almost without exception, our basic industries are in sound condition. This fact is discernable in the mining and allied industries. According to the Copper and Brass Research Association, the copper industry is on a firmer foundation than at any time in its history. It has just passed through a year of unparalleled peace-time prosperity. The outlook for the year 1930 is described as "most encouraging." Much of this optimism is due to the increasing demand at home and abroad for copper to be used in railway electrification, transmission lines, power projects, building, and automobile manufacturing.

In accordance with our policy of keeping our readers well informed concerning significant developments in industry, we sent one of our editors to Montana to inspect the world's largest plant for separating and refining metals by the electrolytic process. By previous training and experience, Mr. Hough is well qualified to describe these properties, and the interesting process of refining by electrolysis.—*The Editor.*

Its 585-foot smokestack is the highest in the world; the Washington Monument could be placed inside of it, and would be completely out of sight.

At Great Falls, the Boston and Montana Company had erected a plant for the production of blister copper, a blast furnace plant for the re-treatment of converter slag, a furnace refinery, and an electrolytic copper refinery. In 1910 the properties of this firm were taken over by the Anaconda Copper Mining Company, and six years later the first electrolytic zinc reduction plant was erected, after years of costly research and experimentation. The present plant produces about 20 percent of the world's total output of zinc. It has a capacity of 335 tons a day, or about 20,000,000 pounds a month, of practically pure zinc.

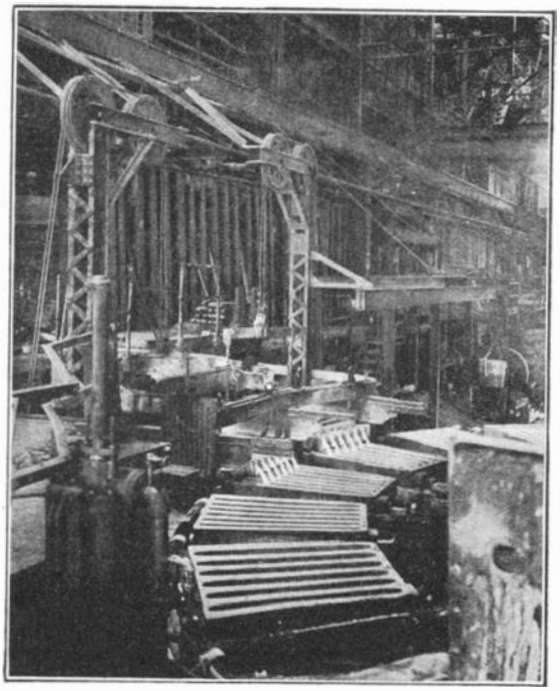
METALLURGICAL science wrestled for years to perfect the electrolytic zinc process. No one seems to know who first thought of leaching roasted zinc concentrates with dilute sulfuric acid and recovering the zinc as metal from solutions by electrolysis; it had been tried as early as 1883, but the most nearly successful early attempt was made in 1898 at a plant in Australia, erected to treat Broken Hill ores. Aided by the development of the selective floatation process for the preliminary preparation of the ore, and stimulated by high war-time prices for zinc, metallurgists of the Anaconda company developed the process which led to the construction of the plant at Great Falls in 1916. The company has another electrolytic zinc plant in Anaconda. These two Montana plants have a combined output of approximately one million pounds of zinc a day. Other plants of a similar nature, owned by the Anaconda Copper Mining Company, are located in Idaho, Utah, Australia, Poland, Italy, and Germany. New plants are being built in Illinois, Canada, and Norway.

Floatation concentrates arrive at the Great Falls zinc plant in open-top, hopper-bottom, 50-ton steel cars. After control and umpire samples are taken of the contents of each car, for use in deciding its composition and value, the concentrates are dumped into storage bins. There are 19 of these bins with a total capacity of about 3300 tons. Concentrates of varying composition are blended to give a uniform feed for the roasters.

To convert the zinc concentrates into a product suitable for treatment in the leaching plant, the material is roasted. This process converts the zinc and lead sulfides into the sulfate and oxide forms, expelling the excess sulfur and oxidizing the iron and other metals in the ore. Each of the 14 roasting furnaces has an individual motor for driving a revolving center shaft which is five feet in diameter, brick lined, hollow, and equipped with 26 water-cooled arms. These arms have rabbles for moving the concentrates from the circumference to the center of the furnace, and vice versa. The furnaces are each 25 feet in diameter, consisting of a brick-lined shell with seven hearths inside and an open hearth on top.

THE furnace gases pass through a settling chamber before going to the "big stack," which is almost as tall as the one at Anaconda. The dust recovered is returned to the roasters; the total flue dust re-treated averages a little over 15 percent of the weight of the new material treated. Calcine, the product of the roasters, is drawn off in hoppers under the furnaces, transported in four-ton cars to revolving coolers, and then discharged into a 400-ton storage bin for shipment by the local electric train to the zinc leaching plant.

Natural gas is used for firing the furnaces. Each one has two burners which are fired directly into the seventh hearth, eliminating the use of fireboxes. As much as eight million cubic feet of natural gas is used daily in the Great Falls reduction works. The gas is piped from the Kevin-Sunburst oil field, about 100 miles northwest of Great Falls.

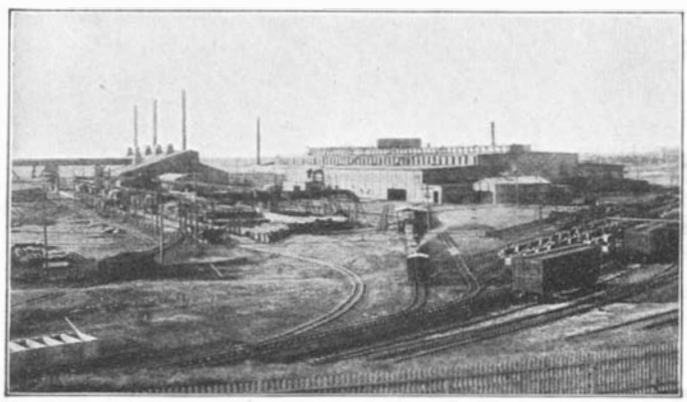


CASTING COPPER WIRE BARS

Streams of molten copper flow into forms that are pivoted upon a casting wheel 40 feet in diameter

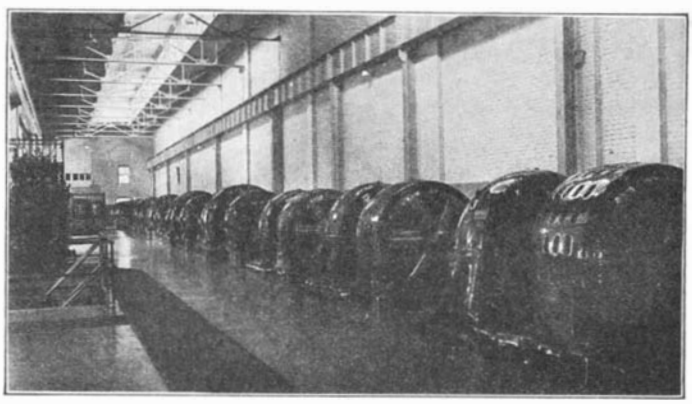
In view of the fact that the furnaces have also been fired with pulverized coal and fuel oil, some interesting comparisons are available. Using pulverized coal of about 9500 B.T.U., it requires about one seventh of a ton of coal for roasting one ton of concentrates. About 14 gallons of fuel oil, with 18,500 B.T.U., and specific gravity of 0.92, is needed for one ton of concentrates. About 2400 cubic feet of natural gas, of 930 B.T.U., is adequate for roasting the same amount of material.

There are three principal steps in the zinc leaching process: first is a neutral or purification leach; second, the acid or finishing leach, and finally a re-treatment of the residue from the acid leach. In huge open tanks of the Pachuca type, the roasted concentrates mix with an acid solution used previously in the electrolytic tanks.



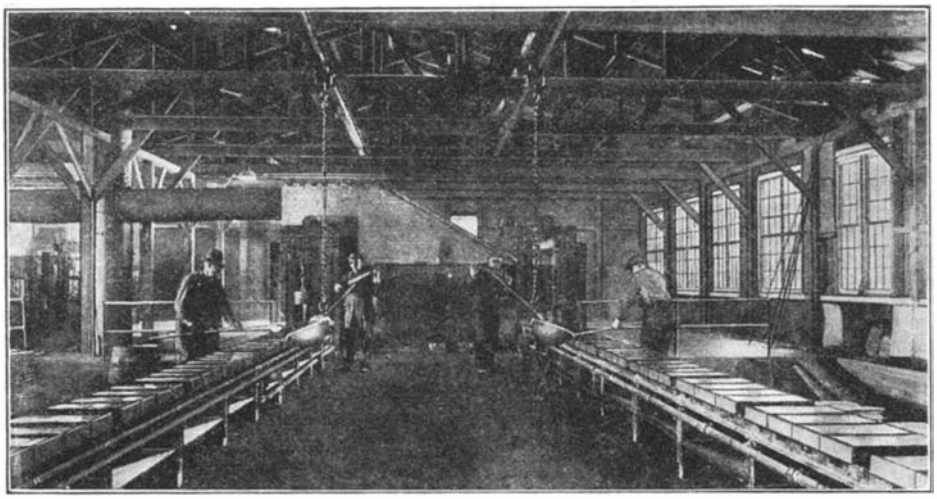
ELECTROLYTIC COPPER REFINING PLANT

In this division of the Great Falls works, smelted copper is refined by electrolysis, melted, and cast into commercial forms



VIEW OF ONE OF THE POWER SUB-STATIONS

Hydro-electric power is received over two 110,000-volt and four 6600-volt transmission lines, then "stepped down" in sub-stations



CASTING REFINED ZINC INTO 50-POUND SLABS

After leaving the electrolyzing division, the thin sheets of zinc are melted. Skilled workmen dip long-handled ladles into the furnaces, and pour the hot, silvery liquid into moulds

The acid is neutralized in the process, and iron, arsenic, silica, alumina, et cetera, are precipitated.

After passing through a series of Pachuca tanks, the solution discharges into Dorr classifiers for removal of coarse material, and the overflow goes to thickeners for the separation of solids from the solution. The pulp is drawn from the bottom of the thickeners and again treated with the leaching solution in the tanks, after which the thickened pulp goes to Oliver filters. The filtrate is returned with the thickener overflow to the first leach, and the residue cake goes to dryers. After passing through the first set of Dorr thickeners, the overflow goes through a purification system which precipitates the copper and cadmium by agitation with zinc dust. After purification, the leached zinc-bearing solution is pumped into storage tanks, ready for the electrolytic treatment.

ACCORDING to Mr. Albert A. Wiggin, manager of the Montana Reduction Departments of the Anaconda company, "The successful electrolytic deposition of zinc from a sulfate solution is primarily dependent upon the purity of the solution fed into the cells." In the leaching and purification processes, no effort is spared to produce a solution entirely free of metals electro-negative to zinc.

Power enters the plant at 110,000 volts, and is stepped down through nine 6100-kilo-volt-ampere, three phase, 60-cycle, water-cooled transformers to 406 volts. This is passed through nine 5800-kilowatt synchronous rotary converters, which yield about 580 volts, direct current, for use in the electrolytic tanks or cells.

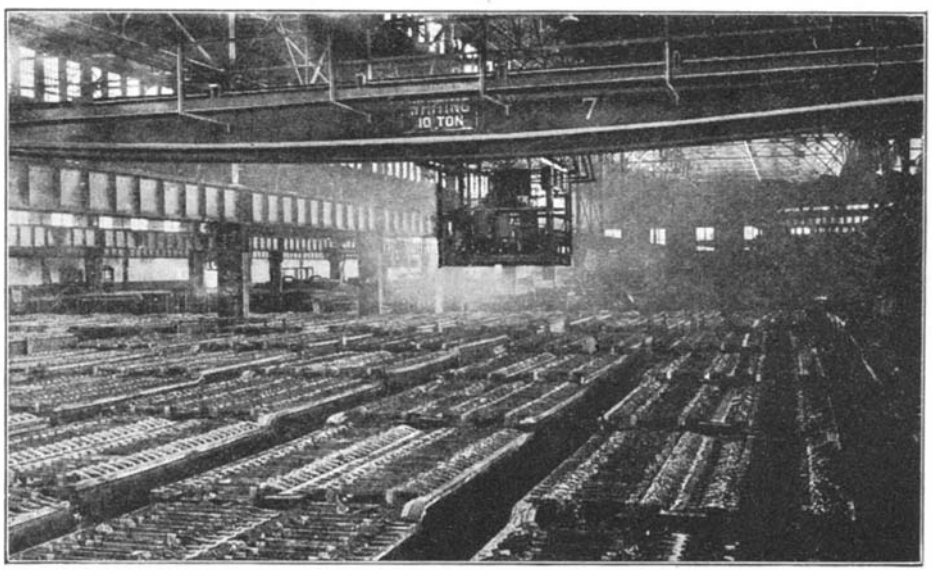
In a building 395 feet by 252 feet, zinc is electro-deposited on aluminum sheets suspended in tanks filled with the zinc-bearing solution. Of the 1164 cells, 1152 are continuously in service. These are divided into eight units of 144 cells each. Lead is used wherever there is danger of contaminating the solution, for lining the cells, and also as anodes from which the current flows to the aluminum cathodes. There is no free acid in the solution when it first enters the tanks, which are arranged in cascade form. When the electrolyte leaves the tanks (to be used for leaching roasted concentrates) it contains acid equivalent to one and one half times the amount of zinc removed during the electrolytic process. To cool the tanks, water is circulated through a lead pipe placed beneath the surface of the solution.

Every 24 hours the zinc-coated aluminum cathodes are removed, and the zinc is stripped off. These thin sheets of zinc are stacked in piles and moved on small cars to the melting and casting department. The sheets are dumped into the furnace through a hole in the roof, probably to be melted beneath the surface, for about 150 tons of molten zinc is kept in each of the three gas-fired furnaces. The molten zinc is dipped out of the furnace by means of long-handled ladles suspended from trolleys on overhead I-beams, and is cast into moulds arranged in rows near the furnace. One man can dip and cast into 50-pound slabs about 30 tons of zinc in an eight-hour shift. No practical scheme has been found for improving upon this laborious method of casting, although various mechanical arrangements have been tried.

Atomized zinc, or zinc dust, is made by transferring the molten metal to graphite crucibles tapped or perforated with one-eighth-inch holes. As the molten zinc falls from these openings it is caught in a jet of compressed air from an atomizing nozzle and is blown into a settling chamber. This product is used in the purification division for removing copper and cadmium from the zinc-bearing solution. Cadmium, by the way, has become an important by-product of the zinc plant, since this metal has come into use for electroplating.

ALTHOUGH the electrolytic zinc plant is the largest of its kind, it is but one of several divisions of the Great Falls Reduction Department. Copper refining operations are conducted on a large scale in an adjoining plant, where copper from the company's smelter at Anaconda is purified by electrolysis.

From 80 to 90 percent of the finished copper produced here goes to the nearby rod and wire mill. For many years all of the copper produced in the Montana mines went to eastern markets, much of it returning later in manufactured form at greatly increased prices. The establishment of the large wire mill at Great Falls has changed this situation, providing for the far west a convenient and economical source of supply.



VIEW IN ONE OF THE ELECTROLYTIC TANK ROOMS

This electrolyzing room is 535 feet long and 252 feet wide, and contains 1530 refining tanks, arranged in cascade form. The illustration shows also one of the seven traveling cranes

Diet Causes Fatigue

Working Efficiency Is Lowered by the Dieting Fad and Increased by Between-Meal Nibbling

FATIGUE, diet, and the working capacity of the modern business girl are closely related, and decrease in working capacity due to fatigue can be offset by the timely ingestion of highly concentrated, energizing foods, according to the findings of Dr. Thaddeus L. Bolton, head of the Department of Psychology, Temple University, Philadelphia, who has concluded a research investigation in which 20 feminine office workers were subjected to exhaustive tests of speed, endurance, mental alertness, and muscular control, at various hours of the business day.

Back of the investigation, according to Dr. Bolton, lies the growing belief on the part of employers that the unwise reducing diets resorted to by large numbers of feminine workers are responsible not only for frequent absences due to illness, but for decreased volume and lowered quality of work while in the office. As the food suplies within the body approach the point of exhaustion, work power begins to fall, and fatigue sets in, starting up muscular trembling and lowering the speed and contractile power of the bodily members.

"OUR studies soon showed," Dr. Bolton says, "that working capacity is comparatively low at the beginning of the office day. The human machine is never, right from the start, ready to deliver its greatest output. Like the race horse, it must go through a warming-up process. Capacity appeared to increase until it reached its maximum at about 2:30 in the afternoon. From that time on, except for a spurt at the end, the curve seemed to fall with a fair degree of steadiness until the office closed in the evening.

"It is well known, however, that in the average office the hours between 2:30 and 5 are the period of greatest rush and strain. The falling curve occurs at the worst possible time. We sought to determine to what extent working power may be sustained at its early afternoon peak by eating suitable quantities of foods which are quick restorers of depleted energy. Foods having a high sugar content were selected because sugar is not only a concentrated energy food, but one which is quickly assimilated by the system. Its effects, therefore, are almost immediately apparent to the trained investigator equipped with the necessary laboratory instruments."

The 20 girls were divided into four groups of five each. One of the groups, the "full food group," was supplied each afternoon with a light meal consisting of cake, candy and sweetened orangeade. Two "mixed food groups" were supplied with the repast on designated days, skipping it on others. The fourth group, known as the "control group," went through the tests of the various elements which, taken together, constitute working capacity, without partaking of the additional meal.

Five different tests were employed, all of which have proved their value in the psychological laboratory. In the "tapping test" the girl tapped upon a metal plate with a stylus at top speed for 15 seconds. Five periods of tapping alternated with ten-second rest intervals. Each tap was recorded by an electrical device. The number of taps determined the score, which, in turn, afforded an accurate measure of the girl's speed and endurance. Both hands, one after the other, were tested.

THE TAPPING TEST

Dr. Charles H. Smelzer of Temple University giving a girl a test for speed and endurance

Co-ordinated muscular action was measured by the "three-hole test." This consisted of making electrical contacts by placing a stylus successively in three small holes in a metal plate, the holes being just large enough to permit the entrance of the stylus. The score made in the test was determined by the time it took to make 80 contacts. The "substitution test," employed to measure mental alertness, consisted of correctly placing five letters of the alphabet on a chart covered with rows of five different geometric figures. The key was given at the top of the chart. Two minutes were allowed for the completion of the test.

"All of the girls showed marked practice gains as they became familiar with the tests," Dr. Bolton says. "This had to be taken into account in compiling our results. Aside from practice gains, the 'control' or 'no food group' continued to show the typical curve of work—the low beginning, the rise until about 2:30, and the falling off until the closing spurt.

"In the case of the 'mixed food groups,' when the girls were supplied with the additional meal as frequently as four times a week, their work appears to have fallen in with that of the 'full food group.' Tabulated summaries of the tests given to members of the later groups show that they were sustained at a higher working rate than the girls in the 'control group.' Their practice gains were continued up to the last, and were greater and more consistent than the gains of the 'control group.'

"THE investigation has shown positive results in favor of small quantities of concentrated food taken in mid-afternoon. The physical and mental let-down which is apt to occur at the busiest period of the business day is to a considerable extent due to insufficient and improperly balanced diets, and can be largely, if not wholly, prevented by eating foods that in small volume act as quick fuel for the body engine.

"Although we dealt only with feminine workers, our findings apply with equal force to the opposite sex. Perhaps, however, special emphasis should be laid upon the support these findings give to the opinions of those who have held that reducing diets are responsible for impairing the efficiency of the modern business girl.

"On the basis of our findings, hard-working business and professional men and women would do well to keep in the drawer of the desk a box of good candy or candied fruit. When energy begins to flag in mid-afternoon, these quick-action foods will act as an emergency ration and supply the calories needed for the rest of the day's work. The sugar in afternoon tea, or in sweetened cold drinks, will have the same effect."

Approximately 500,000 calculations were necessary in compiling, tabulating, and comparing the records of the 20 girls.

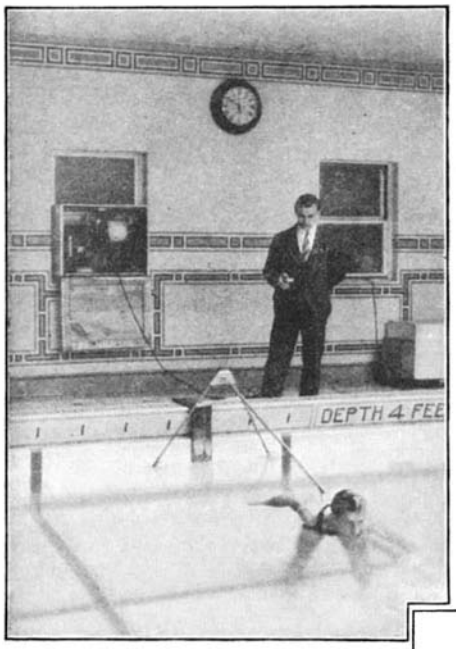
Swimming Speed Analyzed

"In the Breast Stroke We Can Develop the Same Speed as in the Crawl, But Only for a Fraction of a Second"

By PETER V. KARPOVICH, M.D., M.P.E.
Professor of Physiology, Springfield College, Massachusetts

WE watch a powerful swimmer plunge into the swimming pool and then rapidly traverse it using a crawl stroke. He moves so fast and his movements are so well timed that, to our eyes, his speed seems to be perfectly uniform.

We observe another man using a breast stroke. There we can notice that the swimmer is moving by spurts, slowing markedly on recovery, when he draws his arms and legs close to his body. Here we can figure easily the reason for the periodical accelerations and slowing of the speed.



THE NATOGRAPH

Above: The test subject, with the floating tripod and the line connected to the Natograph in the background. *Right: Figure 1:* The simple mechanism of the Natograph

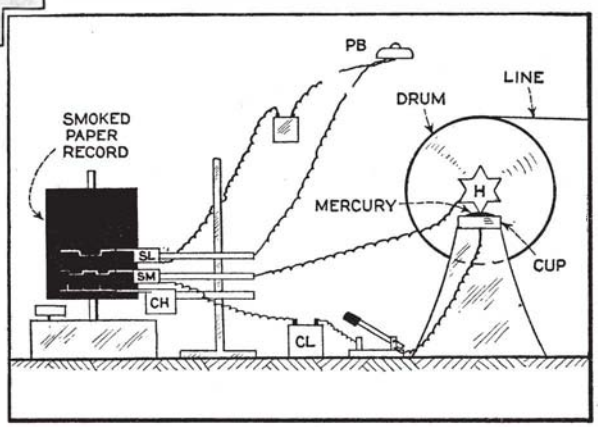
But is the crawl stroke really a stroke where the speed is perfectly uniform? We know that there are several distinct phases in this stroke: lifting one hand out of water and rolling, breathing, pulling, et cetera. Do these changes in posture affect the speed or not? Logically they should, but can we find out definitely?

Swimming is an ancient and yet a young sport. People could swim in prehistoric times, but the present highly developed strokes are of recent origin. Some teachers of swimming are still searching for a new combination that will result in a stroke faster than the ones existing at the present time. Others are trying to improve the existing strokes. The latter effort seems to be more feasible and leads to an attempt to study the variation of speed within a single cycle of a stroke. Preliminary consideration showed at once that an ordinary stop watch could not be used because changes may occur within a second on a distance of a couple of feet.

AS the result of a number of experiments, an apparatus has been devised for the purpose. This apparatus has been named the Natograph in order to distinguish it from the other machines used in research along similar lines. The Natograph registers the progression of the swimmer, by recording the distance covered and the time, and enables us to calculate variations of speed in intervals as small as one fifth of a second, and to measure the relative efficiency within a single cycle of a stroke.

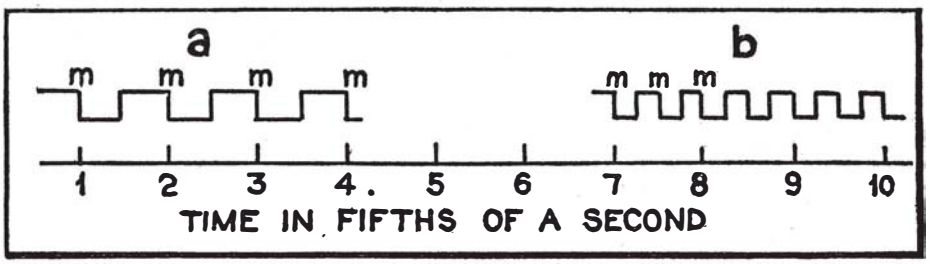
The apparatus shown in the photograph and the diagram, Figure 1, consists of a drum around which a line is wound; the free end of the line is attached to the subject. In swimming, he pulls this line and causes the drum to revolve. A sprocket (*H*) is firmly fastened to the same shaft as the drum. On revolution the points of the sprocket touch the mercury in the cup. The mercury and the sprocket are in a circuit with a dry cell (*CL*) and a signal magnet (*SM*). When the sprocket touches the mercury, the circuit is closed and the pointer of the signal magnet is drawn down.

