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SCIENTIFIC AMERICAN

February 1930 ★ 35¢ a Copy

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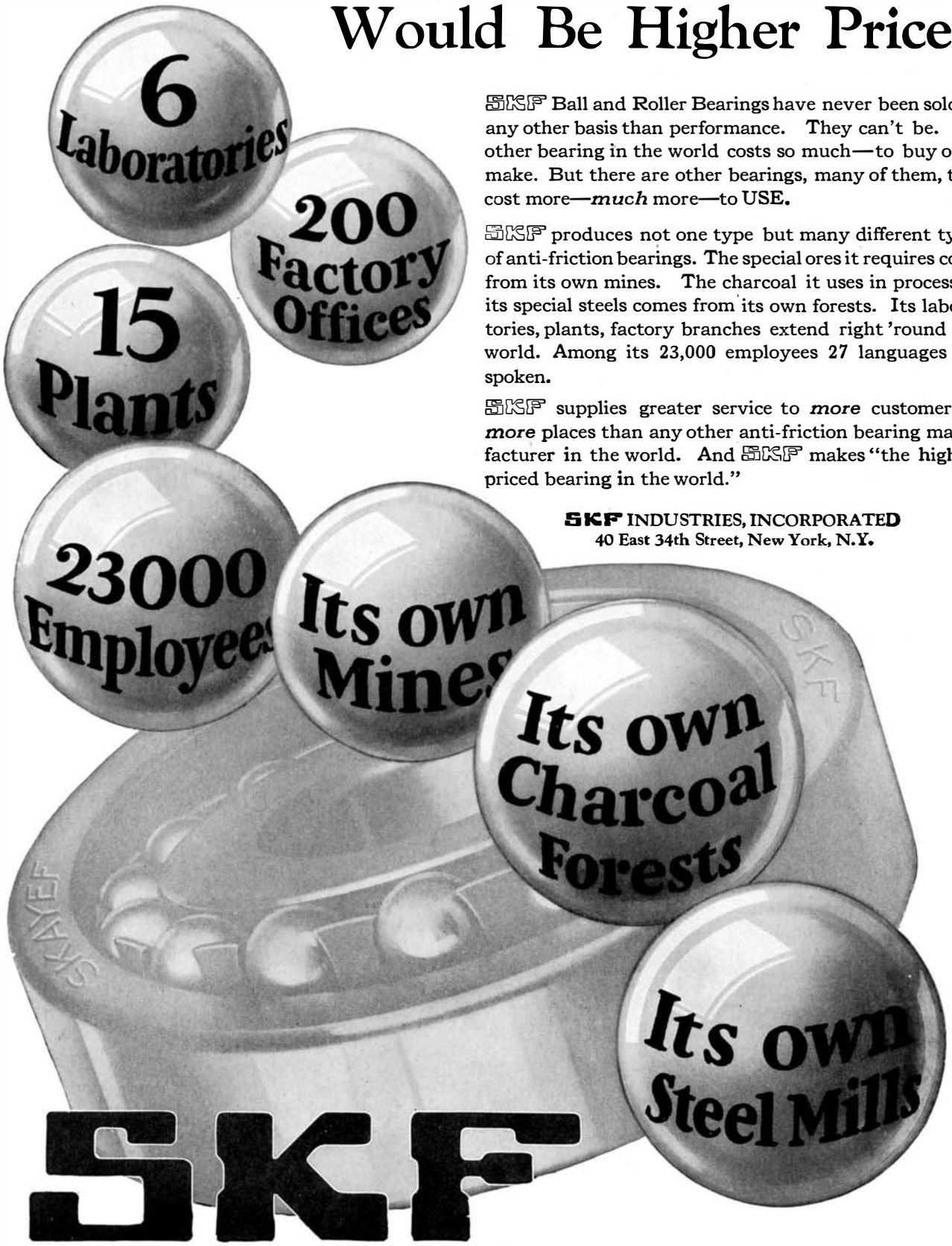

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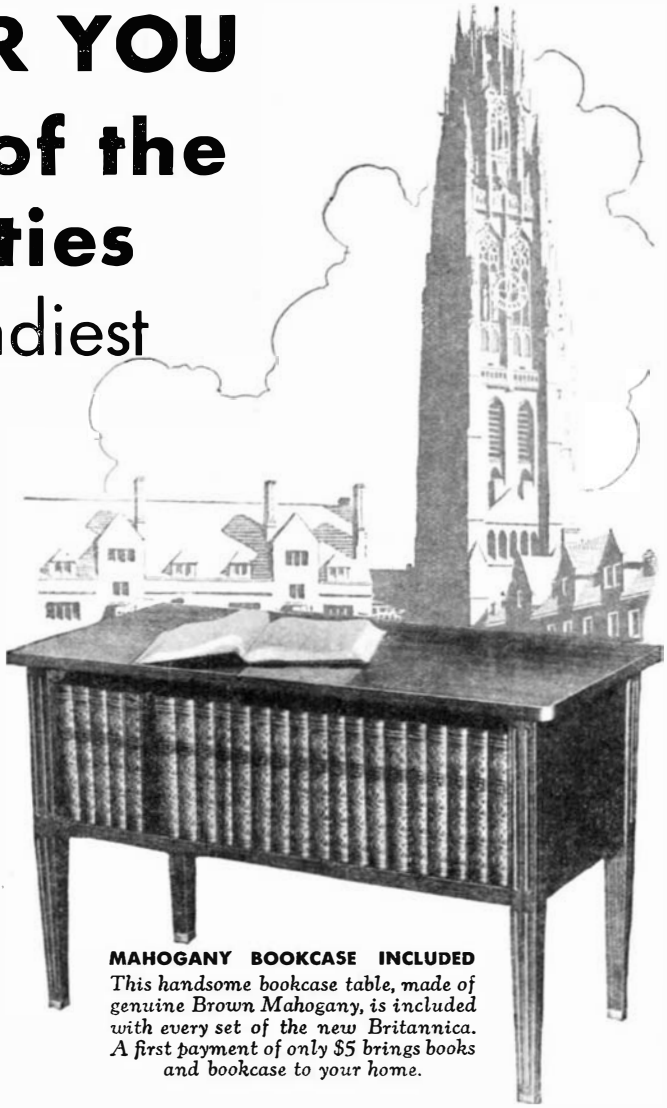

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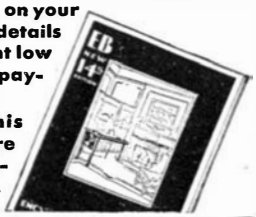

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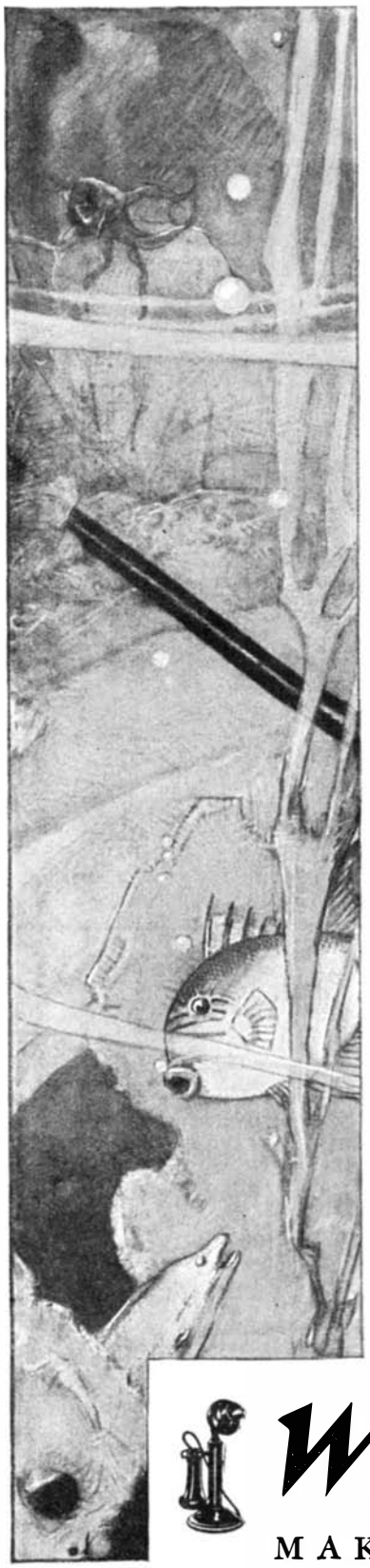