When the contact is broken, the pointer springs back. The circumference of the drum is twenty-four inches; therefore the distance between two points of the sprocket corresponds to four inches of the circumference of the drum. The movements of the pointer are recorded on smoked paper wound around a cylinder, which is set in uniform rotation by means of a clock work. A chronograph (*CH*) marks the time in intervals of fifths of a second. During an experiment we may get a set of tracings similar to the ones represented in Figure 2.



IN this diagram, the distance between any two adjacent "makes" (*m*) of the circuit corresponds to four inches of the distance covered by the swimmer, but we see that the intervals between the makes are not equal. In part *a* we count one interval in 1/5 of a second, whereas in part *b* we find two intervals. This means that the swimmer was moving with a variable speed, the fastest being at *b*.

In order to read these tracings more intelligently, another signal magnet (*SL*), Figure 1, was adjusted to the Natograph. This signal magnet was connected with a push button (*PB*) by means of flexible wires 12 yards long. The experimenter carries this push button in his hand and



NATOGRAPH TRACINGS

Figure 2: The time between the marking of the points *m* enables the operator to determine the speed of the swimmer. Parts *a* and *b* consist of records of different swimming speeds

presses it when he wants to mark a certain part of the stroke. Suppose the experimenter wants to mark the moment when the right hand of the swimmer enters the water during a crawl stroke. He has only to press the button at this particular moment, and the writing point of the signal magnet (*SL*) goes down and marks the paper. See upper lines on tracings B, C, D, and E, Figure 3. Of course, particular care should be taken to have the writing points of both signal magnets on the same vertical line.

The construction of the Natograph is very simple, but one problem was at first very difficult to solve. This was the elimination of the momentum of the drum itself. Although the drum was made very light, it was necessary to use a brake which was strong enough to eliminate the momentum without interfering with the freedom of the progression of the swimmer. The resistance of the brake was negligible when compared with the total force developed during swimming.

FOR testing the breast and side strokes we attached the line directly around the waist of the swimmer, but for the other strokes, such as the crawl for example, it was impossible to do this because the feet might kick the string and spoil the record. To meet this difficulty a simple device was made. It consists of a wooden tripod, two legs of which are supported by rubber balls, and the third strapped to the swimmer. The line leading to the Natograph is attached to this tripod so that it always touches the surface of the water.

The Natogram in Figure 4 represents a record of the breast stroke as performed by a good Filipino swimmer. We can clearly see the variation of the speed in this type of swimming. The lowest speed (eight inches per second) was during recovery when the legs and the arms were drawn close to the body; during this time no propelling power was developed and the resistance was greatly increased. The highest speed was attained during the arm pull (five feet per second); during the leg drive the speed was four feet per second, and during the glide the speed dropped to one and one half feet per second. Comparing the action of the legs and the arms, we notice that the legs started to drive from the lowest speed after the recovery, and the arms from a higher level after the glide. This explains why great speed was often attained during the arm pull. If we introduce a correction, subtracting the starting speed from the speed reached at the end, we find that the leg drive is more effective than the arm pull, which is typical for a good swimmer. In the case of a poor swimmer, this condition may be reversed, whereupon the arms furnish most of the power.

The lower curve in Figure 5 represents a very slow crawl stroke. The "ups" of the curve correspond to the arm action. The low limit is determined by the momentum acquired and the leg action. The duration of a cycle is about one and two fifths seconds. The upper curve represents fast swimming by the same man. The curve is much smoother, and varies only between four and five feet per second. The length of a single cycle is about nine tenths of a second.

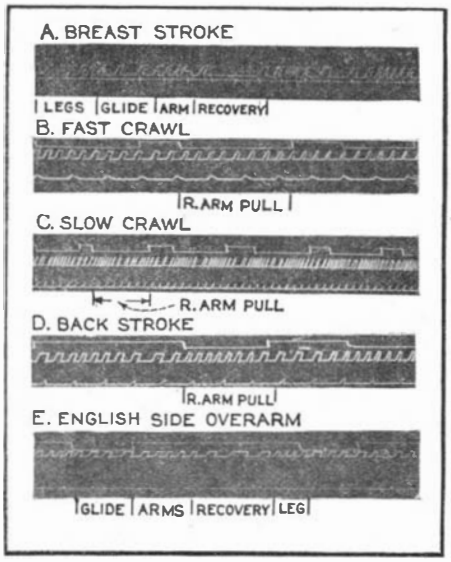
We have found that the duration of the cycle in the fast crawl is shorter, and pull and recovery are reduced in the same proportion. The time during which both arms remain under water was only slightly decreased. The significance of this has yet to be investigated.

In Figure 6, the subject was swimming fast, using the back stroke. Because the arms cannot act as effectively as in a fast crawl, this curve resembles a slow type of crawl. Each elevation on the curve corresponds to the action of one arm.

In Figure 7, made with the side stroke, we see the four distinct parts: the leg action, the glide, the arm pull, and the recovery.

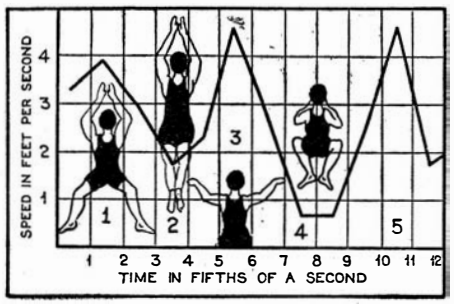
In this short article it is impossible to go into a discussion of all the points that may be discovered on the Natograph. Just recently I have completed the studies of the force developed during various phases of the different strokes and resistance of water that the swimmer has to overcome. The results of these studies perfectly correlate between themselves.

There is one interesting point that should be brought out. Driving a motor car with a variable speed is wasteful. A uniform speed is more economical. The same should be true in the case of the human machine. The crawl stroke is the fastest because it is the smoothest. In the breast stroke we can develop the same speed as in the crawl, but only for a fraction of a second and then on recovery the arms and legs serve as powerful brakes and hinder progress. In making a stroke more efficient, one should utilize the power saved by reducing the resistance.



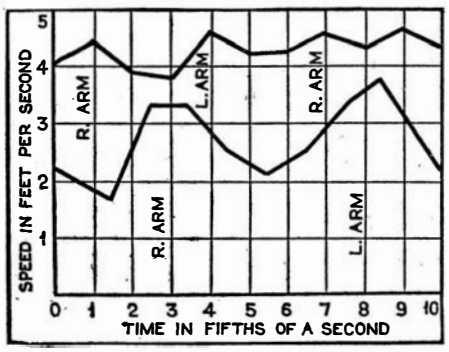
RECORDS

Figure 3: These are reproduced from actual tracings made on the Natograph



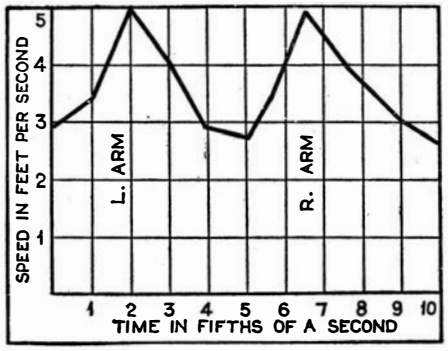
BREAST STROKE

Figure 4: This chart shows vividly how swimming speed with this stroke varies



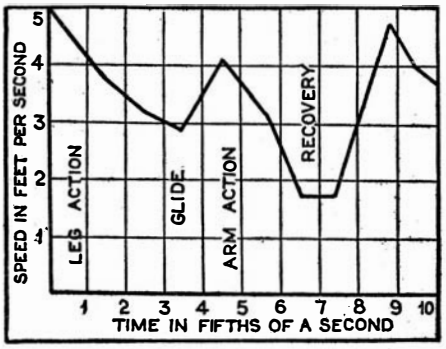
THE CRAWL

Figure 5: Lower curve shows slow crawl: upper, fast. Note the smoother action



BACK STROKE

Figure 6: Curve resembles that of slow crawl because of ineffective arm action



SIDE STROKE

Figure 7: Four distinct parts are shown; leg action, glide, arm pull, and recovery

The Plant's Whimsical Appetite

Some Newly Discovered Requirements for Plant Growth Indicate That Plants Are Highly Sensitive to Certain Chemicals

By EARL S. JOHNSTON
Associate Professor of Plant Physiology, University of Maryland, College Park, Maryland

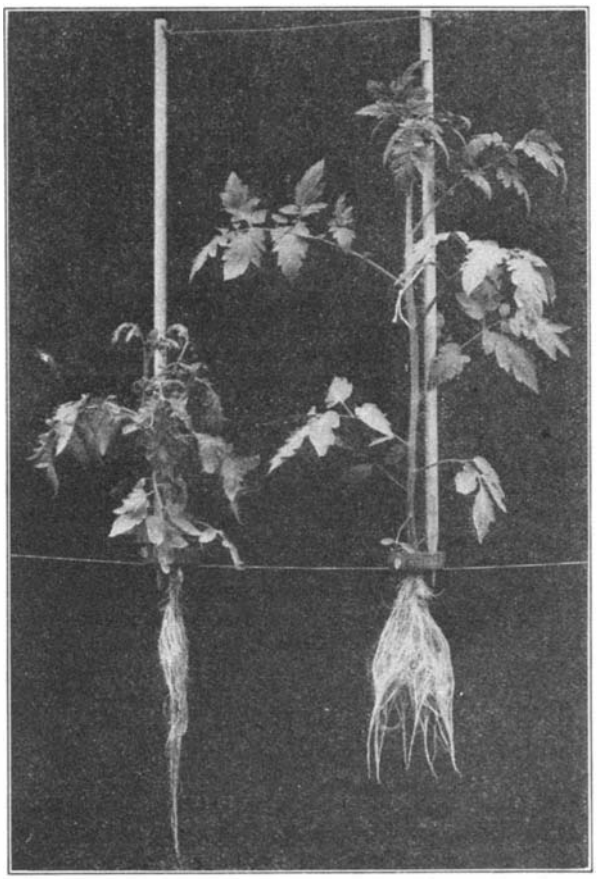
IT is generally believed that plants can grow and develop normally when their diet is limited to the so-called ten essential elements. Most of these elements are found in the ordinary fertilizers used by farmers, gardeners, and other agriculturists. Everyone is familiar with the importance of nitrate, potash, phosphate, sulfate, and perhaps a few other plant food materials. In a somewhat similar manner carbohydrates, proteins, and fats were considered the essential part of the diet for animals, including man. Within recent years, however, it has been realized that man can not live by bread and meat alone. Articles are frequently published on the importance of vitamins. Occasionally, too, we read of the potency of hormones, those interesting chemical compounds manufactured by certain glands, which play such an important part in stimulating or retarding the growth of other tissue. The discovery of iodine in the thyroid was followed by the isolation of a stable iodine-containing hormone, *thyroxine.*

THIS simple example of the importance of iodine in the thyroid has brought into prominence the remarkable rôle that minute quantities of certain chemicals play in animal nutrition. Plant physiologists have been led to see the imperative need for a careful examination of the entire field of plant nutrition and to raise the question: Do plants also need minute quantities of certain less common elements for their normal growth and development?

Chemical analyses have shown that the list of elements found in plants is very long, but the mere presence of such substances does not mean that they are essential. How then can the really essential elements be distinguished from the non-essential? The logical biological test to determine the effect of a given element on plant growth is to grow the plant in soil to which this element has been added. Likewise, to determine the effect of the absence of such an element, the plant should be grown in a soil lacking that particular material. However, soil contains minute quantities of a large number of elements which it is quite impossible to remove or even detect chemically, and since it may be desirable to eliminate even a trace of certain elements in order to see how the plant responds to such a deficiency in its diet, soil cannot be used.

Briefly, the general method in common use is to grow the plants with their roots in pure water to which pure chemicals have been added. Thus a given element can be omitted quite easily. A good plant nutrient solution that contains the common fertilizer elements needed in comparatively large amounts, may be made up from the following salts expressed as volume-molecular concentrations (a method used to express concentration of solutions) and as percentage concentrations:

	vol-mol. conc.	*percent conc.*
$Ca(NO_3)_2$	0.005	0.082
$MgSO_4$	0.002	0.024
KH_2PO_4	0.002	0.027



HEALTH AND UNHEALTH

Figure 1: Tomato plants grown in nutrient solutions. Left, boron deficient; right, similar solution but containing one half part per million of the element boron

In order to keep the plants green, about one cubic centimeter of a 0.5 percent ferric tartrate solution per liter of the nutrient solution should be added daily while the plants are young. The carbon dioxide of the air, and water, help supply the plant with oxygen, hydrogen, and carbon. By the use of distilled water, highly purified chemicals and carefully cleaned culture jars, it has been demonstrated successfully that in addition to the ten elements comprising the old list, we must now add manganese, zinc, boron, and perhaps several others. It must be remembered, however, that these elements are needed by plants in very, very small amounts.

Boron is one of the elements that has been attracting considerable attention. It occurs in boric acid and in common borax, but its need in the plant was not even suspected until recently. In fact boron was considered a poison. Only a few pounds of borax per acre will work havoc to a potato crop. A disaster of this sort occurred a few years ago when certain fertilizers containing borax as an impurity were used. However, a very weak concentration of boron is not only beneficial, but absolutely necessary for the plant's health.

THE necessity of boron to the tomato plant was shown in an experiment in which two groups of plants were grown with their roots in nutrient solutions containing all the so-called essential ions. The solutions were similar with the exception of their boron content. No boron was added to the first group, while just enough boric acid was dissolved in the second to bring its boron concentration up to one part in 2,000,000 parts of water. Representative plants from the two groups are shown in Figure 1. The unhealthy condition of the plant on the left is clearly shown, especially when compared with the healthy one on the right.

Although the concentration of boron (1 part in 2,000,000) is extremely small, yet the plant has little difficulty in detecting it and in making good use of what it absorbs from the nutrient solution. Imagine how much a man would be nourished by eating pea soup

in which there was one pea to every 132 gallons of water. That corresponds to the boron dilution which apparently suits the tomato plant. A concentration five times as strong, or in terms of our soup, five peas instead of one in 132 gallons of water, is distinctly injurious to the plant. Two to three parts of boron per million of water cause the margins of the leaves to die and soon the entire plant becomes unhealthy. On the other hand, the beneficial concentration of one part in 2,000,000 will frequently double the weight of the entire plant. The growth response when the proper amount of boron is absorbed by the plant is almost incredibly out of proportion to the small amount of the element involved.

The poisonous effect of too much boron is to be expected, but the surprising thing is that with no boron the plant is even worse off. The stem will not elongate because the terminal bud dies. The conducting tissues within the stem die. These tissues are composed of small tubes which carry the sugars made in the leaves down the stem. With the destruction of these tubes the plant's health is greatly impaired.

THE sugar manufactured in the leaves can not be transported to other parts of the plant where it is used for growth. Some of the sugar solution thus dammed up in the leaves is changed into starch, a storage form of carbohydrates. In the potato plant such leaves become thick and rolled, as illustrated in Figure 2. This condition closely resembles a disease called leaf-roll in which the conducting tubes are destroyed by disease and starch accumulates in the leaves instead of in the tubers.

Great care is necessary in performing experiments to demonstrate the injury caused by a lack of boron. One experimenter found that no boron-deficient injury was found when tap water was used in making up the nutrient solutions for tobacco plants, but if distilled water was used the plants failed to grow. The addition of a very small amount of boric acid solved the problem. There was enough boron in the tap water to supply the needs of his plants, but none in the distilled water until he added boric acid.

About Plant Fertilizers

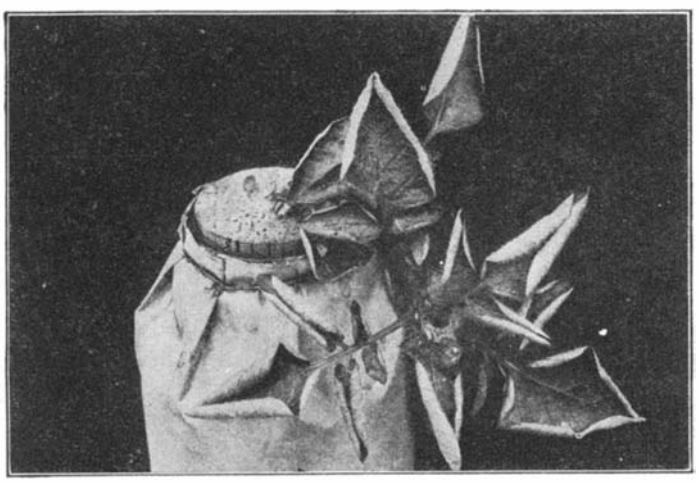
A PURE food and drug act for plants would be a death warrant to all living creatures. Few of us realize on what thin threads life hangs. Perhaps all of us know that in the ultimate analysis all animal life depends on plant life. Not until recently has it been known that many of our crop plants are absolutely dependent on minute traces of impurities or poisonous elements found in most soils and commercial fertilizers. In the light of such knowledge one may question the exclusive use of highly concentrated and purified fertilizers that are being marketed by certain companies.—*The Editor.*

The resourcefulness of the plant in getting its boron is well illustrated by the following incident. Several years ago an experiment was carried out in which potato plants were grown in new earthenware jars filled with pure quartz sand. These cultures were watered with a solution containing the elements previously found essential to plant growth. No boron was added, however. The first set of plants grew very well, but later, when these experiments were repeated, the plants failed to grow normally. After the importance of boron had been pointed out, it was realized that the plants in the first experiment had obtained enough boron from the glaze of the new jars to make good growth. The available supply of boron in the glaze had apparently been exhausted after the first experiment. This theory was put to a test by growing two sets of potato plants in the original jars, using the same general methods and similar solutions made up from the same lot of chemicals. Boron was added to the solutions used in watering one set of plants but not the other. At the end of eight weeks the difference in growth was very marked, as is shown in Figure 3.

PLANT containers of ordinary soft glass, such as the common Mason fruit jar, can very well be used in experiments dealing with boron deficiency. However, such jars may prove worthless when the effects of a zinc-deficient diet are to be studied. Zinc may be dissolved out of certain glasses which would make the results inaccurate in a manner similar to that in which the glazed jars had been used for boron-deficiency studies. In such work, jars made of the familiar Pyrex glass used in baking dishes serve the purpose very well, although they too, like glazed jars, are worthless for boron experiments. When such precautions are taken it has been clearly shown that zinc is just as much needed by a number of higher green plants as is nitrogen or potash, although of course in very much smaller quantities. It must be remembered that zinc, like copper and arsenic, is exceedingly poisonous.

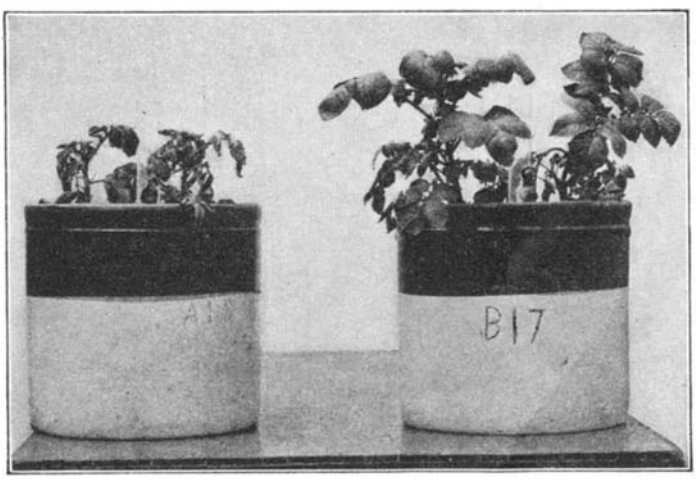
Thus it appears that there are a number of inorganic poisons which act as stimulants or as food to plants when given to them in small amounts. The concentrations of such substances vary with the poison as well as with the type of plant being treated.

With such examples in mind it is no wonder that earlier investigators on the nutritional requirements of plants failed to include some of these rarer ash elements in their list of essential elements. As methods became more and more refined and the chemicals purer, it was found that plants, like animals, demand minute quantities of certain substances which no one heretofore had even imagined to be important, much less absolutely necessary in the plant's diet.



POTATO SEEDLING, BORON DEFICIENT

Figure 2: The seedling was grown in a boron-deficient nutrient solution. The leaf roll characteristics are evident in the picture



A STRIKING CHECK TEST OF PLANT DIET

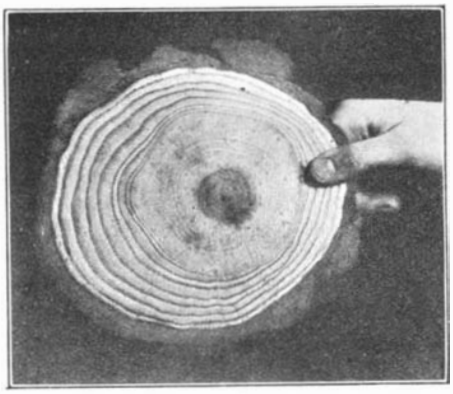
Figure 3: Potato plants grown in sand cultures treated with boron-deficient solution (left) and (right) with boron solution

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Bottle Drifts 7000 Miles

TWO unusually long bottle drifts have just been reported to the Washington Hydrographic Office. One bottle, thrown overboard by Officer O. Haugstad of the Norwegian steamer *Childar*, was picked up among the Marshall Islands after having drifted about 6000 miles. The second was found among the Caroline Islands after a drift of about 7000 miles. This bottle was one thrown overboard by Second Officer R. M. Stall of the American steamer *K. R. Kingsbury*.



Thin section of a "Pondosa" pine showing more rapid growth after mature and unhealthy growths were cut from around it. A tree puts on one or two rings each year

The longest drift in the records of the Hydrographic Office is one made from the southern Indian Ocean to the tip of Cape Horn between May 31, 1909, and May 19, 1912, a total of about 11,820 statute miles. —*Science Service.*

Rapid Lumber Growth Due to Selective Logging

IN the past SCIENTIFIC AMERICAN has commented frequently upon the necessity for conservation of our timber resources, for reforestation, and for the elimination of waste in logging operations. We have, therefore, urged selective logging as one of the best possible answers to this three-fold problem. When only the mature growth is cut for lumber and the unhealthy trees are weeded out, the remaining small, healthy trees are given a better chance to get the sun and light so necessary for their proper growth. The result is that these trees mature much more rapidly, young seedlings are given a chance to develop, and the forest may be cropped in exactly the same manner as a farm.

It is difficult for some people to realize how they may apply this principle in their wood lots. The writer has known farmers to cut ruthlessly all the trees of small forests for firewood or for lumber. To impress the truth upon such people, they have to be shown in a striking manner. Therefore we asked the Shevlin-Nixon Company of Bend, Oregon—whose policy of selective logging is well known—to send us facts to illustrate the benefits of the principle. They forwarded the thin section of a tree, a photograph of which is reproduced on this page.

The tree from which this section was cut grew very slowly for the first 80-odd years of its life, as shown by the compactness of the center growth rings. It was left standing when the mature and unhealthy trees all about it were logged. The result was that it grew in the last nine years of its life a greater volume of wood than it had during all its former life. It thrived on the sun and light that had been denied it while it was crowded by other larger trees in the immediate neighborhood.

"Tempered" Copper

"THE ancients" had hardened copper—tempered copper, as some believed—and so have we moderns. Indeed, we have had several varieties for many years. Nevertheless, persons yet talk of hardening of copper as a long lost art. Numerous uninformed inventors have sought to recover this art.

Dawson, a famous inventor of hardened copper, claimed to shave with a copper razor. He made surgical instruments, shears, and other edged tools of copper. We have a pair of shears, that after at least ten years will cut thin paper and other things demanding a keen edge. His copper was alloyed with 17 percent to 18 percent tin and ½ percent nickel. Through the influence of the nickel, Dawson's copper had a fine grain structure.

Erwin A. Sperry, a Connecticut metallurgist, proposed about 1905 an alloy of silicon and copper for springs. Plain silicon-copper alloy seemed difficult to handle and no one was successful with its fabrication.

Everdur and Tempaloy are two relatively new kinds of hardened copper. Both are alloys of copper with silicon and other metals and have approximately the physical properties of steel. Each was a by-product of research directed primarily toward another end.

During the World War, the du Pont Company was buying chemical plants in order to get their acid works. Some were in bad condition; quick repairs had to be made. Plain copper would not withstand the attack of certain chemicals being made or used in these plants. Tin was so scarce and costly that it could not be used for alloying the copper. Charles B. Jacobs, who was in charge, made castings from silicon copper to meet the situation. They were brittle and did not machine well.

Silicon was being produced in commercial quantities but was not being used for alloying copper. Silicon bronze had been known for a long time, but silicon bronze was tin bronze deoxided with silicon. Of course there was residual silicon in silicon bronze. That is to say: for thorough removal of oxygen a slight excess of silicon was used and a little remained in the alloy. Silicon, however, was not one of the main constituents.

Acid-resisting metals were much needed; researches were being made for alloys of desired qualities using metals that could be had in America. Reserch by Jacobs led to addition of manganese in various proportions to silicon-copper alloy. The alloy thus made worked satisfactorily and gave the required service. It had strength as well as acid-resisting qualities. It was patented and commercial manufacture undertaken. Everdur for castings contains 94.8 percent copper, 4 percent silicon, and 1.2 percent

Courtesy The Shevlin-Nixon Company

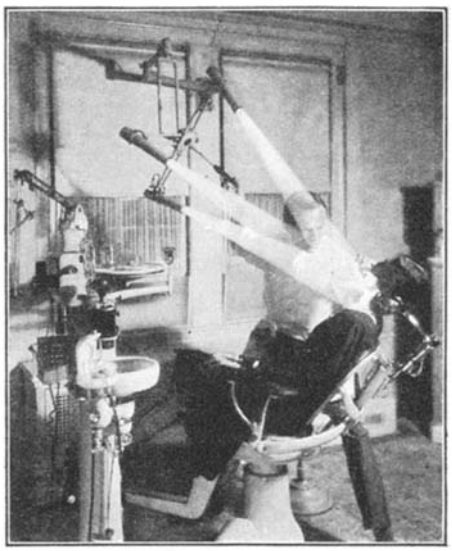
Selective logging removes all but the younger, healthy trees with the result that they get more sun and are protected from fire and windfalls

manganese. For wrought forms, such as rods, wire, sheets, and tubes, Everdur contains 96 percent copper, 3 percent silicon and 1 percent manganese.

Everdur made for casting can be forged and rolled hot, but will not stand much cold working. It hardens rapidly in both hot and cold working. Hence the need for an alloy that could be worked. Wrought Everdur is hardened by drawing or rolling, with marked increase of tensile strength and of hardness. Everdur resists corrosion by many kinds of acid and alkaline liquids. A great variety of uses are being found for this alloy.

Tempaloy is copper carrying nickel silicide. In other words, it is an alloy of copper, silicon, and nickel. It resulted from researches by Michael G. Corson in the laboratory of the Union Carbon and Carbide Research Laboratories during which the possibility of hardening copper by means of certain silicides became apparent.

When heated to 750 degrees to 800 degrees, centigrade, and then chilled, Tempaloy is soft and ductile and can readily be worked cold. Age hardening takes place when the alloy is held at 450 degrees for a few hours. It can be age hardened without cold working or after cold working, as may



With the simple twist, the dentist "spots" a light where he wants it

be convenient. Age hardening after cold working gives considerably higher results than age hardening of Tempaloy which has simply been softened by heating. Addition of aluminum strengthens Tempaloy appreciably and accentuates its hardening properties.

Tempaloy, therefore, is a copper that can be tempered, or more correctly stated in modern phraseology, its properties are developed by heat-treating.

Everdur and Tempaloy open the engineering field to copper. By suitable treatments they can be given such strengths that rods having cross-sections of one square inch would require pulls of 50,000 to 150,000 pounds to break them. Scientific research has thus produced two strong metals, resistant to almost all ordinary forms of corrosion and adaptable to numerous and varied uses. By industrial research in laboratories of the American Brass Company, both metals have been developed for practical application.—W. H. Bassett in *Research Narratives.*

Deafness in Ancient Times

WE are so accustomed to think of Indians as possessed of the most acute vision and the keenest sense of hearing that we can hardly credit the statement that many Indians of ancient times were stone deaf. A common cause of deafness was due to the growth, in the outer ear passages, of numerous small, hard, ivory-like tumors which often filled the passages in both ears, preventng the entrance of sound waves. The condition was widespread among ancient Indians of pre-Columbian Peru, in a prehistoric tribe in Arkansas, in wandering bands of Indians found on the seacoast of southern California, and among aborigines living on the tiny island of San Nicolas, the most seaward of the California Channel Islands. Another type of deafness is due to the infections of the ears arising from large abscesses formed about the teeth.

An accompanying illustration shows the ear canal of an ancient Indian from Peru; another shows several small, hard tumors beginning to fill the passsage. Such tumors are not known among modern people.

Reproduced Daylight for Surgeons and Dentists

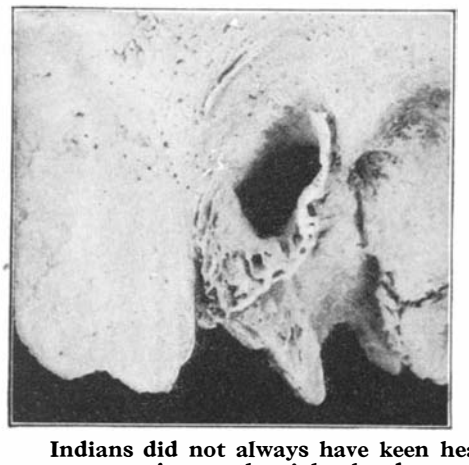
SURGEONS and specialists in the hospital operating room, as well as the dental surgeons in their offices, have long felt the need of a proper method of illuminating their work. Through an invention of Dr. Leon Lazar, a practicing dentist of New York City, a lighting device has been conceived that is totally different from anything heretofore used.

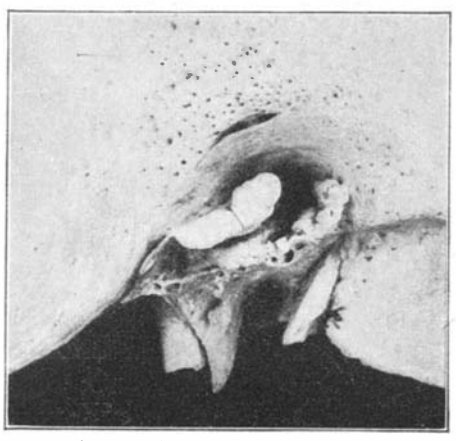
The Lazar light is so constructed that several beams of light may be projected from different angles onto the spot where the surgeon or dentist is working. All beams are controlled from a single handle so that the operator can focus and merge all the beams into one spot of intense illumination, thereby giving a shadowless effect. Each light source is provided with a daylight filter which can be instantly snapped on to convert artificial light into reproduced daylight. Under this light colors and shades appear in their natural values, a feature that is indispensible in

The hospital unit with which surgeons may illuminate the point of the operation without a diffused and troublesome glare

matching of teeth, porcelain fillings, and similar work.

This new light is made in three models: one, the hospital light, is for major surgery; another, the specialist light, is for nose, throat, mastoid, eye, and other minor operations; and the third is the dental light. Many dentists and a number of large hospitals are using these lights, and a number are in use by the United States Navy on battleships and at the Brooklyn Naval Hospital.





Indians did not always have keen hearing. At the left is shown a normal ear cavity; at the right, hard tumors in the ear of an ancient Indian

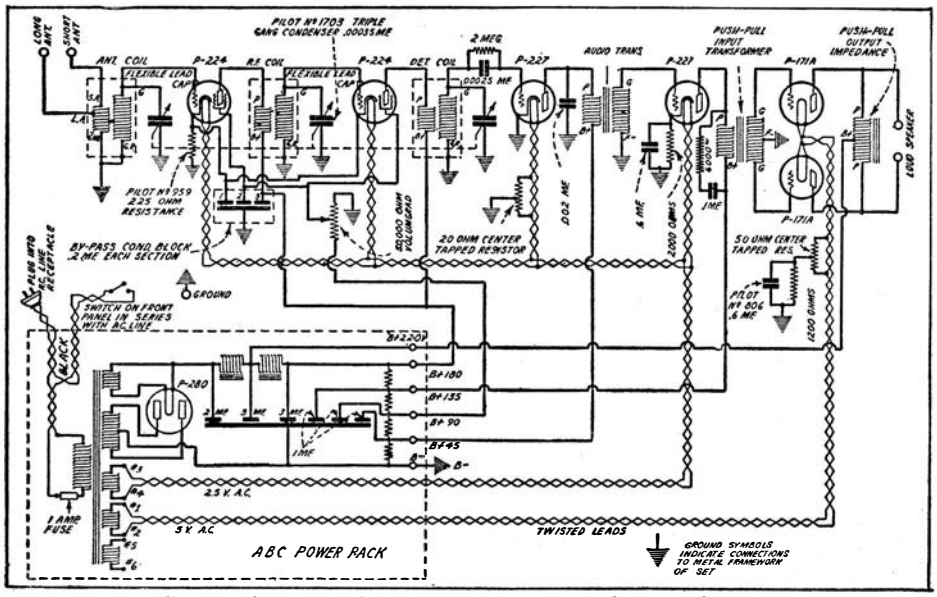
New Wrought Iron Process Eliminates "Puddler"

EGYPTIANS made wrought iron thousands of years ago. This tough and long-wearing metal continued to be made by the same primitive means until the invention of "puddling" in 1784. This slow and expensive hand process is just now giving way to a revolutionary mass-production process developed by Dr. James Aston of the Carnegie Institute of Technology. Adopted by the A. M. Byers Company of Pittsburgh, it will abolish the picturesque "iron puddler" and bring this useful metal back to the many uses for which it has no adequate substitute.

1929 Sunspots Set 25-Year Record

ONE of the things for which 1929 will be remembered in astronomic circles is the record sunspots of its closing month. The spots on the face of the sun from November 24 to December 6 were pronounced at the time as unusual, and an examination of the photographic records of the sun for 25 years has confirmed the first impressions.

C. D. Higgs and F. E. Roach, of the Yerkes Observatory, Williams Bay, Wisconsin, have examined the thousands of



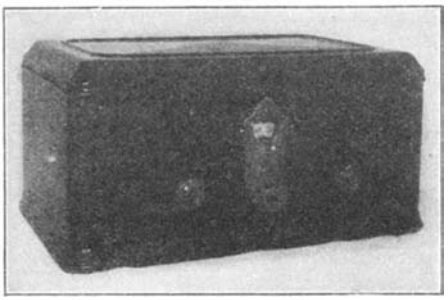
Circuit diagram of the kit-type receiver described herein

photographs made of the sun during the past quarter century, and they find that "there not only was as extensive an area of total spottedness as had ever been recorded in that interval, but also a single spot which probably was not exceeded in size."—*Science Service.*

A New Screen-Grid Radio

THE development of the screen-grid alternating-current tube has opened up a new field to the radio enthusiast. Using these tubes, enormous sensitivity can be obtained, but many experimenters have been disappointed with the results as regards selectivity. This has invariably been due to a lack of understanding of the new tubes and their application to receivers and has now been overcome for the radio constructor by the introduction of a complete, reasonably priced kit that can be made up into the commercial-appearing receiver illustrated in these columns.

This kit, which comes in three forms—the set alone with front panel, the set and a metal cabinet, and the set, cabinet, and a completely assembled power pack that delivers all the required A, B, and C voltages for all the tubes—can be assembled in a short time using only a screw-driver, a pair of pliers, and a soldering iron, even though the constructor knows little or nothing about radio. Every part, down to the last nut and washer, including wire, is furnished with the kit.



Screen-grid receiver in its metal cabinet. Note simplicity of controls—switch, tuning, and volume

A study of the circuit reproduced here will show at once that the set uses two screen-grid tubes, two A. C. tubes of standard design, and two 171A types in a push-pull audio amplifier circuit. Loose coupling between the antenna and the first radio-frequency amplifier insures ample selectivity for all purposes and makes possible the efficient use of single-control tuning. The volume control takes the form of a variable resistance in the screen-grid circuits, and a "tone equalizer" in the second audio circuit serves to suppress some of the higher tones and thus make the lower registers more prominent and pleasing. This equalizer takes the form of a resistance and condenser in series.

The necessity of shielding screen-grid tube circuits is met in this set by the use of aluminum shield cans totally enclosing the two screen-grid tubes and the three radio-frequency transformers. Most of the wiring is located under the sub-panel where it is out of the way and where it is easiest to install. The three variable condensers in the "gang" are provided with "trimmers" which are adjusted for best reception when the set is first placed in operation, after which they need not be moved.

Readers interested in this latest modern radio receiver kit will be supplied with further information upon request.

Chemical Kills Weeds but Lets Little Trees Live

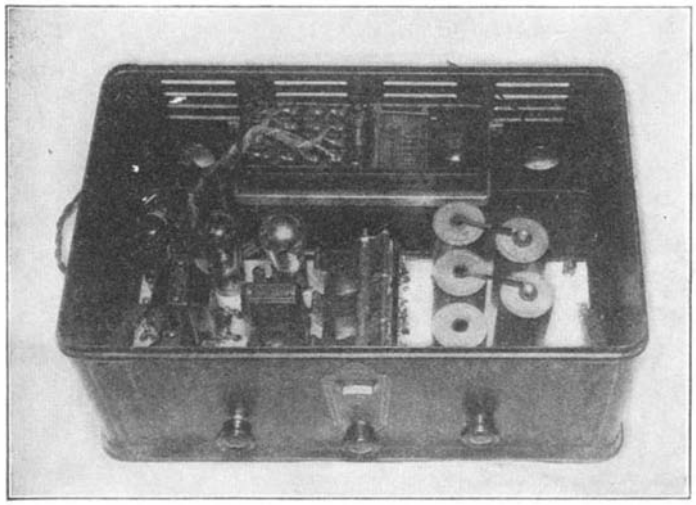
ZINC sulfate, sometimes called white vitriol, will kill weeds in a plant bed full of conifer seedlings but will not harm the little trees, Prof. Ferdinand H. Steinmetz and Prof. Fay Hyland, of the University of Maine, have found. They reported their discoveries recently to the American Society of Plant Physiologists.

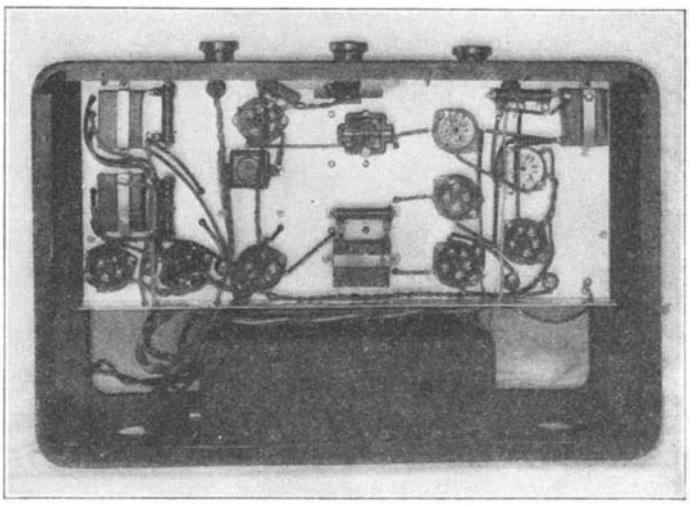
Eight grams of zinc sulfate, dissolved in sufficient water and sprinkled over a square foot of ground, is most effective, it was learned. Germination of the seeds and growth of the little trees was only slightly reduced by the dose, while practically all the weeds were killed.—*Science Service.*

Earth as Power House Yields 200,000,000 Amperes

THE earth itself is a huge electric dynamo generating enough current to supply light, heat, and other electrical needs to the 10 largest cities in the United States for at least a million years. Recent researches on thermal reactions inside the earth, conducted by Dr. Ross Gunn, civilian scientist of the Naval Research Laboratories and inventor of a short-wave oscillator and airplane altimeter that have been taken up by the radio and aircraft industries, indicate that the earth is the greatest known electrical wonder in the universe.

Dr. Gunn has published a theoretical treatise on his studies in the *Physical Review.* The intricate theoretical problem of the earth's electrical condition showed that





Photographs courtesy Pilot Radio and Tube Corporation

Cover of cabinet removed, showing set chassis and powerpack. At right are shielded screen-grid tubes

Bottom view of set. Practically all wiring is below the sub-panel. Note the twisted leads that carry the A. C.

the currents generated inside the earth amount to more than 200,000,000 amperes. Dr. Gunn is careful to emphazise that this tremendous source of energy is unavailable for use by man. Like atomic energy, it will be kept in Nature's storehouse for use perhaps a million years in the future, he says.

According to Dr. Gunn, the tremendous electrical currents that are produced inside the earth arise from the motions of the tiny electrical charges known as electrons. The motions are caused by the very high temperatures existing inside the earth's crust.

Due to a peculiar and complicated type of interaction, the electrons are caused to drift around the earth's axis of rotation. This drift of electrons constitutes an electric current which is so large that, if it were sent through the huge cables supporting Brooklyn Bridge, it would melt them in less than a thousandth of a second.

The presence of the currents that flow in the hot interior of the earth may be detected by anyone who cares to observe the action of a magnetic compass on the surface of the earth, says Dr. Gunn, for it is precisely these deep-seated electric currents that orient the compass needle in a north-south direction. He adds that it has been known for thousands of years that the earth behaved like a giant magnet, but the mechanism by which this magnetism was produced was not understood.—*Science Service.*

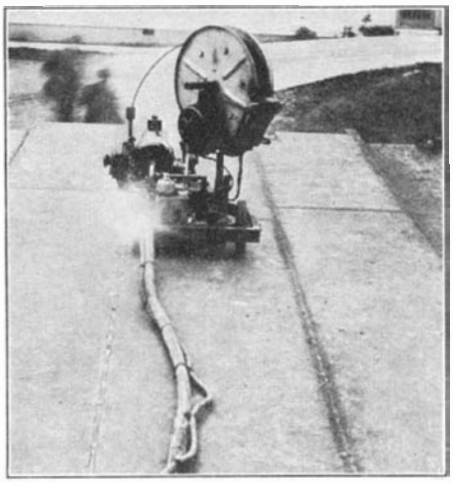
Welded Steel Flooring for All Buildings

THE long-cherished dream of many architects and builders—to erect 100-story buildings—may now be realized as the result of the development of a new type of electrically welded flooring which materially reduces the weight of the structure. The new floor construction, known as the "battledeck" type, was announced and given its first public demonstration at the seventh annual convention of the American Institute of Steel Construction, Inc., at Biloxi, Mississippi, recently.

A sample structure was erected and a demonstration flooring was constructed in the presence of the institute membership, using steel plates and structural steel beams, the plates and beams being "stitched" together to form the flooring. The resulting structure met all specifications and tests satisfactorily.

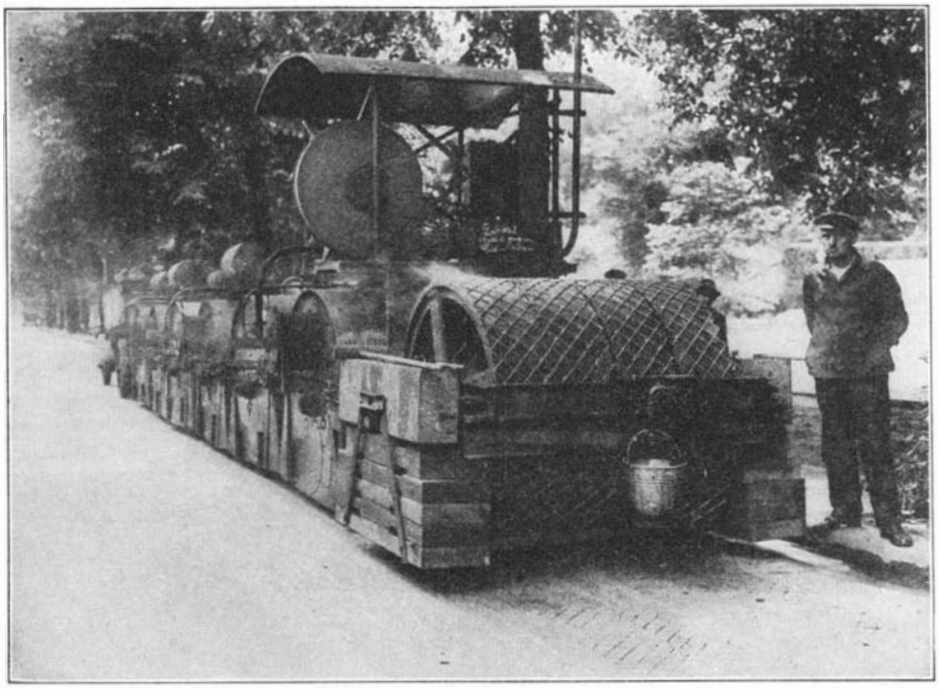
A special electric arc welding machine, operating automatically, has been designed by the General Electric Company for this application and one of the new machines was used in the demonstration.

This machine consists of a three-wheeled self-propelled vehicle driven by an adjustable-speed motor. On the framework are mounted a wire-feeding device, a reel of welding wire, the travel motor, and the control devices. A motor generator at a remote point supplies, through a trailing cable, the current for welding and for operating the travel motor. The speed of travel and the speed of the welding-wire

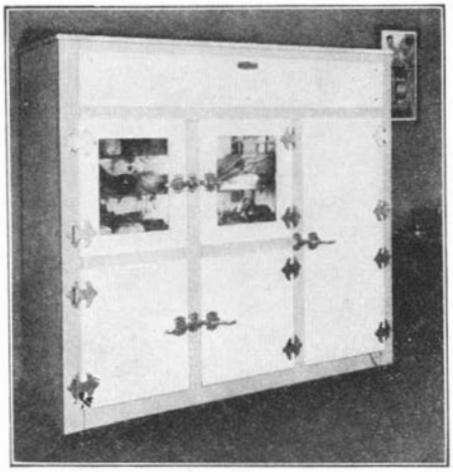


The outfit with which the seams of steel plate flooring are welded. Its operation is notably simple

feed can be varied easily by adjusting small rheostats, thus making it possible to suit the operation to any particular circumstances. In the demonstration at Biloxi a satisfactory weld was accomplished at a speed of 9½ inches per minute.



When the weather is warm in Berlin and the asphalt is soft with the heat, this machine is rolled over pavements to mark them with a pattern like that of bricks to prevent skidding of automobiles. The roller is heavily weighted



A new development: 60 cubic foot commercial refrigerator cabinet

In operation the machine is placed on the beginning of a seam where it is lined up and started running. If by any chance it should tend to deviate from the seam during the course of travel, it can be steered by means of a small wheel on the mechanism. At the end of the seam it is merely necessary to turn the machine around and place it on the beginning of the next seam, proceeding from this point as before until all seams are welded.

The new floor is described by the Institute of Steel Construction as being a solid steel deck which acts as a girder to prevent any torsional distortion of the building when subjected to wind or earthquake action.

The new steel floor is equally applicable to residences, multiple-story buildings, and bridges, and for building construction it will save from 20 to 60 pounds per square foot of floor in dead weight. In connection with a 75-story building with floor panels 21½ feet by 22½ feet, the saving in dead load on the foundations for each column is nearly two million pounds, and indicates that its use will permit an increase of 25 percent or more in the height of the building or in the number of floors without increasing the loads on the foundations.

Commercial Electric Refrigerators

EMBARKING on a still wider field of operations with a new line of products, Frigidaire Corporation has announced a series of porcelain commercial boxes, constructed along principles which have already proved successful in the household refrigeration field, and designed to meet the requirements of virtually every kind of retail business.

The new boxes are of 35, 60, and 110 cubic foot capacity. The smallest is similar to an enlarged household model, having four service windows. The two larger models have a full length door besides the four windows. This door gives access to a meat rack for hanging quarters of meat. Engineers pointed out that three sizes were selected after an exhaustive study of the most popular sizes for commercial refrigerators.

E. G. Biechler, president and general manager of the corporation, in announcing the new boxes, emphasized the fact that the company will continue to make refrigerating equipment to be used with other makes of refrigerators, but in addition now is able to provide a box engineered exclusively for electrical refrigeration and covered by its standard factory guarantee.

Learning to Use Our Wings

Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City

The Safe Aircraft Competition

FROM the writer's personal view of the recently closed Guggenheim Safe Aircraft Competition, in which the Curtiss *Tanager* was the only one to qualify, there emerge the following conclusions:

1. The speed ranges as advertised by our manufacturers, that is, the range between maximum and minimum flying speed, are greatly over-estimated. Those which such manufacturers advertise, in all honesty, are apt to shrink considerably when submitted to the acid test of independent and accurate testing. If the competition makes this clear to industry and public alike, it will have achieved a real service to aviation.