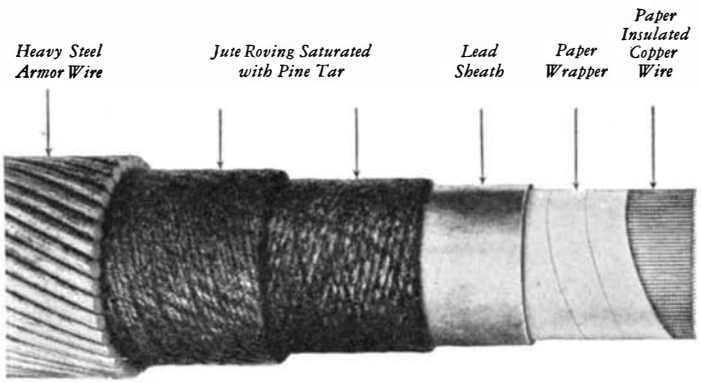

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SCIENTIFIC AMERICAN

February 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

"Painting with light," has become one of the most noteworthy features of the world's great exhibitions. Our cover, done in oils by Howard V. Brown, shows a night scene at the Barcelona International Exposition. Within the decorative area, illuminated by an ever-changing variety of colored fountains and cascades, all direct lighting has been dispensed with. When Chicago stages its second World's Fair, in 1933, even more spectacular lighting effects will be achieved, according to plans recently announced by the Committee on Illumination.

Looking Ahead *With the* Editor

A Microcosmic Egg

"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 vision." It is larger, however, than that of the cow and of many other large animals. To learn more about this biological subject, look for our forthcoming engrossing article.

Down With Crime!

WE hear much about organized crime nowadays, but little of crime detection methods except in fantastic fiction. But society is gradually organizing to combat the criminal with science that will excel in results anything that Sherlock Holmes, Craig Kennedy, or Philo Vance ever did in fiction. Criminals will, therefore, eagerly read our coming article on one city's scientific police department so they'll know what to expect; and you will find it mighty interesting reading.

Suspended Gravitation

IF a bubble of air is released at the bottom of a bottle of water at the instant the bottle is allowed to drop, will the bubble rise in the water? Ten chances to one, your answer will be "yes." But the answer is "no," for it is a case of suspended gravitation. If you don't believe it, you can prove it yourself by an exceedingly simple experiment which will be completely explained and illustrated in a coming article by a famous scientist.

Swimming

SWIMMING is an old and yet a young sport. Scarcely any scientific study of it has ever been made so that when confronted with questions as to the efficiency or speed of modern strokes, we are at a loss for an answer. Now, however, a professor of physiology has, by means of a recently perfected natograph, found the answer to many questions pertaining to swimming and will describe his experiments in these pages soon.

A Newspaper in the Making

CHICAGO is pressed for building space. Thus the Chicago Daily News Building, a model structure in every way, was built over steam railroad tracks. Smoke from the trains beneath is evacuated by an ingenious ventilating system and a stack to the top of the building. This and many other notably up-to-date features characterize this building and the newspaper it houses, as described in an article to be published soon.

Among Our Contributors

Alfred C. Lane

PROFESSOR Lane's eminent career as a geologist has helped to fit him for the latest work for which he has been selected by the leaders of science—the determination of the earth's antiquity by means of the radioactivity of rocks. Educated at Harvard and at Heidelberg, he served during several years as State Geologist of Michigan. Later he was professor of geology at Tufts College. To be exact, his profession is petrology.

Martin Meyer

DR. MEYER is a professor of chemistry and a consulting chemist. Although his researches, as listed in "American Men of Science" are with organic sulfur compounds, lead tetraethyl, dehydrothiotoluidin, perfumes, et cetera, he is said to derive the greatest satisfaction from the popularization of science. In addition to his article in this issue, we will publish soon another interesting and informative article from his pen.