2. It is far more difficult to diminish the minimum speeds, and hence the landing speeds, than to increase the top speeds. Dr. H. E. Wimperis, of the British Air Ministry, points out that the speed of a British fighting plane was increased by 70 miles an hour in the course of a single year. As demonstrated by the Schneider Cup Races there seems to be no limit to the speed of our racing aircraft. At the lower end of the range, progress seems to be much slower and the conventional airplanes, such as many of those entered in the competition, frequently have stalling or minimum speeds of well over 45 miles per hour.

3. The only way to achieve progress at the lower point of the speed range, without sacrifice of other good qualities, is to adopt some device for increasing the maximum lift coefficient of the airfoil.

4. The competition indicated that variation of the camber alone, or variation of the angle of incidence, were not very effective methods of improving the landing speed. It was most unfortunate that one entry which embodied both variable area and camber was not ready in time to undergo tests.

5. The competition indicated quite clearly that the slot, acting in conjunction with a rear flap, was at that date the most powerful and the most practical means of improving the lower range of the aircraft. It indicated further that the slot and flap could be embodied in the design of an airplane without any undue complication and without any danger of failure in flight. Both the Curtiss entry, the *Tanager*, and the Handley Page entry carried the front slot and a rear flap. These planes suffered, in the exceedingly severe tests of the competition, a variety of mishaps such as broken landing gears and damaged tail skids, but at no time did the slot and flap offer any difficulties either in reliability or in pilot's operation.

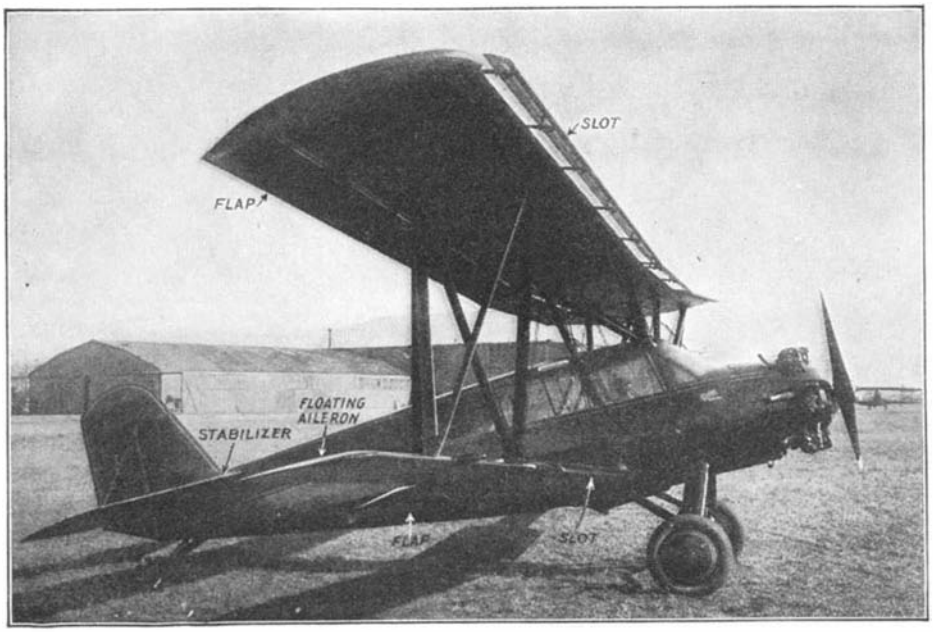
6. The Curtiss Company has announced definitely that it will put the *Tanager*, a cabin biplane, into production. We believe that other American manufacturers will be convinced soon that slots and flaps belong in the modern airplane, and that their use will become general in a few years.

Considering the *Tanager* in some detail, there will be noted first of all, that there is the slot, consisting of an auxiliary airfoil mounted at the leading edge of the main wing. When at high angles of incidence, with the suction on the upper surface of the wing concentrated towards the leading edge, the small auxiliary airfoil mounted on a suitable form of roller moves forward automatically and creates a Venturi-like passage between the auxiliary airfoil and the main wing. The streamline flow, destroyed by the high angle of attack, is immediately restored by this passage which allows an auxiliary flow from the region of high pressure below the wing to the region of low pressure above the wing.

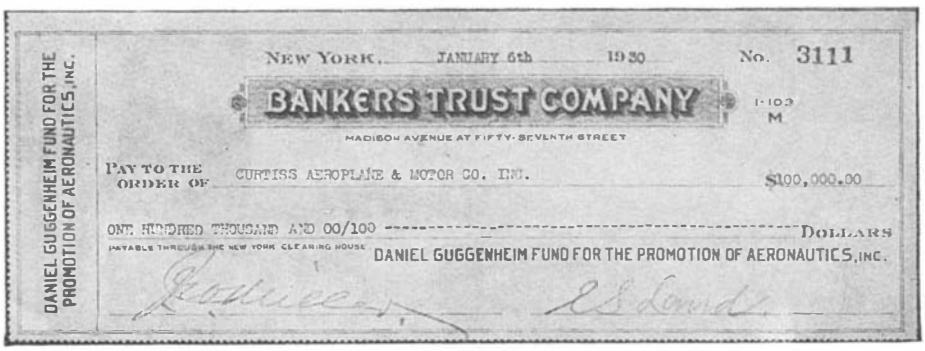
The opening of the slot allows the wing to go to an incidence of some 24 degrees, instead of the usual 16 before "burbling" of the air flow occurs. The lift is thereby increased some 40 percent for a thick wing, and some 60 percent for a thin wing. It is difficult to use the action of the slot alone, because to take advantage of its lift-increasing property, it is necessary to have an airplane whose angle of incidence at landing is high. The chassis, to realize a three point landing with front wheels and tail skid touching at the same instant, must be long and stilt-like. This decreases the performance of the aircraft because the weight and air resistance of the landing gear increase with its length.

If, however, a rear flap is placed all along the rear edge of the wing, the situation changes. First of all the use of the rear flap in conjunction with the front slot increases the lift not some 40 to 60 percent, but over 100 percent! Secondly, the depression of the rear flap brings down the angle of incidence at which maximum lift is achieved to normal proportions, and the landing gear design need no longer depart from convention.

The front slot can be suitably linked up



A side view of the prize-winning *Tanager*, with the various important parts indicated and named. These features are described on this and the opposite pages



A reproduction of the check tendered to the designers of the qualifying Curtiss *Tanager*. Requirements of the competition are put forth on the opposite page

with the rear flap, so that the action of the rear flap is also automatic. As the front slot opens it pulls down the rear flap. As the front slot shuts, the rear flap gets in line with the wing as should be the case within normal flying speeds.

The Handley Page entry had the rear flap interconnected in this manner. The designers of the Curtiss *Tanager* preferred to place the control of the flap in the hands of the pilot.

Experience in the competition seemed to indicate that the manually controlled flap is preferable. The automatically controlled flap has a tendency to take charge itself and to shut the front slot just when its help is needed the most. This is because the air presses up on the flap and tends to raise it at all times, so that the flap and slot are, so to speak, working against one another.

Another important feature of the Curtiss entry was the floating aileron. In order to achieve the maximum possible increase in lift, it is advisable to have the rear flap run the entire length of the wing span. Hence the ailerons should, if possible, be outside the wing system proper. Also, the conventional aileron acts least effectively at high angles of incidence and low speed, when it is required the most. The floating aileron as used by the Curtiss company gets around this difficulty. The ailerons are so arranged that they float in the air stream and are always at zero angle of incidence, although they can at the will of the pilot be raised and lowered on respective sides so as to achieve lateral control.

The great advantage is that the ailerons always start from a neutral incidence and are therefore effective no matter what the incidence of the wing as a whole may be. Further, since the ailerons are symmetrically double-cambered surfaces, when one is lowered and the other raised their air resistance remains the same because of this symmetry. Hence the ailerons introduce no unequal resistance at the tips of the wing, and no tendency to turn the machine off its course.

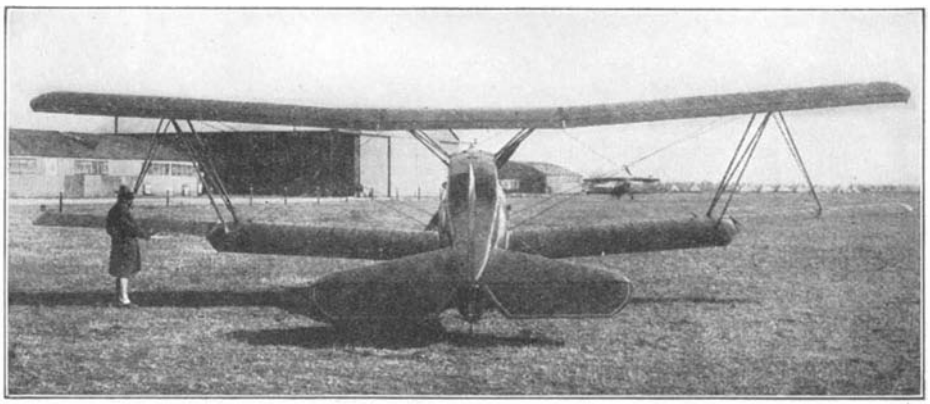
Still another feature of the *Tanager* is the rapidly adjustable stabilizer which can be moved through a far greater range than the ordinary adjustable stabilizer. At very high angles of incidence, with the flap depressed, the center of pressure tends to move back, and it is hard to keep the machine in the high angle of attack condition. The rapid and powerful adjustable stabilizer action takes care of this difficulty.

The main dimensions of the *Tanager* were as follows:

Spar—43 feet 10 inches (for both wings)
Chord of both wings—5 feet
Wing area—330 square feet
Overall length—26 feet 7 inches
Weight empty—1900 pounds
Useful load—850 pounds
Engine—170 horsepower Curtiss "Challenger"

The exact performance of the *Tanager* in the competition has not yet been released, but our readers will appreciate its performance sufficiently well if they note that the plane satisfied all the requirements of the competition, although only by a narrow margin. These requirements were:

Useful load per horsepower—5 pounds
High speed—110 miles per hour
Climb—400 feet per minute



Looking at the *Tanager* from the rear. This photograph shows plainly, at the lower wing tips, the two ailerons which are always at a zero angle of incidence

Low speed—power on—35 miles per hour
Minimum gliding speed—power off—38 miles per hour
Length of landing run—100 feet
Steady glide over an obstruction 35 feet high, and coming to rest 300 feet from base of the obstruction
Length of take-off, 300 feet
Take-off over an obstruction 35 feet high at a distance of 500 feet from rest
Flattest glide of 8 degrees to the horizontal
Steepest glide of 12 degrees to the horizontal at a speed not exceeding 45 miles per hour.

The Sun Compass

TO establish a course, the pilot has the conventional magnetic compass and the more refined earth inductor compass. Both types are fairly satisfactory everywhere, except near the poles where the magnetic directing force becomes too uncertain.

Accordingly, for his successful flight over the South Pole, Commander Byrd had recourse to an instrument operating on a totally different principle—the sun compass. The sun compass is a clock with a single hand, moving at the same speed as the earth about the sun. The face of the clock bears the usual hour divisions. The tip of the hand carries a needle and the base bears a screen marked with two perpendicular lines. The sun casts a shadow of the pin on the screen.

The Bumstead sun compass

Before starting from Little America, Commander Byrd set the hand of the clock at true solar time. He turned the entire instrument until it read due south, as indicated by the compass markings on the base plate. Then he moved the latitude scale and set it at 90 degrees, the location of the pole. When the party took off, the pilot swung the plane until the sun cast the shadow of the pin between the lines of the screen, where it was held until the goal was reached.

Inasmuch as the hand of the clock makes one revolution in 24 hours and the earth makes one complete revolution in the same time, the compass and the hand of the clock remained in a constant relative position so that a straight line might be maintained.

When Commander Byrd reached the South Pole and turned for his base, he rotated the base plate until it read north instead of south, and the airplane was again directed to bring the shadow of the pin back on the screen.

Air Transport Communication

R. L. JONES and F. M. Ryan, of the Bell Telephone Laboratories, in a paper delivered recently before the American Institute of Electrical Engineers, dealt with the very important subject of telephone communication between plane and ground.

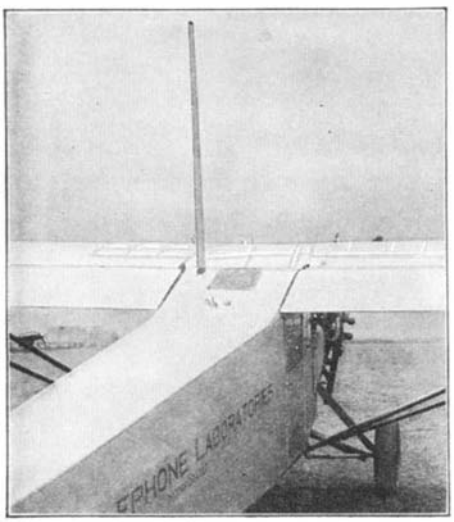
In air transport work the dependence on weather conditions makes it an absolute essential of safety that there be frequent and complete communication between the pilot and the ground. Radio telephony is preferable to radio telegraphy as it requires no skilled operator and is much more rapid.

The problem of establishing such radio telephone service presents many difficulties, but the engineers of the Bell Telephone Laboratories, using a large three-engined plane as their flying laboratory, have practically solved it.

The experiments conducted at Whippany, New Jersey, furnish another argument for high altitude flying. Both the strength and the intelligibility of the telephone signals are improved when the plane is high above the ground.

The antenna is quite a problem in aircraft radio. For reception, all that is needed is a self-supporting, stream-lined mast of hollow wood construction, with an internal conductor, and extending about seven feet above the fuselage. For transmission, however, such masts are not generally suitable. The frequency band for aircraft radio telephony is between 1500 and 6000 kilocycles. It is the lower frequencies which give the best results, but for this work, long trailing wires are essential. It may therefore be necessary, in

Owing to the high noise level in airplanes, a special type of telephone transmitter must be used. Here is the hand type which has been developed for this use



A general type of self-supporting stream-lined mast antenna widely used for airplane radio receivers for the reception of weather reports and signals from beacon stations

air transport work, as distinct from military aviation, to use the less suitable higher frequencies because they permit of fixed antennas of relatively small dimensions.

Aircraft radio telephony must meet many unusual requirements. There is first of all the noise of engine, exhaust, and propellers to overcome and in the design of both the microphone and the receiver, special precautions must be taken to exclude external sounds.

Another problem is in the violent electrical disturbances introduced by the usual ignition system of the aircraft engine. Magnetos, the electric ignition circuits, and the spark plugs, must all be electrically shielded. Here is another argument in favor of the Diesel engine; it will dispense with the ignition system and thus aid radio telephony.

Again, it is necessary to bond all metal parts of the airplane, in order to avoid noises in the receiving equipment from intermittent contacts between various metal parts of the plane. When transmitting apparatus is used on board an aircraft, such bonding is also necessary to prevent the possibility of high voltages developing between metal parts and causing sparks or arcs.

At the moment radio telephony reception is probably more important in air transport than transmission. The aircraft receiver for government weather signals is a comparatively simple affair. It is equipped with three tuned circuits—one for the antenna and one for the output circuit of each of the stages of radio frequency amplification. The receiver is mounted in a metal box about 12 inches long by 8 inches high, and weighs only 13 pounds. A small electric generator supplies the necessary power; it is driven by propeller, which is one-bladed, and the centrifugal force of the unbalanced blade actuates a governor so that speed and output remain constant, no matter what the speed of the airplane may be.

A single-blade wind-driven generator of the type used to supply filament and plate voltages to the receivers used on airplanes. The speed and output are constant

The special telephone set used by the pilots in airmail planes. The receivers are in the helmet

Another characteristic of radio telephony is the special headphone which is used by the pilot and the special telephone-type transmitter which may be fastened to the head or held in the hand.

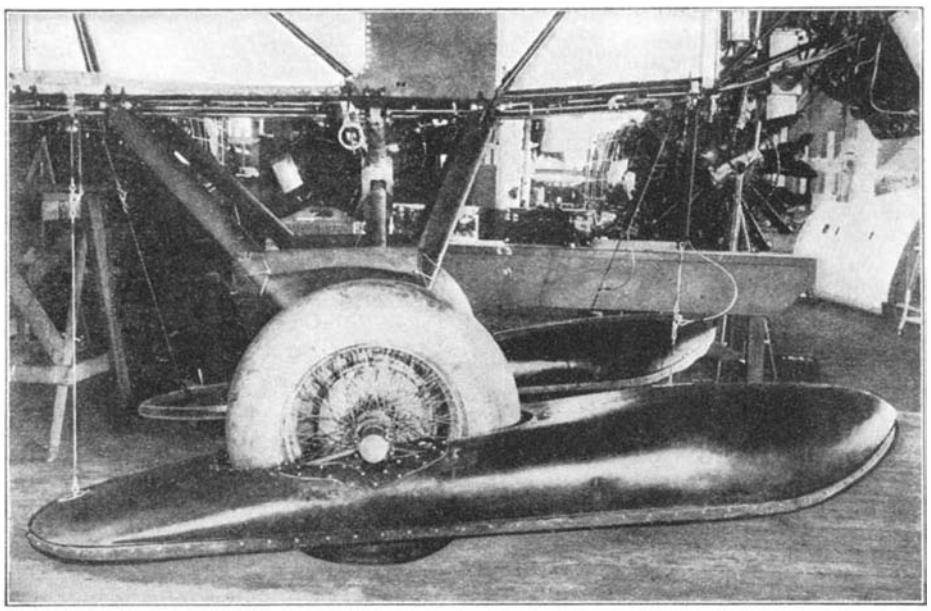
Beryllium

MUCH interest has been aroused by various notices which have appeared in this magazine concerning the extraordinary light metal beryllium. In our January issue, on page 89, mention was made of the cost of beryllium ore at about 60 dollars a ton. This high price, it is hoped, will be greatly reduced in the near future so that the price of approximately 225 dollars a pound for the refined metal may be placed at a level where it will not be prohibitive to the industrial development of uses for the material.

Snowphibions

SNOWPHIBIONS is a recently coined term to designate airplanes which can alight on dry land or on snow indifferently, in analogy with the amphibion which can alight on water or land. The snowphibion built by the Boeing Airplane Company is being put in use on their airline between Chicago and San Francisco, where differences of climate over the long stretch make it uncertain whether snow is to be expected or not.

The snowphibion is provided with a long ski, something like a pontoon in construction. This is pivoted about the wheel axle, with the pivoting motion restrained by rubber cords. Also, by a mechanism analogous to that of the retractible chassis, the ski can be raised or lowered relative to the wheel axle. When lowered, the plane lands on the ski; when raised the wheel is free to act as usual.



A close-up view of a snowphibion landing gear for use in regions where the pilot may be called upon to land on either snow or bare ground. The ski may be lowered or raised: when lowered, the plane may land on snow; when raised, the wheels are used. In the photograph the ski is shown raised

Current Bulletin Briefs

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

Engineering

MANUAL OF FIRST-ORDER LEVELING, by Henry G. Avers, (Special Publication Number 140, U. S. Coast and Geodetic Survey) contains general instructions for this type of surveying, as revised to conform to the present accepted practice. *U. S. Government Printing Office, Washington, D. C.—30 cents.*

CONSTRUCTION, REHABILITATION, AND MAINTENANCE OF GRAVEL ROADS SUITABLE FOR MODERATE TRAFFIC, by Carroll C. Wiley (Circular Number 18) is a well illustrated report covering investigations and tests made concerning the methods, materials, and equipment best suited for gravel highways. *Engineering Experiment Station, University of Illinois, Urbana, Illinois:—30 cents.*

THE MOJAVE DESERT REGION IN CALIFORNIA, is a 759-page book with accompanying maps giving complete information about the geographic, geologic, and hydrologic features of one of the continent's most interesting regions, covering an area of about 25,000 square miles. *U. S. Government Printing Office, Washington, D. C.—Two dollars.*

DESIGN STANDARDS FOR OXWELDED STEEL AND WROUGHT IRON PIPING is an illustrated booklet prepared to enable the engineer and architect to design piping systems according to the best practice yet developed. *Linde Air Products Company, 30 East 42 Street, New York.—Gratis.*

Commerce

MARKET DATA HANDBOOK, a 535-page compilation of authoritative statistical data, covers the entire country by counties. The information is arranged in convenient classifications for reference use, showing the localization of all industries as a guide to aid sales managers, manufacturers, advertisers, *et al.* The book is issued by the Department of Commerce. *U. S. Government Printing Office, Washington, D. C.—$2.50.*

COAL BUNKERING STATIONS AND FUEL OIL STATIONS, a new fueling directory covering 300 world ports, has been prepared by the Shipping Board and the Department of Commerce, from data collected by the Department of State through its consular officers. *U. S. Government Printing Office, Washington, D. C.—30 cents.*

FOREIGN COMMERCE AND NAVIGATION OF THE UNITED STATES, is a 661-page volume containing classified statistical and summary tables for 1928 and comparative years, covering all United States foreign trade. *U. S. Government Printing Office, Washington, D. C.—$1.50 (buckram bound).*

Wood

SMALL DIMENSION STOCK, ITS SEASONING, HANDLING AND MANUFACTURE, is a report of the National Committee on Wood Utilization, the 12th of a series on the marketing and use of lumber. The purpose of the report is to develop standard methods of small dimension production, by detailed recommendations. *U. S. Government Printing Office, Washington, D. C.—20 cents.*

THE STORY OF AMERICAN WALNUT begins with the days of King Solomon, marches down the centuries with the master woodworkers of various periods, and concludes with a lesson on means of identifying and judging walnut furniture and interior woodwork. *American Walnut Manufacturers' Association, 616 South Michigan Avenue, Chicago.—Gratis.*

Miscellaneous

ABSTRACTS OF DISSERTATIONS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (1929) covers numerous papers dealing with specialized topics in science, education, history, and classical literature. An appendix covers the activities of the Graduate School. *University of Pittsburgh, Pittsburgh, Pennsylvania.—Gratis.*

BRIEF OF WALTER H. WHEELER, applicant for a permit to produce hydro-electric power for phosphate fertilizer manufacture on the Flathead River in northwestern Montana. This brief shows clearly the plans, as presented before the Federal Power Commission, for the development and utilization of power from "the Muscle Shoals of the West." *Forbes and Daniels, Kellogg Building, Washington, D. C.—Gratis.*

MANUAL FOR BIRD BANDERS, by Frederick C. Lincoln and S. Prentiss Baldwin, (Miscellaneous Publication Number 58, Department of Agriculture), describes and illustrates many approved types of traps and contains much information in regard to ornithological research. *U. S. Government Printing Office, Washington, D. C.—30 cents.*

SOME SOCIAL AND ECONOMIC ASPECTS OF HOMEWORK, Special Bulletin No. 158 published by the New York Department of Labor, treats the problem of homework from the viewpoint of the statistician interested in effecting curative measures. *Department of Labor, 124 East 28th Street, New York City.—Gratis.*

BLACK HORSE OF THE SEA, by Robert D. MacMillen, is a handsome booklet describing the salvage service symbolized by a runaway black horse, known for nearly 70 years by sea-faring men. *Merritt-Chapman and Scott Corporation, 17 Battery Place, New York City.—Gratis.*

RARE METALS is a booklet presenting in very readable form the history, properties and uses of the metals tantalum, tungsten, and molybdenum. *Fansteel Products Company, Inc., North Chicago, Illinois.—Gratis.*

Tantalum, described in the booklet "Rare Metals," is obtained from a remote district in Australia. The inset shows the ore, powder, and a tantalum bar

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

New Process Enables Metal Coating to be Sprayed on Anything

METALLISATION, as its name implies, is a process by which articles are covered with a metal layer. The latest developments of this process make possible such startling achievements as the spraying of molten metal on such delicate surfaces as paper, cloth, and celluloid, forming a coating so adhesive that it seems almost an integral part of the base. Usually the metal which is to be deposited is employed in the form of a wire, although metal dust or powder may be used if another apparatus is employed.

The usual apparatus consists of a pistol, weighing about three pounds, connected to cylinders of oxygen and acetylene, and to a source of compressed air. The compressed air actuates a small turbine which feeds the wire—supplied from a reel—through the nozzle of the pistol, where it meets the oxy-acetylene flame and is melted, the compressed air atomising the molten metal and forcing it at high velocity—some 3000 feet per second—against the object which is being coated.

The rate at which the wire is fed through the nozzle varies according to the nature of the wire, control being provided by a needle valve which adjusts the air flow to the turbine. As the flame is of a reducing nature, the atomised metal is protected from oxidation, hence metallisation can be continued until the desired thickness of coating, from 0.001 inch upwards, is attained. A pleasing matte finish is obtained, which can be buffed if a polish is desired.

The only precaution required, apparently, is to ensure that the surface to be metallised possesses an open texture—metal articles should be sand blasted, using dry sand—and that it is perfectly clean and free from moisture, scale, or oil. Paper, cloth, and wood can be metallised without trouble, but the paper must not be glazed, and wood should be sandpapered or given a light passage in the sand blast. It should be remarked that there is very little heat effect on the surface of the work; therefore delicate materials such as celluloid or a photographic film can be treated without harm. The coating is extremely adherent, and cannot be separated from its support, either by bending or severe hammering.

Simple Device Measures Explosive Gas in Mines

A RATHER clever device for the determination of the amount of the explosive "fire-damp" gas in mines has been perfected in England. The principle of its operation is chemical, being based on the fact that one volume of methane, when burned, produces two volumes of steam. The steam condenses, producing a reduction of pressure, the reduction being proportional to the amount of methane burned. The methane is burned in a copper combustion chamber containing an electrically heated platinum spiral and connected with a U-tube liquid gage graduated to read directly in percentages of fire-damp.

Chemists Pre-Determine Relative Corrosiveness of Soils

THREE billion dollars a year is lost by the corrosion of iron and steel, according to Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research. It is small wonder, therefore, that methods of reducing this staggering waste occupy the attention of chemists in many industries. One very large item on this corrosion bill is that charged against the corrosion of pipe lines, for distributing gas, oil, and water. W. T. Smith, in a recent issue of *Chemical and Metallurgical Engineering* describes how chemists analyze the soil in which the pipe is to be laid and thus determine the best methods of protecting it against corrosion.

Soil samples are taken, at intervals of not more than one mile, by means of an auger, to the depth at which the pipe will lie when in service. Wherever definite changes in topography or surface conditions are encountered, additional samples are taken, as are liquid samples from any streams or rivers the line may cross. Each representative sample is placed in an air-tight container marked with specific information for identification at a later date.

When the samples arrive at the laboratory they are weighed as received, air-dried, and weighed again to determine the moisture content. A solution is made by thoroughly mixing a portion of each sample with distilled water. Both the solution and the soil are then subjected to a carefully worked-out series of chemical analyses to determine the amount of certain constituents known to be active factors, under certain conditions, in accelerating or inhibiting corrosion. In addition to the chemical analyses, each sample is subjected to determinations for hydrogen-ion concentration and physical, electrolytic, and accelerated corrosion tests.

Courtesy J. W. Richards & Son

Left and above: **Taking samples of soils along a pipeline for use in charting the relative corrosiveness**

When the complete analytical data has been calculated and charted, an equally important part of the corrosion survey begins. It is one thing to "analyze" a soil and quite another to interpret the knowledge gained in terms of relative corrosiveness. By means of a method worked out

Courtesy Wailes Dove-Hermiston Corporation

Coating pipe with Bitumastic enamel by the rolling-rig method; from the facts revealed by the corrosion survey, coating specifications are made

by Percy J. Richards, of J. W. Richards and Son, and William Thompson Smith of Ford, Bacon and Davis, Inc., all the known and suspected corrosive factors are correlated and balanced against each other. As mentioned above, these factors include surface conditions, analytical data, moisture, and any other local situation that may be of importance. The result is interpreted in terms of relative intensity of corrosive action at all points along the pipeline, with specific recommendations as to the amount of protection necessary on varying sections.

Electrical Eye Detects Smoke

AN electrical smoke detector is the latest example of the invasion of the "mechanical man" into the field of the chemist. Scientists of the General Electric Company have developed a machine that is so sensitive to the existence of smoke or haze in air that it immediately reports the situation. We have previously described, in these columns, several of the ingenious devices used to detect poisonous carbon monoxide in the mines and tunnels, such as the Holland Tunnel connecting New York and Jersey City. Now we present the electrical eye which detects excess haze or smoke in this tunnel, thus warning the superintendent that the ventilating fans should be speeded up.

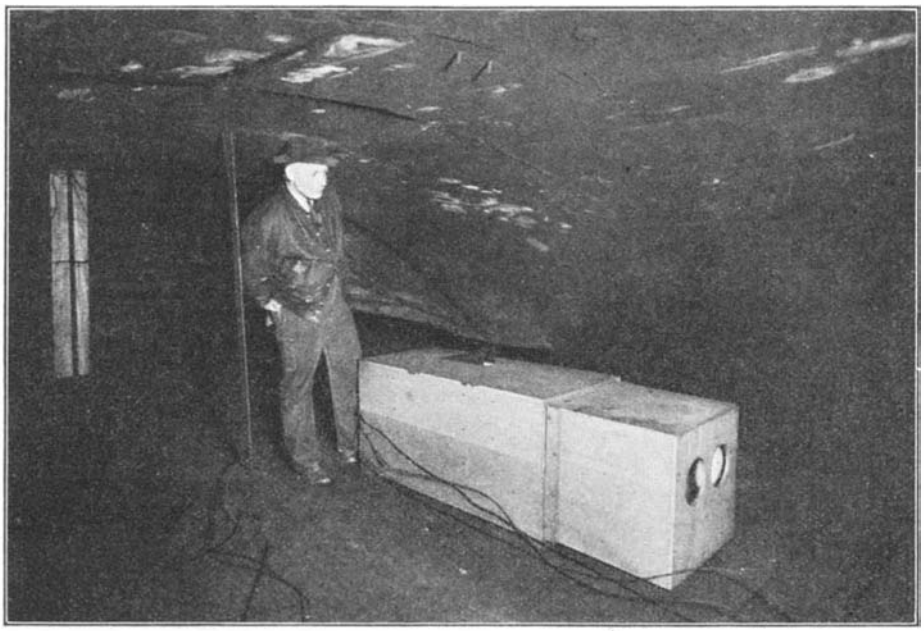
In applying the light-sensitive photo-electric cell to tasks of this kind, Ole Singstad, Chief Engineer and Superintendent of the Holland Tunnel, hopes to work important operating economies and to provide an additional safeguard in controlling the air conditions in the tunnel. As now used experimentally in the tunnel, the "electric eye" is directly connected to a recording device a quarter of a mile from the mouth of the tunnel. Impulses from the photo-electric cell circuit guide a pencil point over a sheet of paper graduated in time and in volume. At any instant the supervisor knows how much haze is in the tunnel, and if the visibility decreases from any cause whatsoever he can relieve the situation by speeding up the fans or by putting additional fans into service.

At the present time the detector is located in an exhaust duct, a long cave-like chamber above the traffic lane, near the New York exit and at the point where the roadway grade is at the maximum and where the amount of exhaust gases expelled from the heavy truck traffic is greatest. The exhaust duct is dark except for fitful beams of light admitted through narrow openings in the roof of the passage way. These openings provide an exit for the air.

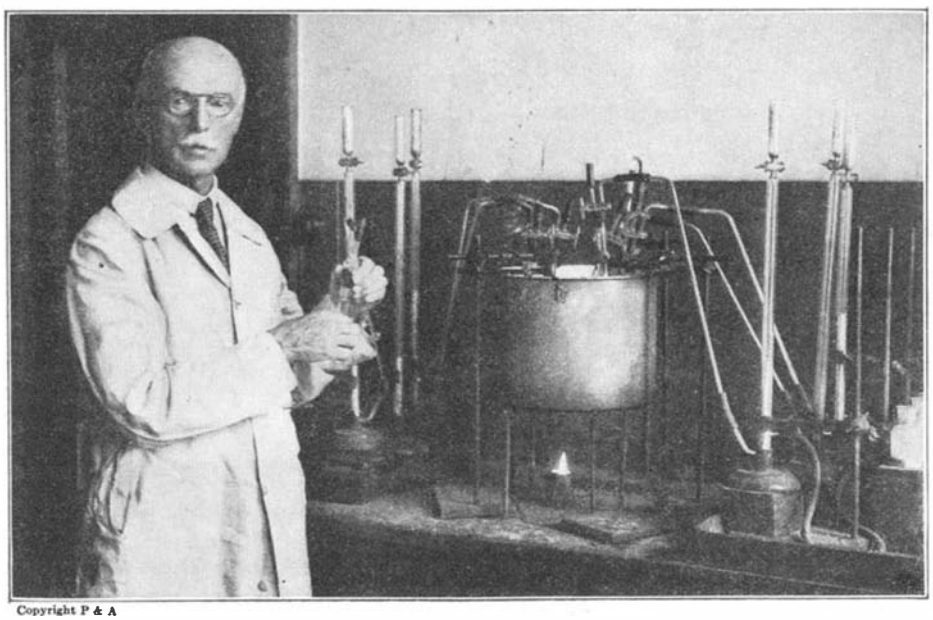
The detector consists of two units, a light source and a photo-electric cell and, 150 feet away, a target. Light provided from a lamp with concentrated filament is directed through a lens to the distant target. This target consists of two mirrors set at right angles. The light beam hits the first, which directs it to the second mirror and thence is reflected back 150 feet to the light-sensitive tube.

As the exhaust air of the duct passes through the light beam, the quantity of the light is diminished. This variation or dimming of the light is not perceptible to the human eye but the photo-electric cell responds to the most minute changes. The greater the amount of light, the greater the current passing through the tube. The photo-electric cell, which is about the size of the familiar "peanut" radio tube, is directly connected to an amplifier where the current is built up, and passed on to the recording device a half mile away.

The projected use of the photo-electric cell as a fume detector may presage the development of a household and business house robot watchman, which will be a smoke detector that will sound an alarm at the first appearance of smoke on the premises. A photo-electric cell and a light source might be installed in cellars, in attics, or in warehouses filled with combustible goods. Such a tube connected to a bell or some other form of alarm could be depended upon to give warning with almost the first appearance of smoke.



The "electrical eye" now being tried out in the Holland Tunnel under the Hudson River; the photo-electric "eye" detects the presence of excess smoke



Copyright P & A

Dr. Arthur Harden, Professor of Biochemistry at London University, whose work has been recognized by making him co-recipient of the 1929 Nobel Prize

Coats Aluminum With Lime as Base for Paint

ALUMINUM articles, when boiled with milk of lime containing a little calcium sulfate, are given a fine-grained, closely adherent, dead-white coating which may prove to be an excellent foundation for the application of paints or enamels, says Leon McCulloch, in a recent issue of *Chemical and Metallurgical Engineering*. The coating probably cannot be recommended for corrosion resistance but it gives a surface that can be written upon. If alloys of aluminum rather than the pure metal are given the treatment, various shades of gray are obtained.

In applying the coating, ten grams each of lime and calcium sulfate (preferably the fully hydrated sulfate) are used for each liter of water. Although the action of the calcium sulfate is unknown, it is found to give smooth, adherent coatings which would otherwise be pitted.

As there is apparently deterioration of the bath upon aging, fresh materials should be added each day. The bath is stirred gently and is kept at about the boiling point, although a temperature of 85 degrees, centigrade, has given satisfaction. Time for the process may vary slightly, although the coating does not increase ap-

(*Please turn to page* 245)

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

The Cause of Influenza

IN 1892 a bacteriologist named Pfeiffer described a germ which he thought was the causative organism of influenza. At various intervals since that time other organisms have been described, also alleged to be causative, and the bacteriologists continue to debate the question as to the exact nature of the influenza germ.

Modifications of the Pfeiffer organism have been described every year, associated with various coughs, colds, and similar infections of the nose and throat. It is emphasized that the various types of germ described as Pfeiffer organisms do not constitute in any instance a unit; that is to say, they are not uniform in distribution or in the way in which they bring about disease.

During the last great epidemic of 1918, organisms were recovered from thousands of cases all over the world, and there is no evidence that uniformity exists even in the many types of organism associated with that epidemic.

In attempts to discover and definitely to identify the influenza germ, experiments have been made with human beings who voluntarily submitted themselves to inoculation with pure cultures of the various germs that have been isolated. The earliest definite report of successful human inoculation with pure culture of the Pfeiffer organism is that recorded by Dr. D. J. Davis in Chicago in 1906.

However, Doctor Davis pointed out at the time that while the Pfeiffer germ may produce definite symptoms on inoculation into human beings, the symptoms produced are not those of true influenza.

During the 1918 epidemic, volunteers were inoculated with 13 different strains of organisms isolated from cases of influenza. All of them developed symptoms, but again it was shown that these symptoms were not the typical symptoms of epidemic influenza.

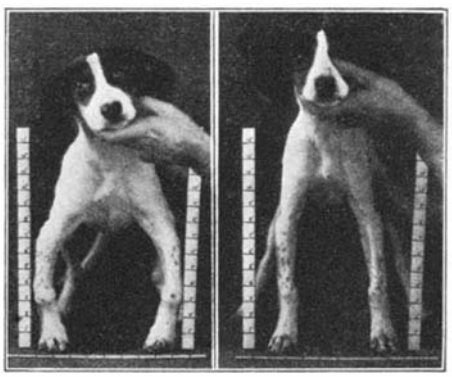
Indeed, after surveying all of the evidence of innumerable inoculations with all sorts of organisms taken from the nose and throats of people during epidemics, Prof. E. O. Jordan comes to the conclusion that it can not be definitely asserted that negative inoculation experiments are not in themselves sufficient to rule out Pfeiffer's organism as the cause, since it is quite possible that there are some unknown factors influencing the likelihood of a person to catch influenza or associated with the way in which the organism is transferred from one person to another. After death from influenza no uniformity of kind or distribution of bacteria can be detected in the body.

During influenza the resistance of the body is lowered and a great variety of germs invade the tissues. As a result, all sorts of bacteria have been found in influenza and the medical profession has become exceedingly suspicious of new discoveries in this field.

Until a germ isolated by any investigator has been thoroughly tested by independent investigators under various conditions in different hospitals and laboratories, it is not safe to accept it as the causative germ of this extremely difficult and elusive malady.

Of the organisms given most serious consideration in recent years, the green-producing streptococcus isolated by Mathers and Tunnicliff in 1918, the one discovered by Rosenow in 1919, and innumerable similar germs isolated in various parts of the world immediately thereafter deserve special consideration. The filter-passing organism described by Meyer in 1919 and the organisms discovered by Olitzky and Gates of the Rockefeller Institute and called by them *bacterium pneumosintes* would seem to deserve as much consideration as is now given to the Falk germ recently announced as the cause of this disease.

Recently investigators in the University of Chicago have carried out a series of experiments on human beings and on animals and have isolated an organism which they feel is the specific cause of influenza. Four monkeys were inoculated with the Pfeiffer bacilli, but did not develop symptoms resembling influenza in man. Such symptoms were developed in 16 monkeys which were inoculated with material obtained from eight human beings who were suffering with influenza. Cultures of bacteria developed from the secretions of patients with influenza were sprayed into the nose and throats of the monkeys and these monkeys developed symptoms resembling influenza. Monkeys which had developed symptoms following inoculation with cultures were put in cages with other monkeys, and the other monkeys apparently caught influenza from the infected monkeys. There were controls made by spraying the nose and throats with salt solutions and non-infectious material, and monkeys sprayed with these materials did not develop any of the symptoms referred to. During the course of the investigation, several of the workers developed symptoms resembling those which are caused by influenza.



Two female dogs from the same litter, one of which, left, received as the primary constituent of its rations 66.9 percent of untreated oats; the other received the same quantity, commercially irradiated. The rest of the ration consisted of skimmed milk powder, casein, alfalfa, sodium chloride, and tricalcium phosphate

Unfortunately it is difficult to interpret these results, due to the fact that it is hard to tell clinical epidemic influenza from other respiratory infections both in monkeys and in man. A great deal more work must be done under controlled conditions by workers in other laboratories before a certain appraisal can be placed on the value of the work already accomplished.

Irradiated Cereals

WORKERS in Wisconsin in the department of agricultural chemistry showed in 1923 that the food taken by a rat could be exposed to ultra-violet and in that way serve to prevent rickets in the rat. Later numerous investigators throughout the world showed that a definite compound, ergosterol, is the substance which is rendered potent against rickets by exposure to ultra-violet rays. The workers in the University of Wisconsin later developed methods for irradiating rolled oats and other cereals, and such foods are now generally available for use in the average home.

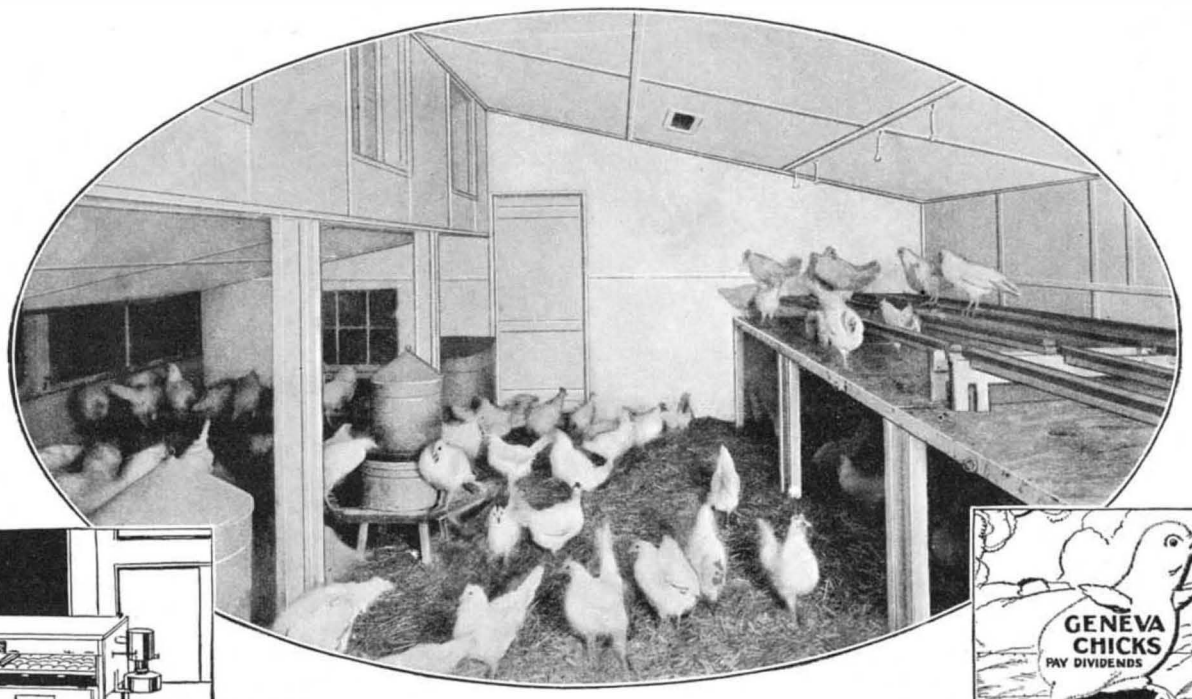
It has been shown by experiments on animals that rickets may be prevented by feeding such products to them. The irradiation does not seem to destroy the other vitamins that are in the food, nor does the irradiation of the food produce harm in those who eat it. Apparently the outside limit for vitamin D is far beyond the amount that the average person could take in an ordinary diet. Storage of the food does not cause destruction of the vitamin that is formed, except after periods of almost two years. Household cooking does not affect the activity.

By feeding commercially irradiated oatmeal, rickets was prevented in dogs and in rats and there was no interference in growth or in reproduction, as was shown in tests made on rats over a period of 15 months in four generations.

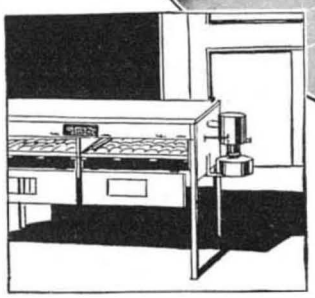
Soy Beans Versus Milk

IT is generally recognized that human milk is the best food for infants and that in the absence of human milk, the best substitute is cow's milk in some form, modified usually by the addition of various ingredients, such as sugar, water, or egg. There are, however, some diseases in infancy in which cow's milk is not desirable, and there are some infants who react severely to milk, breaking out with eruptions and developing symptoms like those of asthma. It is believed that some cases of severe eczema in infants are due to such sensitization.

In case an infant is unable to take cow's milk, it is necessary to have another sub-



For easily cleaned floors in poultry houses



For sturdy incubators

For signs and cut-outs

They *hatch 'em—raise 'em—sell 'em* with PRESDWOOD

In Racine, Wisconsin, a big manufacturer of incubators finds that Masonite Presdwood gives his product great strength, withstands moisture, is naturally attractive in appearance, and requires no paint for protection. On a Missouri farm, an expert poultry raiser uses this same grainless wood on hen house floors and under roosts, because of its smooth sanitary surface which is so easily cleaned.

Withstands the weather

In Kalamazoo, a sign manufacturer makes attractive cut-outs which advertise baby chicks, and finds Presdwood ideal for his purpose. It does not crack, split or splinter; is easily cut to shape. It withstands the weather, takes any finish readily, and does not warp when properly handled.

And so it goes in hundreds of industries and in thousands of home workshops where Presdwood has been adopted because of its many advantages.

Factory experts, operating punch presses, milling machines or band saws, like Presdwood for its workability. It is strong and dense, yet easily cut. It can be worked with knife or chisel or saw, and can be nailed near the edge without splitting. Always the same in strength and density, Presdwood adds quality and dependability to manufactured items. Makes manufacturing more profitable, too, because of the way this grainless wood cuts down costly rejections in final inspection.

Contractors, handling concrete work, use Presdwood to line the forms because of the thousands of dollars it saves. Its lighter weight cuts down drayage costs. Its workability reduces the time of making, erecting and wrecking the forms. Its perfect smooth surface eliminates all grain and knot marks, and produces a superior surface that requires no hand smoothing except at construction joints.

Masonite Structural Insulation

Presdwood's companion product, Masonite Structural Insulation, was used in the walls and roof of the hen house above illustrated.

It was used to save fuel, to reduce the feed needed in the generation of body heat, to keep the hens warm and healthy in order that egg production might be kept at a maximum during the winter.

The Presdwood booklet is Free

No wonder builders, home owners and manufacturers everywhere are turning to Presdwood. The complete story of this grainless wood, with illustrations of its uses, is in the Presdwood booklet which is sent Free on request. Your copy will be mailed promptly on receipt of the coupon.

MASONITE CORPORATION
111 West Washington Street Chicago, Illinois

MASONITE CORPORATION, Dept. E-3, 111 W. Washington St., Chicago, Ill.
Please send me, Free, a sample of Masonite Presdwood and the Presdwood booklet.

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Address.....

City..... *State*.....

Masonite
PRESDWOOD
Made by the makers of
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REG. U.S. PAT. OFF.

stitute for human milk. In an attempt to find such a mixture, Drs. L. W. Hill and H. C. Stuart of Boston have experimented with a preparation of the soy bean. This has been used in one form or another in China as a supplementary infant food for many years. Using a soy bean flour as the basis of a preparation, Doctor Hill found that infants sensitive to cow's milk can be kept in a good state of nutrition by a preparation containing soy bean, calcium carbonate, and salt. The soy bean flour already contains some magnesium, potassium, and phosphorous. In order to raise the amount of fat, olive oil was added to the mixture.

Device for Determining Hemoglobin

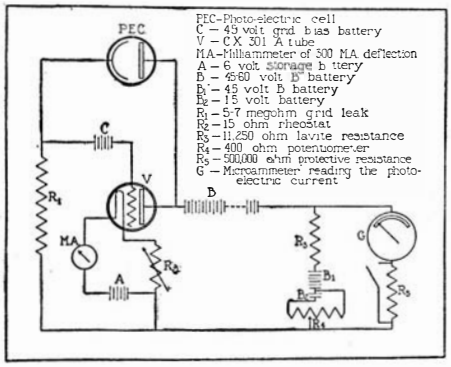
THE hemoglobin or red coloring matter of the blood is one of the most important substances in the human body, since it is responsible for carrying oxygen throughout the system to the various tissues. There are innumerable rough methods for determining the amount of hemoglobin that is present in the blood at various times. Few people are able to show what is called "100 percent", although florid types and people with certain diseases may show extremely high figures. The vast majority of people in good health show figures around 85 to 95 percent. In certain forms of anemia and jaundice, the hemoglobin may drop to low figures, and newspapers are likely to say that "the blood has turned to water".

Workers in the Mayo Clinic have developed an exceedingly ingenuous apparatus for measuring the amount of hemoglobin by a photo-electric method, involving the use of a photo-electric cell illuminated by a scource of light which is kept constant, providing readings on a galvanometer. When a solution of a substance which contains a characteristic absorption band is placed between the source of illumination and the photo-electric cell, together with a selective spectral filter which transmits radiant energy in the region of the characteristic band, the amount of light which reaches the photo-electric cell will depend on the concentration of the substance in solution possessing the specified absorption band. By calculating according to certain definite physical laws, it is possible in this way to measure accurately the amount of hemoglobin in any specimen of blood.

Another advantage of this method is its applicability to the determination of the amount of various unknown substances in true or colloidal solutions, provided the unknown substance in solution possesses at least one characteristic absorption band for which a spectral filter, transmitting radiant energy only in the specified region, can be made and used in the device.

The Heart of Pharaoh

THE Book of Exodus said, "And the Lord hardened the heart of Pharaoh," and that he did not listen to those who tried to counsel him to pity. Investigators in Egypt removed the wrappings of the mummy of this Pharaoh on July 8, 1907. The identity of the monarch was proved by the writings on the shroud. When the body was examined, it was found that there were patches of actual hardening in the heart and in the large blood vessels leading from the heart. A portion of the tissue was sent



Diagrammatic sketch showing the electrical hookup of the photo-electrometer. In the upper right-hand corner is a list of the component parts, together with the key letters used in the diagram. An ordinary radio vacuum tube is used as the amplifier

to the pathologic museum of the Royal College of Surgeons in England and Mr. S. G. Shattock compared the tissues with those of a man recently dead from hardening of the arteries. They were quite similar. It is possible to infer from the nature of the degenerative changes, that as Pharaoh became older his outlook was narrowed, his spirits depressed, his enthusiasm lessened, and that he would be likely to hesitate to embark on any new venture.

The Extent of Illness

ONE of the first reports of the Committee on the Cost of Medical Care, which is making a five-year survey of disease in the United States and the manner in which it is controlled by the medical profession, indicates that the vast majority of time lost from work is due to the common cold and other respiratory diseases. Digestive diseases and similar disorders follow, and women suffer greatly with disturbances associated with their particular physiology. Acute and chronic diseases of the kidney and diseases associated with childbirth are also exceedingly frequent. The United States still has 36,000 cases of smallpox every year, an utterly inexcusable condition, in view of the fact that this disease could be stamped out completely if an enlightened public opinion should force general vaccination and isolation and quarantine of all cases.

There are approximately 900,000 feebleminded imbeciles and idiots, 100,000 blind, 1,000,000 with speech defects, and 3,000,000 children either wholly or partially deaf.

The United States has more physicians proportionate to the population than any other nation of the world. Our hospitals have increased more rapidly in number and equipment than those of any other nation. Approximately 1,000,000 people are ill every day and about 700,000 are in hospitals.

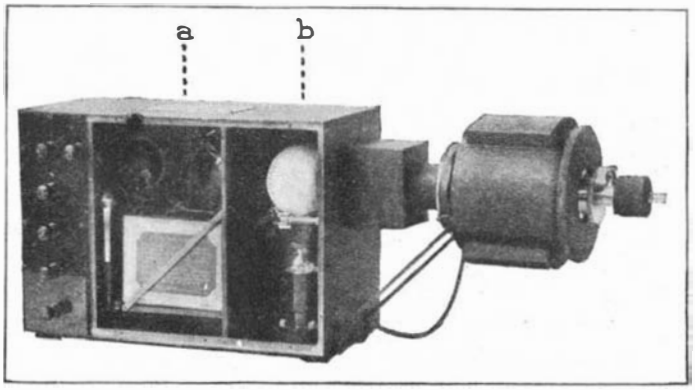
The problem of disease is one of the most serious of all of the considerations that affect mankind, and it is not surprising that its investigation should be attracting the greatest brains and the largest outlay of funds that are provided by the great foundations developed for the social welfare of man.

Anaphylaxis

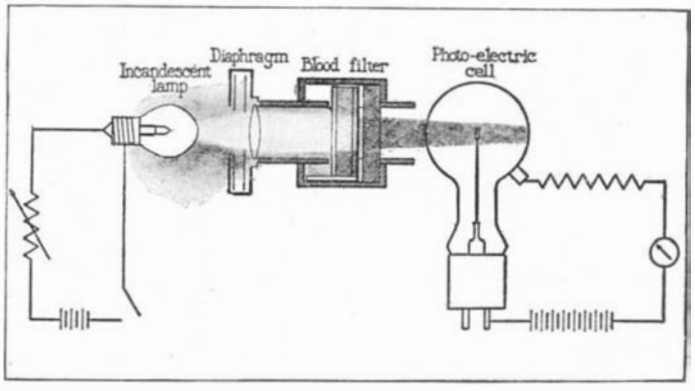
THERE is something in the human and animal body that causes it to become sensitized to various protein substances and to react to these substances by a series of symptoms which may be sufficiently severe to produce sudden death. This reactability is known as anaphylaxis and the exact mechanism is not yet wholly understood. Recently Dr. R. W. Lamson has again surveyed the subject in an endeavor to find out just what produces the symptoms.

When a guinea-pig is injected with a serum and is re-injected with the same serum about three weeks later, it manifests anaphylaxis by a sudden shortness of breath, primarily due to its inability to empty the lungs. Human beings become sensitized to various protein substances by heredity, through overdoses, through injection, or in various other ways. There are people who are sensitive to light, to heat, and to cold.

All of this indicates how scientific medicine is beginning to understand the nature of the human body, but also what a vast amount still remains to be learned concerning the specific mechanical and physical reactions of the tissues.



The photo-electrometer with side removed to show at *a* the vacuum tube used for the amplifier, and at *b* the photo-electric cell in position. See above text, at left



A schematic diagram of the essential physical features of the photo-electrometer as applied at the Mayo Clinic to the measurement of hemoglobin of the blood

CARS THAT STAY YOUNG

Look for car beauty, of course, but also make sure of the extra thousands of trouble-free miles that come with a "Timken Bearing Equipped" car.

Consult the list—note where the Timken Bearings are—give thought to the hard service points that need this extra protection and safety—that is the way to measure car worth in terms of continued youth.

For unequalled staying qualities are definitely assured by the combination of tapered construction, *POSITIVELY ALIGNED ROLLS* and Timken-made steel—*found only in Timken Bearings.*

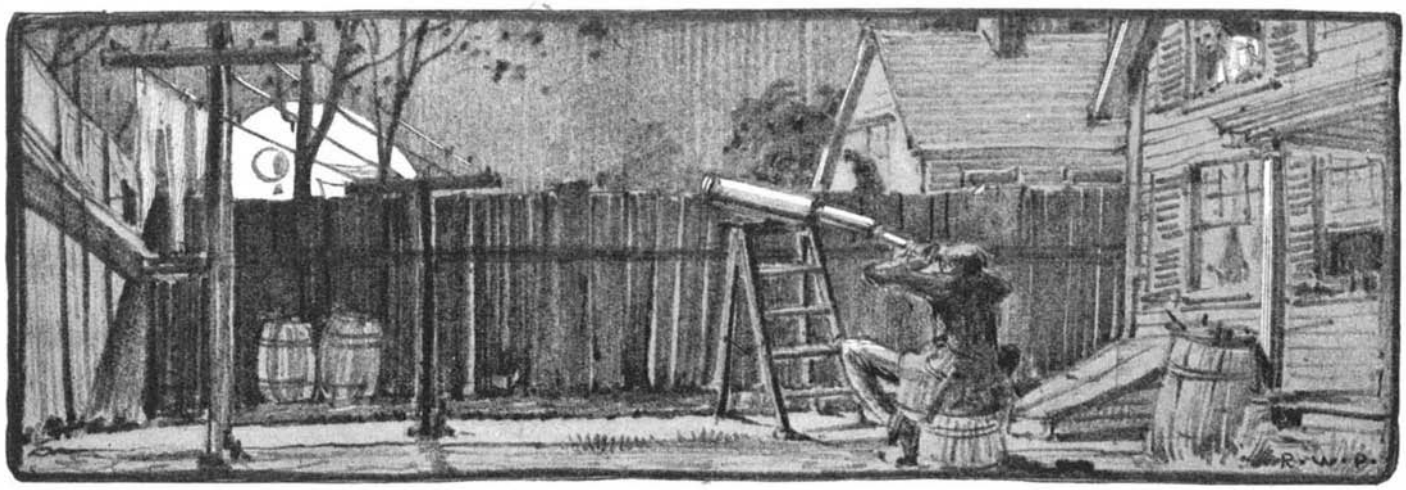
THE TIMKEN ROLLER BEARING CO.
CANTON OHIO

TIMKEN BEARING EQUIPPED

Crosses Indicate "Timken Bearing Equipped" Points

Make	Model	Front Wheels	Rear Wheels	Pinion	Steering	Differential
Auburn	All	x	x	x		x
Cadillac	All					x
Chrysler	De Soto	x	x	x		x
	Plymouth	x	x	x		x
	66,70,77	x	x	x		x
	Imperial	x				x
Cord	All	x	x		x	x
Cunningham	All	x	x	x		x
Dodge	All	x	x			x
Durant	40, 60, 63, 66	x	x	x		
	70	x	x	x		x
Elcar	75	x	x	x		x
	95, 96, 120	x	x			x
Ford	All	x		x	x	x
Franklin	All	x	x	x	x	x
Gardner	All	x	x	x		x
Graham-Paige	612	x	x	x	x	x
	615	x	x			x
	621, 827, 837	x	x		x	x
Henney	All	x	x	x		x
Hudson and Essex	All	x	x	x		x
Hupmobile	Model S	x	x	x	x	x
	Model C	x	x	x	x	x
Jordan	All	x	x	x		x
Kissel	75 & 95	x	x	x		x
	126	x	x	x	x	x
Kleiber		x	x	x		x
LaSalle	All					x
Lincoln	All	x	x	x	x	x
Locomobile	86 & 88	x	x			x
Marmon	68	x				x
	78		x			x
	Roosevelt	x	x	x		x
McFarlan	All	x	x	x		x
Moon	All	x	x	x		x
Nash	Std 6	x	x	x	x	x
———	All	x	x		x	x
Peerless	All	x	x			x
Pierce-Arrow	All	x	x	x	x	x
Reo Flying Cloud	The Master	x	x		x	x
	Flying Cloud	x	x			x
Roamer		x	x	x		x
Stearns-Knight	6-80	x	x	x	x	x
	8-90	x	x	x	x	x
Studebaker and Erskine	All	x	x	x	x	x
Stutz	All	x	x	x		x
Willys-Knight and Whippet	All	x	x	x	x	x

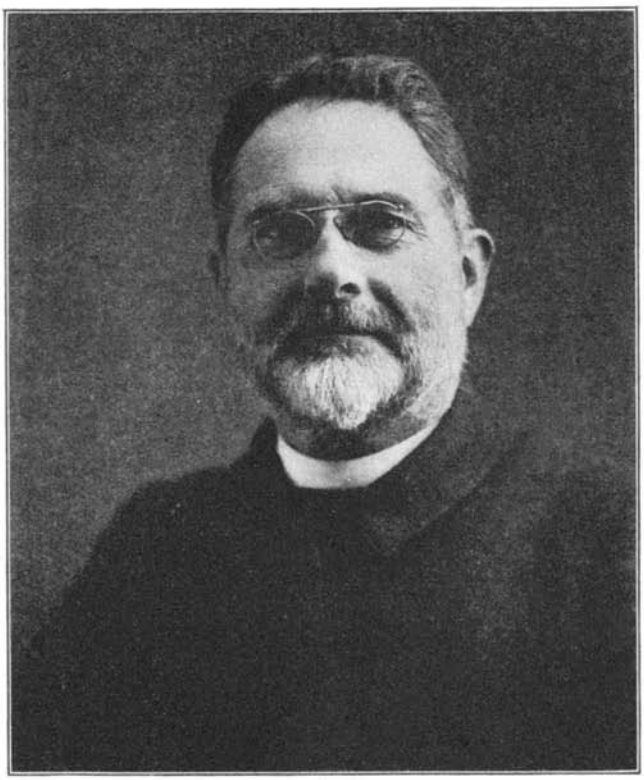
TIMKEN Tapered Roller BEARINGS



The Amateur Astronomer

MEMBERS of the amateur telescope making fraternity—the "C. P. R" (carborundum, pitch, and rouge) as Ellison our original preceptor once dubbed us—will take keen interest in the photograph reproduced at the right. This is a perfect likeness of Ellison. It is suggested that amateurs paste this picture in their copy of "Amateur Telescope Making." Had it been at hand when the new edition of that instruction book was in preparation it would surely have been included within the volume, which was originally built around Ellison's book, "The Amateur's Telescope" as a nucleus.

NOTHING but refractors are shown this month. So far as is known, these are all of the refractors that have been made since Ellison's unequalled instructions were included in "A. T.M." It is possible to make a refractor (of a sort) without due attention to the calculation of curves and care with other details; in fact many have been made from second-hand lenses previously used for other purposes. Henry Kawecki of Chicago (no street address submitted), a high school student, has made the one shown at left, using as the objective what he describes as "a lens which was once a mirror of plano-convex type from which the silver and paint were removed." The tube is three lengths of four-inch stove pipe and the eyepiece was taken from a microscope. Despite what some might regard as a doubtful type of objective, the maker states that he sees clearly Saturn's rings and Jupiter's moons, using 125 diameters magnification. "The chromatic aberration," he writes, "is not as bad as may be expected." He is now making a reflector.



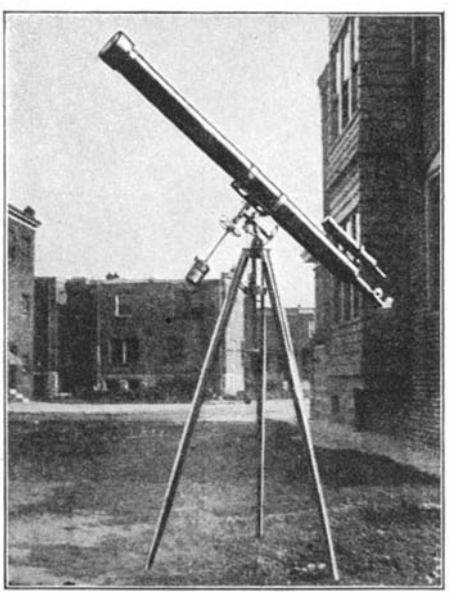
The Reverend Mr. William F. A. Ellison, telescope maker, Director of Armagh Observatory, Armagh, Northern Ireland

Fred Caley, 5122 Hawthorne Street, Frankford, Pennsylvania, writes: "I enclose a photo of a refractor I recently constructed, thinking it might be of interest to the ever-increasing army of telescope makers. I used the second formula given in 'A.T.M.' viz., three equal curves and a plane surface. Ellison states, 'The only snag is the plane surface.' I *heartily corroborate* his statement. The objective is 5¼ inches clear aperture and has a 76-inch focal length.

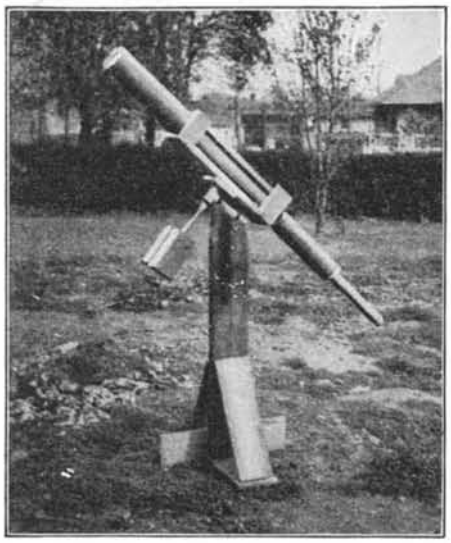
"The telescope is equipped with a worm gear, universal joint, and extension rod that can be worked without taking the eye from the ocular. Setting circles and a diagonal eyepiece are also fitted. Total cost, not more than 70 dollars.

"I previously ground and figured an eight-inch reflector which gave very satisfactory results. I also made a 5½-inch flat and a couple of prisms, in order to gain experience. The refractor turned out much better than I expected."

Mr. Caley has obviously gone at this job right: after suitable preparatory experience of a prac-



Left: **Mr. Kawecki's synthetic refractor, and (*right*) the 5¼-inch refractor made by Mr. Caley, from Ellison's instructions**



Franklin W. Smith's refractor

tical nature—making mirrors, prisms and flats, all of which enlarges one's resourcefulness in optical work—he has tackled the more difficult objective lens job and succeeded.

A SIMILAR approach to the objective lens has been made by Franklin W. Smith, 407 Scott Avenue, Glen Olden, Pennsylvania, whose telescope is shown in the illustration reproduced above.

"After finishing my first reflecting telescope, which was described in your January, 1927, issue, I have made several small reflectors, and have recently completed a refractor," Mr. Smith writes. "The achromatic objective has an aperture of three inches and a focal length of 60 inches. Great care was taken while polishing the convex surfaces of the crown glass to prevent wearing down the centers excessively; in this way, positive spherical aberration was avoided, and it was therefore possible to finish the figuring, which was controlled by Ellison's ingenious 'auto-collimation test,' quickly and without difficulty.

"The color correction and defining power of the telescope seem satisfactory; double stars such as *alpha Geminorum*, *gamma Virginis*, and *gamma Leonis* are readily separated, even under the rather poor conditions of seeing which prevail here at certain times of the year.

"Although it takes vastly more time and labor to make a refractor than to make a reflector of the same aperture, the actual work is really no more difficult, assuming, of course, that the worker has had sufficient

George E. Stephenson and refractor

experience to enable him readily to produce a zone-free optical surface. I found that it required over four times as much work to make the three-inch refractor as to make a five-inch reflector. Not only are there four surfaces to work instead of one, but at least three of the four curves are much deeper than the single curve of the reflector. While rough grinding I soon came to the conclusion that the use of metal tools previously turned on the lathe to the proper radii would be a much more economical means of producing the deep curves necessary, since a glass tool grinds the edges as well as the center of a concave surface and the center as well as the edge of a convex, and much labor is needlessly expended.

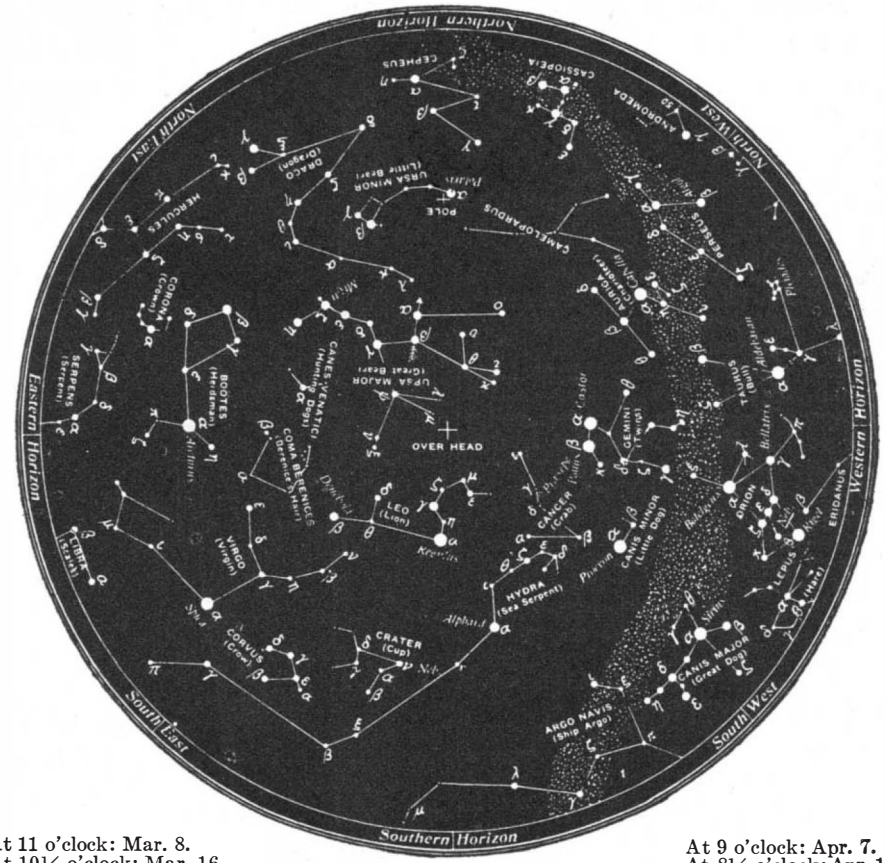
"The auto-collimation test is as simple to apply as the ordinary mirror test, assuming of course that a flat the size of the lens is available. I prepared the flat by the method given on page 37 of 'Amateur Telescope Making.'

"Since completing the three-inch refractor, I have been using it for observing variable stars. Under ordinary conditions of seeing it will show stars slightly fainter than magnitude 11. In this locality, the theoretical limit of a telescope can be reached on exceptionally good nights only. At least that has been my experience with the 10-inch Clark refractor of the Haverford College Observatory."

The fourth refractor shown is apparently one of the synthetic type. The photograph reached us without accompanying letter and bore on its back only the name of the sender, Mr. George E. Stephenson, Roosevelt Avenue, Roosevelt, Long Island.—*A.G.I., Tel. Ed.*

The Heavens in March

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Mar. 8.
At 10½ o'clock: Mar. 16.
At 10 o'clock: Mar. 23.
At 9½ o'clock: March 29.
At 9 o'clock: Apr. 7.
At 8½ o'clock: Apr. 14.
At 8 o'clock: Apr. 22.

NIGHT SKY: MARCH AND APRIL

MERCURY is a morning star, rising a little before 6 A.M. during the early part of the month, but lost to the sunlight long before its close. Venus is an evening star and is coming out gradually from the twilight. By the end of the month she sets at 7.10 P.M. and is fairly conspicuous. Mars is a morning star rising between 5 and 5:30 A.M. and is still far off and faint. On the first he is in conjunction with Mercury, the two planets being only half a degree apart. Jupiter is an evening star in Taurus, but is so far north that he remains in sight until after midnight. Saturn is a morning star, rising at 2:40 A.M. on the 15th, and can be observed before daybreak, though only at a low altitude. Uranus is an evening star too low in the west to be easily observed, but Neptune is just past opposition and is visible telescopically almost all night. On March 15th its R. A. will be 10h 16m, and its Decl. 11° 31′ N.

The moon is in her first quarter at 11 P.M. on the 7th; full at 2 P.M. on the 14th; in her last quarter at 10 P.M. on the 21st; and new at 1 A.M. on the 30th. She is nearest the earth on the 12th and remotest on the 24th. As she completes her orbit she passes through conjunction with Uranus on the 2nd, Jupiter on the 7th, Neptune on the 13th, Saturn on the 22nd, Mars on the 27th, Mercury on the 29th, Uranus again on the 30th, and Venus on the 31st.

Chemistry in Industry

(*Continued from page* 237)

preciably beyond a certain thickness, as is shown by the test of a piece of aluminum foil 0.001 inches thick:

Time, Minutes	Thickness, Inches
15	0.0017
30	0.0018
60	0.0020
240	0.0024

Upon analysis, the coating on a ¼-mil foil was found to consist of Al_2O_3, 54.5 percent; CaO, 5.75 percent; SO_3, 10.7 percent; and water expelled at 300 degrees, centigrade, 29 percent. The coating is always hydrated as formed, but the water may be removed by baking at 300 degrees, centigrade.

Edible Oil from Nut Shells

PECAN oil, described by chemists of the United States Department of Agriculture as of very mild, agreeable, and characteristic flavor, is one of the latest additions to the long list of products manufactured from what were formerly farm wastes.

Fine nut fragments accumulate at the pecan-shelling plants. Chemists have made experimental pressings of this waste and determined the properties and composition of the oil, which is of excellent quality and can be used for making salad dressings or other edible products. It is necessary to express the oil before the nut waste becomes rancid, as otherwise the oil would not be edible.

Fuel Gas From Farm Waste

CORNSTALK gas to light and heat cities was announced recently by the American Chemical Society. Ordinary sewage and plain cornstalks are allowed to decompose, forming the gas. From these two wastes, University of Illinois chemists are recovering large quantities of methane gas, usable for heating, operating autos in place of gasoline, and driving generators producing electricity. They also are recovering carbon dioxide which they propose to utilize by converting it into "dry ice."

The chemists believe they have an apparatus so simple that it can be installed by the farmer to make his family sewage turn his cornstalks into cheap cooking gas. It requires no machinery; bacteria from sewage do the necessary work.

The author of the discovery is Dr. A. M. Buswell, Professor of Sanitary Chemistry at Illinois, assisted by C. S. Boruff. Dr. Buswell said "The material used is dried cornstalks after husking. The stalks are shredded with an ordinary shredding machine, boiled, soaked in water or soaked in lime.

"The apparatus is simply a small tank provided with a cover to collect gases. A farmer could produce enough gas to supply the needs of a family of four or five from the material which could be fermented from a gas tank eight feet in diameter and eight feet deep."

The authors estimated that a circle of corn land eight miles in diameter would produce enough cornstalks to meet the usual gas consumption of a city of 80,000.

Our Point of View

Our Limitation Conference Delegates

(*Continued from page* 189)

1928, and is the natural successor to Lowden as the representative of the mid-west agrarian movement. Mr. Dawes has a certain impatience for detail, and a small tendency to picturesque but inexact phraseology that somewhat impairs his large abilities. As ambassador to The Court of St. James, he plunged boldly into European diplomacy with which he had had no previous experience, depending entirely upon his good intentions and his native ability; even his short experience at London must have taught him that international relations cannot be hastily adjusted nor treaties between great states compressed into friendly epigrams.

Mr. Hugh Gibson, American Minister to Belgium, one of the youngest members of the delegation, a Californian by birth, graduated from the Ecole Libre des Sciences Politiques, Paris, and began his career in the diplomatic service in 1908. He served as Secretary of Legation at Brussels from 1914 until our entrance into the World War. During the trying days of German occupation of Belgium he was Brand Whitlock's trusted assistant and greatly assisted Mr. Hoover in his work of Belgian relief. In company with the Spanish Ambassador, he made the final useless appeal to the German Governor General to reprieve Edith Cavell.

He showed conspicuous ability as Chairman of the American Delegation to the Conference for Limitation of Naval Armament in 1927, in resisting British claims to a superiority in cruiser strength over our own navy. If the British public harbors any resentment to Mr. Gibson on this account it should recall that he as fearlessly faced the Germans in behalf of Nurse Cavell. Mr. Gibson brings to his task a fine mind ripened by long experience in world affairs. He knows too much of the horrors of war to be a militarist and knows too much of the ways of the world to weaken the defenses of his own country.

MR. Dwight Whitney Morrow comes from West Virginia, was educated at Amherst with ex-President Coolidge, studied law at Columbia and began the practice of law in New York City in 1899. He joined the firm of J. P. Morgan and Company in 1914 where he remained until he resigned to become Ambassador to Mexico in 1927; he found time from his business affairs to serve on numerous charitable and welfare boards.

Mr. Morrow has a talent for reconciling apparently irreconcilable ideas, and has shown great aptitude in finding a basis of agreement for people with divergent but not necessarily conflicting interests. He served during the war as Adviser to the Allied Maritime Transport Council.

He first attracted the nation's attention by his judicial conduct as Chairman of the President's Aircraft Board in 1925 when, under his guidance, the board thoroughly explored the aviation situation in our country and laid out the comprehensive program of aviation development that is rapidly placing our country in the forefront of world aviation.

In 1927 President Coolidge sent Mr.

Morrow to Mexico as Ambassador to that insurrection-torn country where he made an almost instantaneous appeal to her proud people and gained their respect and almost their affection. He is no miracle worker and would be the first to disclaim some of the complimentary statements made about his efforts in Mexico, but it can be said in all moderation that he has dispelled much of the prejudice against our country previously current in Mexico. The causes of unrest in Mexico are too deep-seated to be removed in two years and Mr. Morrow's reputation as Ambassador will be longer lived if his remarkable work is not exaggerated by over-zealous friends.

Mr. Morrow's long business experience, his broad outlook, and his veritable genius for conciliation fit him for his new task. His previous services have brought him the respect of his countrymen and it is fair prophecy that at London he will again serve them well.

MR. Charles Francis Adams, the great-great-grandson of John Adams, departed from Harvard in 1888 with his A. B. degree, but soon returned as Treasurer of the corporation, and the present flourishing state of Harvard's finances attest his business ability. He is better known to his countrymen perhaps as the amateur skipper who sailed the *Resolute* to victory in the international races of 1920. Since his appointment as Secretary of the Navy he has diligently applied his fine understanding to the problems of the Navy Department. His love for the sea formed an immediate bond between him and the navy personnel.

John Adams established the Navy Department in 1798; his son, John Quincy Adams, formulated the Monroe Doctrine which is only as strong as the United States Navy; Charles Francis Adams, the son of John Quincy, during our Civil War vigorously reminded the British Government of its obligations as a neutral state; and now Charles Francis Adams 2nd returns to London to present his country's reasons for a navy second to none. Certainly the spirits of his sea-minded ancestors will hover sympathetically over the latest member of the family to enter the lists as champion of his country's rights on the ocean.

Senator David Aiken Reed is a product of Princeton and the University of Pittsburgh. He commenced his career by practicing law in Pittsburgh in 1903. The World War interrupted his legal work and he went to France as a Major in the 311th Field Artillery. His service overseas earned him our own Distinguished Service Medal and caused the French Government to make him a Chevalier of the Legion of Honor.

Senator Reed for two years has been Pennsylvania's sole representative in the Upper House, and although a comparative new-comer, he has ably carried the added responsibility. He has an aggressive personality and when he raises his long form from his seat in the Senate the listener is sure to hear some unqualified statement. His Princeton training makes him abhor a solecism and amid the bustle of affairs he is not too busy to call the Senate's attention to the faulty construction of a sentence. He is a leading member of the Military Affairs Committee and has shown unusual interest in questions of national defense. His influence among his col-

leagues, both Republican and Democrat, will be of great assistance to President Hoover in getting the Senate's approval to a limitation pact.

Senator Joseph T. Robinson, Democratic leader in the Senate and Democratic candidate for Vice President in 1928, represented the 6th District of Arkansas in the House from 1903 to 1913; was elected Governor of Arkansas in January, 1913; and during the same month was sent by his state to the Senate where he still continues to serve.

Senator Robinson became generally known to his countrymen as a virile campaigner when he swung 'round the circle during the 1928 campaign. His selection as a delegate reminds the world that domestic politics in the United States ceases at the water's edge and assures the Democratic party that the Administration is not seeking to monopolize any prestige it may acquire in its conduct of foreign affairs.

If Senator Robinson approves of a naval pact he will be of much assistance to Mr. Hoover in getting it approved by the Senate; if he does not, as minority leader he can almost certainly prevent its acceptance by the Senate, so he wields a greater power than any other delegate.

REAR Admiral Hilary P. Jones, Retired, entered the navy as a Midshipman from Virginia in 1880. He has served in all the grades from Midshipman to Admiral, having commanded the United States Fleet with temporary rank of Admiral, 1921–1922. During the World War he commanded a division of the Cruiser and Transport Service. Despite his services on the active list as Vice Admiral and Admiral, in accordance with the provisions of an ungenerous naval law he retired as a Rear Admiral in 1927.

Rear Admiral Jones has been again recalled to active duty as a naval adviser largely because of his familiarity with the entire question of limitation of naval armament—he attended the 1927 Conference for Limitation of Naval Armament at Geneva, as a delegate. He brings to this problem a knowledge of naval matters and world affairs, and although he may be relied upon stoutly to defend American interests, he is no saber-rattling chauvinist and knows enough of war to prefer peace.

Admiral William V. Pratt, Commander-in-Chief of the United States Fleet, knows from the very latest fleet maneuvers the needs of our navy for cruisers. Like Admiral Jones, he has served in all the naval grades. During the World War he served as Assistant Chief of Naval Operations, and during Admiral Benson's inspection trip to Europe, Admiral Pratt acted as Chief of Naval Operations although only a Captain in rank. He had previously graduated from the War College and therefore brought to his position a theoretical knowledge of modern war that stood him in good stead. He acted in an advisory capacity to the American delegates in the Disarmament Conference of 1921 that scrapped American battleships.

Since the war he has been President of the Naval War College, Commander-in-Chief of the Battle Fleet, and is now Commander-in-Chief of the United States Fleet.

Rear Admiral William Adger Moffett, Chief of the Bureau of Aeronautics, has had many thrilling moments in the air but he probably got his greatest thrill on April 22, 1914, when he steamed into the inner

harbor of Vera Cruz with the light cruiser *Chester* and by her destructive fire on the buildings sheltering Mexican snipers, opened the way for the American landing force. His prompt action and conspicuous initiative on that occasion saved the lives of many American sailors.

In an unusual sense, Admiral Moffett is Chief of Aeronautics, for the office was almost created for him and he has been the sole incumbent since its establishment in 1921. Caught on shore during the World War, he threw his enormous energy into the task of expanding the Great Lakes Training Station into the largest naval training station in the world. He accompanied Commander Lansdowne on the transcontinental flight of the *Shenandoah*, and is an enthusiastic believer in both heavier and lighter than air craft. His presence among the advisers should insure that the interests of naval aviation will not be forgotten in any limitation agreement.

Rear Admiral Joel P. R. Pringle is at present President of the Naval War College at Newport. During the World War he was Chief of Staff for the American destroyers based on Queenstown and as the senior American naval officer present at Queenstown, was in virtual command of the American forces serving at that important station.

Admiral Pringle maintained most cordial relations with Admiral Sir Lewis Bayly, British Commander-in-Chief in Ireland, and in consequence there was a unity of action between British and American naval forces rarely found among allied forces. Since the war, Admiral Pringle has served at sea in command of the battleship *Idaho* and as Chief of Staff of the Battle Fleet.

Rear Admiral Harry E. Yarnell is Chief of the Bureau of Engineering and as such is intimately acquainted with the most recent developments in marine engineering. His knowledge will be most useful to the board in considering the relative values of cruisers.

During the World War he commanded the *Nashville*, but was soon summoned to London by Admiral Sims to serve on the War Plans Committee.

After the war he went into naval aviation and is still a qualified aviation observer. He commanded the Aircraft Squadrons, Scouting Fleet, in 1924-25, and in 1928 commissioned, and later commanded, our latest aircraft carrier, the *Saratoga*. He is a War College graduate and has also served on its staff, and as a member of the War Plans Division, in Naval Operations. Throughout his career, Rear Admiral Yarnell has been noted for his sound judgment.

REAR Admiral Arthur J. Hepburn is the youngest Admiral in the Navy. At present he is Chief of Staff for Admiral Pratt, Commander-in-Chief of the United States Fleet, and brings to the Conference a thorough knowledge of the operating needs of our fleet. During the World War he organized and commanded the American submarine chasers operating in Ireland, and subsequently served as Director of Naval Intelligence. His sea experience in the United States Fleet has been unusually extensive, for he commanded our largest superdreadnaught, the *West Virginia*, then served as Chief-of-Staff, Battleship Divisions and of the Battle Fleet, before becoming Chief-of-Staff, United States Fleet.

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W. Edmunds Spon, Editor

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For Sale by SCIENTIFIC AMERICAN

Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Rights to Fruit Spray Removal Process Contested

RIGHTS to a process of vital interest to the fruit industry of the country, claimed by the Department of Agriculture and the California firm of Brogden and Trowbridge, are involved in litigation now pending in the Patent Office. According to the claims made by the Department of Agriculture, the process using a dilute solution of acids or alkalis in removal of spray residue from fruits and vegetables was conceived and put into practice by employees of the Department. However, application for patent submitted by the Department in the name of Arthur M. Henry, government chemist, was declared by the Patent Office to be in interference with the application of Brogden and Trowbridge.

The process has been extremely useful in preparing fruit for market, and has been in almost constant use in various fruit-producing regions since 1925. It has been stated publicly by the Department of Agriculture that if the Henry application is granted, it will be dedicated to the service of the public and may be used by anyone without royalty charges or other costs. Mr. Henry is a chemist of the Philadelphia station of the Food, Drug, and Insecticide Administration of the Department of Agriculture.

Copyright Denied Because of Disclosure in Patent

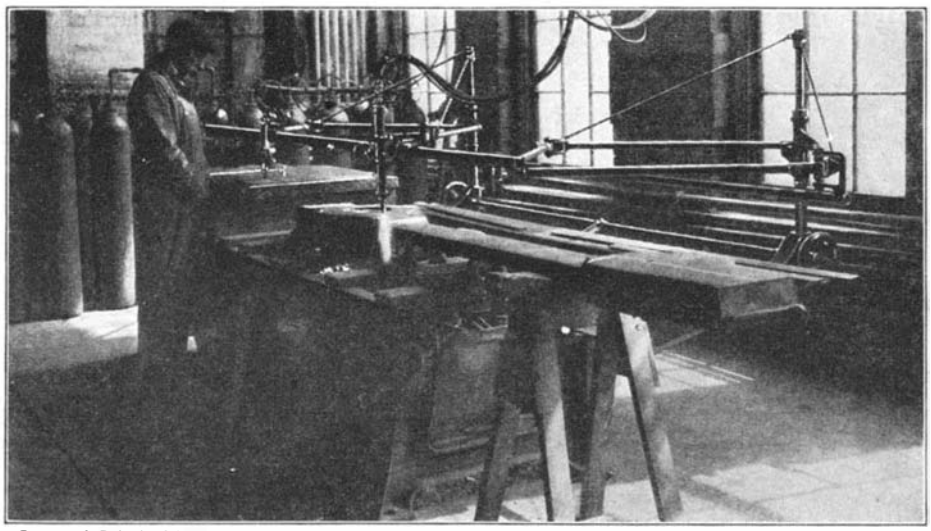
WHEN an inventor has applied for and obtained a patent on a certain model or relief diagram, he cannot extend his monopoly by taking out a copyright on what he has already diagramatically disclosed, according to the Circuit Court of Appeals for the Second Circuit. In the case of Alfred Korzybski *vs* Underwood and Underwood, Inc., it was found that Korzybski had made a full disclosure of his invention in his patent application. Later he sought to obtain a copyright on the design involved, with no substantial distinction between the disclosure of the patent and the design of the copyright, and no real question of merit of a particular design as compared with the drawings of the patent.

Quoting from Weil on copyrights, the Court said: "While in doubtful cases the Court will hold that presumably the fact that a given work is patentable is ground for holding it is not copyrightable and *vice versa*, it seems that there is no rule of law nor is there any consideration of public policy which will prevent the issuance of both a copyright and a patent to cover the same work in its different aspects in a proper case. . . . A novel household utensil may be modeled by a great sculptor. Its form may be artistic in the highest degree, its machinery may show the qualities necessary to patentability, its use may be purely utilitarian and it may be so constructed as to be one inseparable unit. In such event it should be both copyrightable and patentable."

However, it also was pointed out, such a situation does not arise on the facts of the present case, when there seems no room for distinction in design. Section seven of the copyright act provides: "That no copyright shall subsist in the original text of any work which is in the public domain." The defendant had done no more than photograph the device in question, which it had a full right to do, because the subject matter of the patent had become public property.

Patent Sustained for Combination of Pantograph and Blow Torch

DECIDING on the validity of the Worthy C. Bucknam patent (Number 1059329) covering the combination of a cutting torch with a pantograph by which the torch is guided, the District Court for the Northern District of Ohio has ruled the Bucknam claims valid and infringed. The case in suit was instituted by the Air Reduction Company, Inc., against the White Tool and Supply Company. In the decision of the Court, it was noted that the patentability of the combination was substantiated by the fact that the devices of the plaintiff based on this invention have gone into wide use, supplanting earlier devices and methods.



Courtesy Air Reduction Sales Company

Cutting a locomotive side rod with an oxygraph, one of the numerous industrial applications of W. C. Bucknam's combined pantograph and blow torch

In the description of the invention, the Court said: "Bucknam devised a pantograph frame pivoted to a post at one corner of the parallelogram; one of the arms carried a torch or blow pipe with the nozzle pointed down to the surface of the metal to be cut; and to the end of an extension of another of the arms was attached a swiveled roll tracer, which, being set in motion either by hand crank or electric motor, traveled over the lines of any pattern or blue print that might be put under it, and so moving, caused the torch to move with precision and regularity over the same course, and cut the metal cleanly, with astonishing accuracy, and exactly in conformity to the pattern."

The prior art had associated the pantograph with various devices, such as a pyrograph for burning designs on wood, sewing machines for placing stitches in designs on cloth, and electric welding apparatus. However, the Court held, it was new and patentable to combine a pantograph with an oxygen blow torch for cutting metal along various lines to leave a smooth edge. The arts are so remote, and the construction so different and altered, that invention was involved in the transposition, mere double use not being involved.

It also was held by the Court, with respect to the defense of double patent, that where two patents issue the same day, there is no presumption that the lower number is the prior patent. In such instances the higher number will not be held void for double patenting even if the lower number accidentally contains a claim similar to those of the higher number. This notation referred to Patent Number 1059271, issued the same day as the other Bucknam patent noted above. In the trial, the plaintiff relied solely on certain claims of Patent Number 1059329, covering, in effect, the same invention.

By means of the pantograph attachment, cutting by means of a blow torch has been improved materially. This apparatus has gone into widespread commercial use, to meet the need for cutting shapes from steel plates and billets according to drawings or templates. Large and small devices based on this principle are made and sold by the plaintiff, holder of the Bucknam patents and others of similar nature.

This apparatus, in both sizes, consists of an oxy-acetylene cutting torch mechanically supported on a pantograph,

actuated by a tracing wheel driven by a small electric motor. The tracing wheel may be guided by hand over the lines of a drawing, or it can be guided automatically by means of a metal template. Metal up to 20 inches in thickness is cut by this means into any desired shape or design. In the smaller apparatus, the torch operates on a one-to-two ratio with the tracing wheel, following the movements of the tracer on a reduced scale. The larger apparatus cuts an exact reproduction of the path traversed by the tracing wheel, thus producing the large cutting area necessary for locomotive, forge, boiler, tank, and heavy machine-shop work.

Advertisement Admitted as Evidence

WHILE advertisement is not proof of trademark use, it is evidence of contemplated use and is entitled to weight with other testimony of use, in the opinion of the First Assistant Commissioner of Patents. This decision was made in ruling that the trademark "Primfit" is deceptively similar to "Trimfit," both marks being used as designations for hosiery.

Considering it obvious that the marks were so similar in sound and appearance as to cause confusion if both products were to appear in the same market, the only point to be decided was whether the holder of the first registered mark, "Trimfit," had proved prior adoption and use. Unsigned copies of typewritten statements, not properly identified, were not considered proper evidence showing that the mark was in use. No explanation was offered as to why the originals were not produced.

A page said to be a copy of an advertisement of his firm was offered by the witness, showing that in the February 1923 edition of the *Hosiery Retailer* use had been made of the "Trimfit" trademark for advertising purposes. The Commissioner held it obvious that the company would not insert in a publication an advertisement of that type unless the company were intending or in a position to offer its goods under the trademark. Additional proof of prior use of the mark was presented in testimony showing orders for labels and their printing and delivery with copies of orders, and samples of hosiery bearing the trademark. The conflicting mark was ordered cancelled.

Contributory Infringement of Process Patents

THE Circuit Court of Appeals for the Second Circuit, in Novadel Process Corporation *vs* J. P. Meyer and Company, has recently decided an interesting case involving the infringement of a process patent by one who sells the ingredients for use by the purchaser in performing a process of bleaching flour. The patent sued on was what is known as a "process patent," that is to say, one covering a step or a series of steps whereby materials and things are changed either physically or in their chemical characteristics, producing a new article of manufacture.

The particular process involved in the suit consisted in adding certain chemicals to flour for the purpose of bleaching the flour. No one can infringe such a patent who does not actually perform the process or assist another in performing it. A process for manufacturing soap or preserves, or for bleaching flour would not be infringed by one who sold soap, preserves, and flour prepared and treated by a patented process if the seller had not actually performed the process whereby the products were produced.

In this case, both parties sold under certain trademarks the chemicals which when added to flour constituted the patented process. The owner of the process patent not only had the right to carry out the process of bleaching flour, but also the right to sell the required chemicals to millers to enable them to carry out the bleaching process.

While the infringer does not appear to have been engaged in performing the bleaching process, the Court ruled it nevertheless sold to millers the necessary chemicals—substantially those chemicals employed in the patented process. In so doing, the defendant knew that the millers were to use the chemicals in bleaching flour, and intended and directed that the chemicals should be so used, instructing the millers how to use them.

The millers, using the chemicals purchased from the defendant, performed the patented process and thereby infringed the plaintiff's patent. As the defendant had instigated such infringing acts, even though it had not itself performed the infringing process, the court held that it was a contributory infringer. The defendant was enjoined from selling its chemicals when knowing that they would be used in a process which infringed the plaintiff's patent.

Infringement of Registered Trademark in Foreign Commerce

A RATHER unusual infringement case has been decided by the Court of Appeals for the Second Circuit. The suit was instituted by Hecker H-O Company, Inc., against Holland Food Corporation. The defendant had made no sales apparently, in the United States, but it purchased cereal products in this country from various manufacturers, packing the products in packages, boxes, and barrels, and applying thereto the trademark "Hofood." The goods were shipped from American ports to foreign countries, including England, Holland, Belgium, Switzerland, and Greece, where they were sold. Although no sales had been made in the United States, where plaintiff's registration was in force, the court nevertheless held that "labeling packages, boxes, and barrels with the mark 'Hofood' and sending them into foreign commerce for sale in foreign countries was a violation of the trademark act."

The defendant raised the question as to whether, if the labels showing the infringing trademark were affixed in foreign countries where its product was sold, it would constitute an infringement and violate the provisions of the trademark act. The court declined to decide that question, on the ground that it was sufficient, for the disposition of the present case, to hold that the act of the defendant in affixing its infringing mark in this country was a violation of the act.

In a similar case, tried in the District Court in the Southern District of New York some years ago, the court held it to be an infringement to place an infringing trademark on certain textile fabrics in this country and ship them to Turkey for sale. In that case there was ample proof that the owner of the trademark had established a large business in Turkey for exactly the kind of fabric on which the defendant had placed the infringing mark. The defendant was held to have infringed not only by applying the mark in this country but by selling the merchandise in the plaintiff's market in a foreign country, and was enjoined and forced to pay damages as well as the costs of the suit.

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payment must accompany each insertion.

Anyone desiring the address of a patentee listed in this section may obtain it by addressing Munn & Co.; those desiring official copies of patents herein listed, may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

WING - STRUCTURE - VARYING DEVICE FOR AEROPLANES—Whereby the wing structure, and the curvature of the profile of the wings, may be changed from a monoplane to a biplane, for varying the amplitude of the lifting surface, at the will of the pilot, even during flight. Patent 1738463. Aldo Tammeo.

Pertaining to Apparel

CORSET—Of substantially conventional type, having elastic side sections, but having a normally permanently positioned section at the front, which may be removed, and a plurality of fastening means adjustable to take up stretching of the various parts. Patent 1738434. Joseph J. Kispert.

SHAWL COAT—For children, formed from a one-piece rectangular fabric folded together and secured so that it will remain in position to act as sleeves, a body and a muffler, without cutting or materially creasing the garment. Patent 1739433. Helen B. Young.

GLOVE AND METHOD OF MAKING THE SAME—A glove of the slip-on or gauntlet type, having an opening at the side and an integral inwardly turned hem joined to a finishing strip in such manner as to provide an attractive appearance, with strength and durability in use. Patent 1740218. Schuyler E. Benjamin and Wendell P. Murray.

BINDING—Especially adapted for gloves, being composed of superimposed flexible strips of contrasting colors, the outer of said strips having longitudinal perforations to enable the double thickness to follow the contour of the binding edge. Patent 1742117. Albert Aaron and Schuyler Benjamin.

Designs

DESIGN FOR A DOLL OR SIMILAR ARTICLE—Patent 80030. Adolph Gramlich.

DESIGN FOR A TOY GLIDER—Patent 79978. Andrew A. O'Brien.

DESIGNS FOR RADIATOR ORNAMENTS—The inventor has been granted three patents for ornamental figures for vehicle radiators. Patents 80122, 80123 and 80124. Biagio Intingaro.

DESIGN FOR A COAT—Patent 80132. Dorothy Long.

DESIGNS FOR DRESSES—The inventor has been granted three patents on designs for dresses. 80131, 80133 and 80134. Dorothy Long.

DESIGN FOR A COMBINATION CURTAIN POLE, CURTAIN-ROD BRACKET AND SUSPENDING MEANS—Patent 80184. Bror G. Norberg.

Electrical Devices

AUTOMATIC CIRCUIT CLOSER FOR ELECTRIC SIGNAL LIGHTS AND SIGNS—Of the disk type flasher, intended for use in alternately changing colored lights at definite intervals to suit the needs of traffic, or may be used for other signaling requirements. Patent 1738444. William E. Nagem.

CIRCUIT BREAKER—For the ignition and lighting circuits of a motor vehicle when its motor ceases operation, so that in parking, should the operator fail to turn off, the device will automatically disrupt their circuits and prevent injury to the battery. Patent 1737961. Frank P. Ellis.

VACUUM TUBE—An electrode support comprising an annular body having layers of insulating materials of different dielectric strengths and permittivities in such manner that the permittitivity of the layers descreases in value inversely with the distance from the electrode. Patent 1739513. Ralph W. Lohman.

ELECTRIC DEFROSTER FOR REFRIGERATING COILS—Whereby electric heat will be automatically applied to the cooling units of a refrigerating plant at predetermined intervals, and the accumulation of any appreciable amount of frost on said units will be prevented. Patent 1742062. William B. Day.

Of General Interest

HOLDING DEVICE FOR IRONING-BOARD COVERS—By means of which a cloth or other form of covering can be securely held in a taut condition thus presenting a smooth surface for ironing operations, the device is adjustable to boards of various widths. Patent 1737300. Joseph H. Dayton.

WEATHER STRIP—Composed mainly of metal and having a rubber or flexible portion, may be cut to fit any window-frame or casement and attached by merely pressing the strip into its support, will be absolutely weathertight. Patent 1738350. Frank B. Buckhout.

FOLLOWER FOR FILING-CABINET DRAWERS—For holding filed articles in a substantially upright position in the drawer, the bottom being equipped with longitudinally spaced keepers, the followers having dentent means engaging with the keepers to lock the followers against movement. Patent 1738419. Alexander Burger.

VALVE—Of the quick-acting type, employed on boiler blow-off lines, on lines carrying viscous fluids or gritty matter, which will be tight when closed, and have a free waterway, equal to the size of the pipe. Patent 1738450. Edward F. Ryan and Edward T. Adams.

CABLE GUARD—Adapted to be secured to a post by a simple means, which also serves to connect a pair of similarly formed sections, said sections having slotted flanges which overlap to receive and support the cable. Patent 1738447. Irving E. Quist.

LIGHTER—Such as are commonly known as cigar or cigarette lighters, in which the lighter mechanism is movable relatively to the container, so as to either enclose the lighter or project it in position for use. Patent 1738451. Karl Schreer.

WHISTLE CUP—So constructed as to induce a small child to drink the milk or other contents of the cup in order to blow the whistle, which can only be operated when the cup is empty. Patent 1739451. Clarence B. Fowler.

METHOD OF FLOWING OIL—By introducing a current of heat around the perforated tubing at the well bottom, to break down the heavier constituents and reduce the viscosity of the oil thus accelerating its flow from the well. Patent 1737894. Edward P. Reynolds.

DISAPPEARING PICTURE ILLUMINATOR—By virtue of which a lamp and reflector may be instantaneously moved from a concealed inactive position at the rear of the picture to an exposed projecting position for flood-lighting the picture face. Patent 1739320. Herbert D. Lloyd.

FOUNTAIN PEN—So constructed that the filling operation is very much simplified, permitting any required amount of ink to be drawn into the barrel and the pen filled with facility. Patent 1739235. Thomas Pearson.

SPOUT—For dispensing devices, which may be readily moved from an active to an inactive position for forming a closure, is particularly adapted for use with syrups served on a table, the receptacle being kept clean on the outside. Patent 1738077. Thorvald Petersen.

TOOTHBRUSH—Embodying a flexible brush element, which is readily removable from the holder, and may be spread apart so that its entire surface may be cleansed, thus preventing bacteria lodging between the bristles. Patent 1739324. William M. Neissl.

BOTTLE STOPPER—Which may be readily manipulated when it is desired to discharge the contents of the bottle, but so constructed as to render it impossible to refill the bottle. Patent 1739393. Robert H. Harmon.

SHOWER-CURTAIN RING—Constructed with rollers shaped to conform to the supporting rod so that when the curtain is moved to an operative or inoperative position the ring will slide freely along the support and will not become jammed. Patent 1739382. Louis Auster and Marie Auster.

PEDESTAL SUPPORT—Having a fixed standard supporting base, and a rotatable or turn-table top surface, which is particularly adapted for use in supporting an electric fan, or may be used generally. Patent 1739466. Henry C. Kihneman.

BUILT-IN BED LAMP—Having incorporated in the head-board framework a unitary construction of a lamp, the lamp being so embodied in the decorative portion of the framework that it appears a part of the bed frame. Patent 1739337. James B. and James F. Von Canon.

DEVICE FOR MIXING AND STRAINING LIQUIDS—The device having a wall slotted in such manner as to cause the liquids poured therethrough to be subdivided into converging intersecting streams thereby insuring a uniform mixture when poured into separate receptacles. Patent 1740223. Benjamin Burvenick.

FIRE LIFE-SAVING DEVICE—Embodying an endless cable having means for lowering persons from a building by means of a friction block, and means permitting ready insertion of the cable in a tortuous channel formed within the block. Patent 1740317. Carl Romson.

CARRYING DEVICE—A simple construction with which a person may lift a heated vessel, pot or pan with its contents from a stove or oven, carry it to any desired point, and there release it, without being burned. Patent 1740211. Sarkis Vahouny.

SAMPLE CARD—Including a plurality of cards each differing in shade and having an exposure area through which the skin may be compared with the card so that a face powder of the desired tint may be selected. Patent 1741080. Bernard F. Stenz.

CONTAINER AND SERVER FOR SPREADS—Which includes a hollow receiving body protected against dust, for holding spreads such as butter, jelly or analogous edibles, and for facilitating the uniform spreading over the surface of a slice of bread or its equivalent. Patent 1741089. Jacob Zitzerman.

MEANS FOR SAFEGUARDING CONCRETE STRUCTURES AGAINST LEAKING FRACTURES—By forming on the upper surface grooves to form false joints, and filling said grooves with a non-hardening waterproof filler, and laminations of flexible material superimposed to allow for expansion and contraction and prevent leakage. Patent 1740110. Eugene R. Oden.

LIFE PRESERVER—Wherein a single piece of material is folded upon itself to form pockets, the bottoms being entirely seamless there are no stitches to rot, and therefore no danger of losing the buoyant material after long periods of disuse. Patent 1742104. Ernest W. Skoldberg.

METHOD FOR VARNISHING LEATHER AND LIKE MATERIAL—To impart a glazed and brilliant surface but without changing the appearance of the leather, by gelatinizing the surface with a suitable acid, and then applying a varnish having cellulose ester as a base. Patent 1742146. Jean Paisseau.

INKED RIBBON AND METHOD OF MAKING THE SAME—For typewriters, which includes an endless strip of tubular fabric, inserting a strip of cardboard between the runs of the fabric, passing the same between inking rollers, then reversing and repeating the operation to thoroughly impregnate the ribbon. Patent 1742093. Bertrand Paradise.

VISIBLE-CARD INDEX FILE—Comprising a transparent pocket secured to the card body for receiving a record slip, and means whereby the operator may easily insert a card in front or to the rear of the record slip. Patent 1742087. Luigi Lombardini.

WINDOW BOX—Which may be used as cold weather ice box, may be readily mounted on window sills of different shapes and sizes, and will be closed or opened with the raising or lowering of the lower window sash. Patent 1742051. James C. Young.

JUICE EXTRACTOR—For extracting juice from citrus fruits, whereby a maximum amount of juice will be obtained from fruit halves, a funnel directing the extracted juice into a container. The device may be readily disassembled for cleaning. Patent 1742089. Charles Meyer.

Hardware and Tools

CYLINDER-BORE POLISHING AND FINISHING ATTACHMENT—A machine tool attachment, for finishing and polishing any cylinder bores after they have been bored with the rack tool, the device produces an absolutely smooth finish, and may be adjusted to cylinders of different sizes. Patent 1738443. Robert L. Meaux.

METAL-BENDING TOOL—Particularly adapted for the straightening of bent or otherwise distorted automobile fenders and running board brackets, to restore them to their original form without the necessity of removing them from the vehicle and without scratching. Patent 1737084. John R. Hilstad.

GRAPPLE FOR HANDLING HOT CASTINGS—Of the crossed lever type, commonly used to lift and transport heavy castings, so constructed that the hands of the operators do not come in close contact with the block, thus eliminating bad burns. Patent 1740383. Isaac L. Wessel.

LID-SUPPORTING MEANS FOR CABINETS OR BOXES—A stay which allows of the lid being raised to a certain position and supported, but if an additional upward movement is given the stay becomes automatically released and allows the lid to close. Patent 1741081. Joseph A. Stone.

LATCH FOR PIVOTED HANDLES—A latch for hand implements, such as pruning shears, for holding the handles against relative movement when not in use, but which may be readily released to free the handles for operative movement upon gripping the same. Patent 1741109. William G. Heimer-Dinger.

Machines and Mechanical Devices

FILLING MECHANISM—For measuring liquids such as syrups, whereby the desired quantities may be disposed in each bottle, irrespective of the temperature or density of the liquid, measurement may be varied to the slightest fraction of an ounce. Patent 1738432. James Kantor.

ANIMAL TRAP—Having separate means for holding each jaw in an open set condition, and a trigger for each jaw affording means for independently releasing the same, whereby the trap may be sprung from either side. Patent 1738448. James A. Rollins.

MIXING APPARATUS—Which reduces mixing time to a minimum, thereby reducing power consumed, permits of dustless operation, is provided with novel means for charging and discharging, and may be operated with the least possible attention. Patent 1738440. Angus D. Mac Lellan.

BOAT-PROPELLING MEANS—A form of disc-like propeller for boats, hydroplanes, or other water craft, in shallow water or water containing weeds or other growths, which tend to foul the usual type of propellers, or over sandbars and shoals. Patent 1738410. Max W. Weir.

FEED MECHANISM—For singly feeding slugs to a means for forming collapsible tubes, in such manner that the same will be disposed in a predetermined position, the mechanism may be readily adjusted to compensate for varying thickness of slugs. Patent 1741033. George H. Neidlinger.

AWNING-ACTUATING MECHANISM—Whereby the awning may be rolled or unrolled, according to whether the roller is rotated in one direction or the other, the device is characterized by its adjustability in order to render the actuating shaft readily accessible. Patent 1740190. Earl Martin.

HIGHWAY TEMPLATE CONSTRUCTION AND MAINTENANCE MACHINE—Having surface treating blades which will construct, shape, dress and maintain the shoulders, ditches and slopes adjacent the surface courses of road beds, accurately shaped in cross section after the road has been completed. Patent 1741127. Charles E. Hair.

CLAY-TREATING ATTACHMENT FOR PUG MILLS—An attachment for mixing certain dry chemicals with liquid, and discharging the mixture into the clay of a pug mill, for neutralizing certain alkalies contained thereby so that the burned product will produce no objectionable appearance. Patent 1740504. John Grotencort.

PRESSURE-FLUID HAMMER—Reciprocated by the action of steam, yet having a wide range of adjustment so that the hammer can be manipulated at will, especially adapted for use in dressing or repairing drill bits and the like. Patent 1740818. Virgil S. Killings Worth.

RECORD-CHANGING MECHANISM FOR DISK-RECORD SOUND-REPRODUCING MACHINES—Comprising a rotative record carrying table, means for holding a plurality of records adjacent said table, and transfer mechanism which will permit the operator to select and place any disk record upon the turn table of a phonograph. Patent 1741040. Frank H. Seal and Harry Hawkins.

KNITTING MACHINE—Which permits a fine adjustment of the stop blocks on the yarn carrier bar, so that the needles may knit together smoothly in a continuous fabric, strips of different colors, without any overlap or projections. Patent 1742036. Asher Kipnis.

AUTOMATIC DRIVE FOR OPENING AND CLOSING MOLD BOXES AND METAL-CONTROLLING ORGANS IN MACHINES FOR CASTING STEREOPLATES—Operated by continuously rotating spur-wheel segments and mechanical elements, which in the working periods are moved quickly, and in the time of cooling the cast plate are moved slowly. Patent 1739432. Carl Winkler.

DISTRIBUTING DEVICE FOR LIQUIDS—Having a sucking pump for raising the liquid into measuring reservoirs, the rod of the piston of the pump controlling valves which regulate the admission and control the distribution of the liquid. Patent 1739437. Henri Boutillon.

PISTON—For use in connection with the cylinders of reciprocating motors, pumps and the like, adapted for permitting ready access to the piston pin for rebushing without requiring the removal of the pin and its rod from the cylinder. Patent 1737915. Alexander C. Carrillo.

REAMING MACHINE—Which will afford facilities for utilizing the power of a prime mover to turn the reaming tool, adapted to permit the reaming of various articles more quickly, and with less manual exertion than is usual. Patent 1739424. Harold T. Snell.

MACHINE FOR MAKING TILE—Characterized by the application, with molding pressure, of a suitable wet backing of cement to a facing layer of colored cement previously applied to a highly polished metal plate, the plate automatically effecting a trowelling of the tile surface. Patent 1739379. George B. Stead.

VALVE FOR TANK CARS AND THE LIKE—A valve which will positively prevent the escape of liquid, may be opened to any desired position, and locked in that position, and also locked in closed position, or to prevent accidental opening or tampering. Patent 1740319. George Stancu, Jr.

Medical and Surgical Devices

DENTURE—Comprising an artificial tooth, and a bridge element consisting of a flat plate of platinized gold, an integral pin on the plate and wings, which fit into a bore and recesses to receive the tooth. Patent 1738460. Jacob J. Stark.

APPARATUS FOR LIFTING AND MOVING INVALIDS—Comprising a person-supporting frame to be normally placed upon a bed or operating table, and means whereby the frame may be suspended from a carrier, raised or lowered and moved from place to place. Patent 1738758. Catherine M. Cottman.

Musical Devices

MUSICAL INSTRUMENT—Comprising a sound box for receiving an harmonica and adding to the harmony and augmenting the music produced thereby, the ordinary harmonica producing music in one key only, a knowledge of music is unnecessary in the operation. Patent 1739914. Fred C. Peslin.

Prime Movers and Their Accessories

FUEL CONTROL—An auxiliary air supply to be drawn on by the suction of the engine, at low speed the auxiliary air will be practically zero increasing slowly with the speed of the vehicle. Patent 1737196. Olaf Mortenson and Olfan De Guire.

PISTON RING—Including accurate ring forming sections and means for imparting an outward movement with respect to the piston for preventing leakage of fluid, resulting in loss of power, or entrance of oil to the combustion chamber. Patent 1739361. Henry Jaedike.

ENGINE MUFFLER—Including a series of compartments through which sound waves and exhaust gases must pass to reach the outer air, these compartments communicating only through restricted orifices which cause the sound to be completely broken up. Patent 1741078. Winthrop T. Scarritt.

Railways and their Accessories

RAILWAY - CAR - TRUCK SIDE FRAME—Which dispenses with the use of numerous heavy bolts and pins, which does not sacrifice supporting strength, and which greatly facilitates the removal of the car wheels and axles with their boxes, by an ordinary journal jack equipment. Patent 1740338. Repard H. Davenport and James Porter.

CONNECTOR FOR RAILS—A bed rail connector characterized by its structural simplicity and ready application to bed rails and posts, in a manner to fixedly secure them against movement, yet permit an easy detaching when dismounting the bed. Patent 1735307. Adolf Weston.

Pertaining to Recreation

TOY—Including a parachute and a spring gun, the parachute offering little resistance when shot and will rise to a considerable distance, but on gravitational discent it will automatically open and float lightly to earth. Patent 1738347. Hallie H. Bell.

FIGURE TOY—In which a plurality of figures, representing ducks, or any object desired, are so mounted for movement that as one advances into upright position, the other disappears producing the effect of diving. Patent 1741103. Edward E. France.

Pertaining to Vehicles

ATTACHMENT FOR VEHICLE WHEELS—Which may be readily and positively secured to vehicle wheels and tires of various sizes for preventing skidding on slippery streets, or whereby a vehicle may be removed from mud holes, ruts or the like. Patent 1738453. John C. Sheller.

AIR DEFLECTOR—For use in connection with window openings of automobile doors, being adjustable for deflecting air, rain, snow and the like away from the opening, as well as to deflect air into the window. Patent 1738418. Joseph T. Bond.

GLARE SHIELD—Adapted to be attached to, and extend forward of, the steering column of an automobile in such position that it is readily accessible for adjustment, to protect the operator's eyes from the glare of oncoming headlights. Patent 1737934. Oscar L. McKinley.

GEAR-SHIFTER MECHANISM—An electrically operated mechanism adapted for application to, and use with, any form of sliding gear transmission, for controlling the starting, low, intermediate and reverse speed and directional movement of motor vehicles and the like. Patent 1738462. William G. Stevens, Jr.

VEHICLE—In the form of an ambulance for mines, resiliently mounted so as to eliminate shocks to the injured, and whereby patients may be comfortably carried from the point of accident to the exterior of the mine. Patent 1737493. Gilbert O. Crank.

PARKING DEVICE FOR AUTOMOBILES—Which will enable a car to be parked in a space slightly longer than itself, by means of auxiliary wheels disposed at the rear axle, to be dropped into operative position for moving the car transversely. Patent 1736498. Peter Jensen.

TRANSMISSION GEAR—For motor vehicles, whereby the driven shaft is caused to rotate at the same speed as the power shaft prior to engagement of a sliding gear with its mating gear thereby reducing clashing and resultant objections. Patent 1737451. Baylies V. Clark.

CHANGEABLE - SPEED TRANSMISSION - GEAR ATTACHMENT FOR CYCLES—A complete self contained transmission entirely enclosed and fully lubricated, all wearing parts running in a bath of lubricant, adapted for use with conventional bicycle frames and may be installed by the user. Patent 1736680. William A. Toliver.

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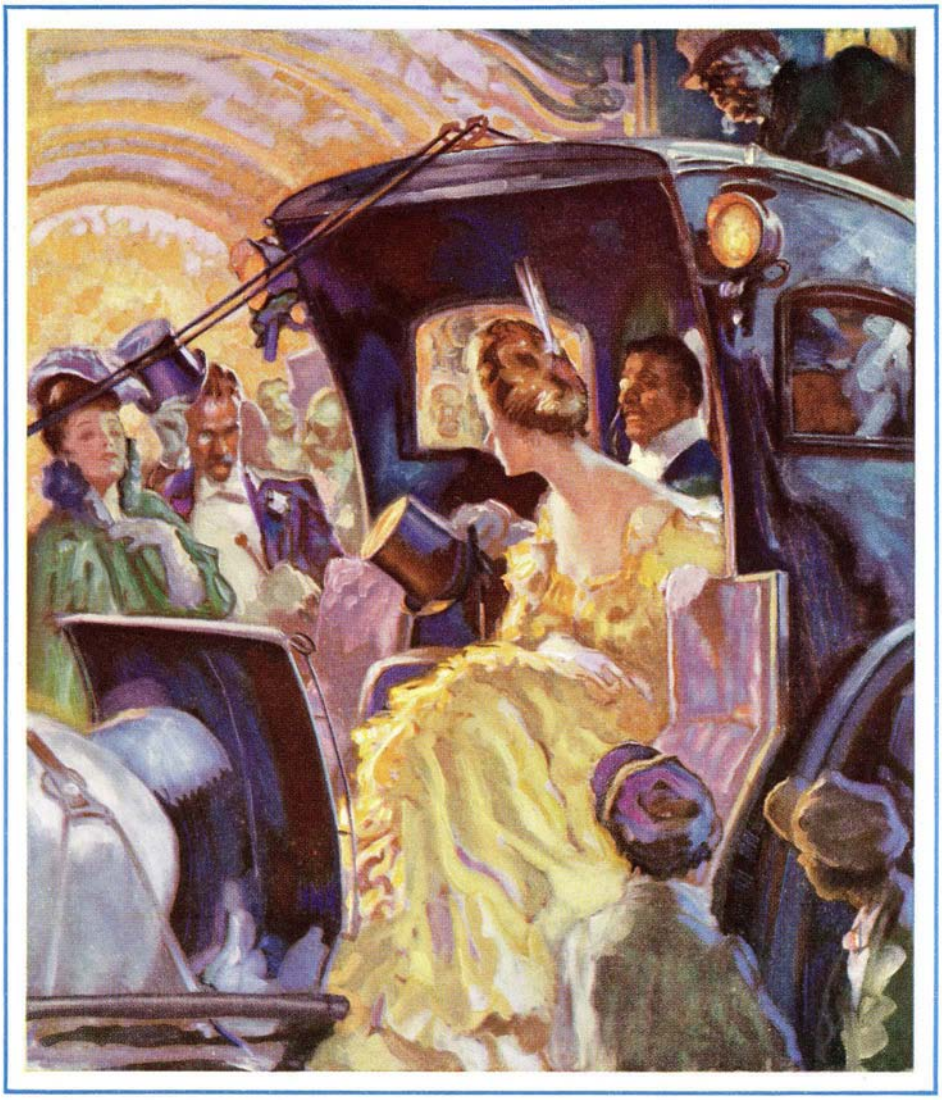

Luxurious Transportation

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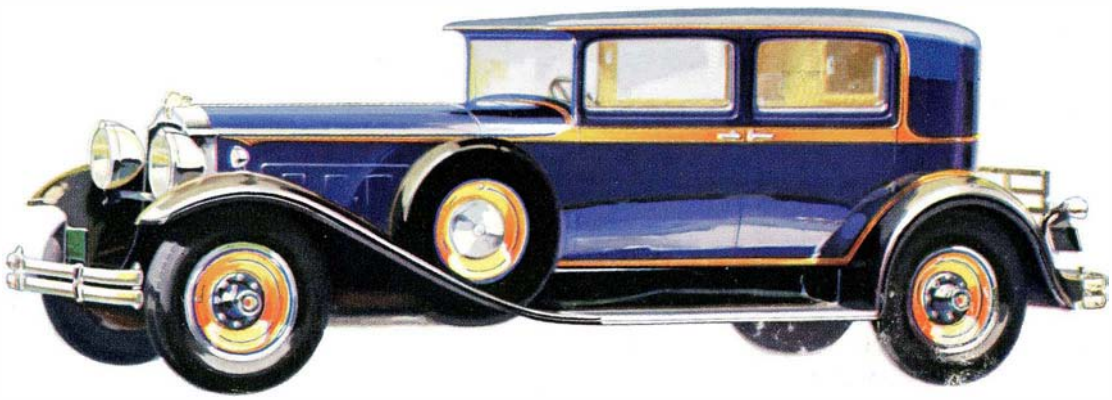

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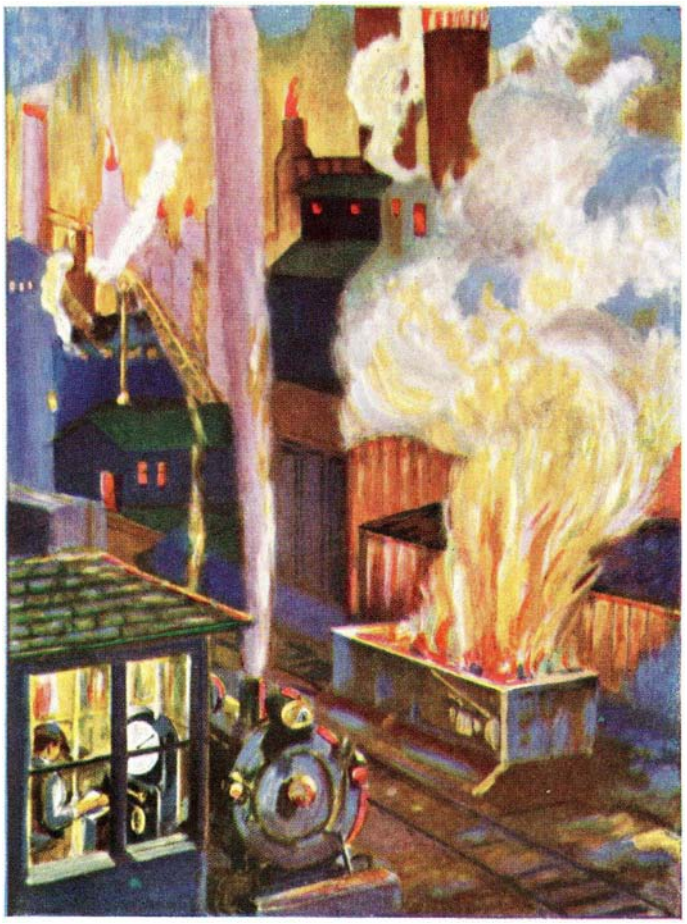
Beginning the Second Century of an Ideal



FROM Egypt came the crude balance. From Rome the unwieldy steelyard. In five thousand years of civilization man had made no worthier contribution to the science of accurate weighing until a century ago.

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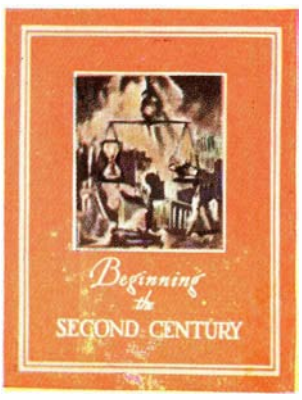

A copy of "Beginning the Second Century" will be sent postpaid if requested on your letterhead. This book contains interesting historical information as well as a practical discussion of weighing methods that save time and money for modern industry.

Fairbanks, Morse & Co., Chicago

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