Calvin P. Stone

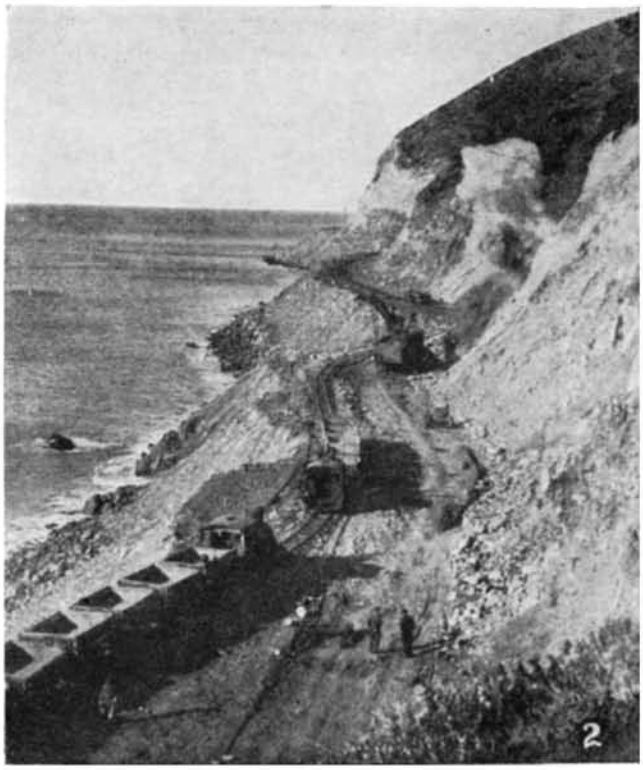
DR. STONE, Stanford psychologist who writes of rats in this issue, finds them an interesting subject for observation and study. He was for a time Director of Research of the Psychological Laboratory in the Indiana State Reformatory. During the World War he was psychological examiner in the United States Army. Animals have supplied him with much material, his specialty being animal psychology and behavior.

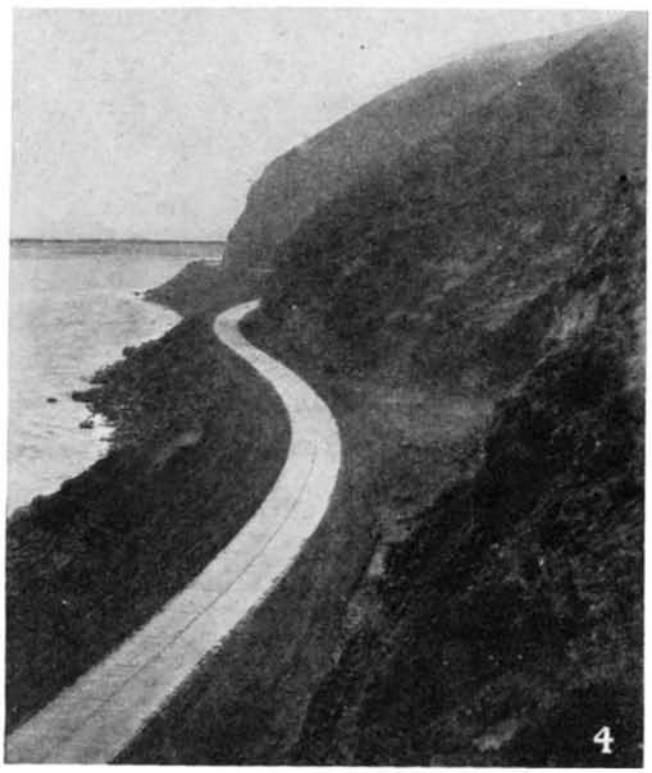
F. M. Jaeger

CONSIDERED an international authority in his chosen field, Dr. Jaeger is now professor of physical and inorganic chemistry at the University of Gronigen, Holland. His researches have taken him into abstruse physics and chemistry and he has, successively, been a physicist, mineralogist, chemist, and crystallographer, and has published much on all these subjects. His book "Inleitung tot de Studie der Kristalkunde" is the only one of its kind devoted to a comprehensive study of symmetry in all its aspects and is authoritative. During part of the 1928-29 term, he was George Fisher Baker non-resident lecturer at Cornell.

Private James P. Rigby

THE winner of our light-plane contest, Private James P. Rigby of the 65th Service Squadron, located at Luke Field, Honolulu, T. H., was born June 22, 1909, in Media, Pennsylvania, and spent his early childhood in New Jersey. After finishing high school, he enlisted for the Hawaiian Department of the Air Corps in February, 1928. His first ten months were spent in a Bombardment Squadron, but desiring to be in the Engineering Offices he obtained a transfer to his present squadron where he finds ample time to browse through technical literature and study as well as read the SCIENTIFIC AMERICAN, *Aviation*, and *Flight*. When his current enlistment terminates he hopes to find employment with an airplane company. He pays a charming tribute to his widowed mother who made his career possible by giving him a good education.

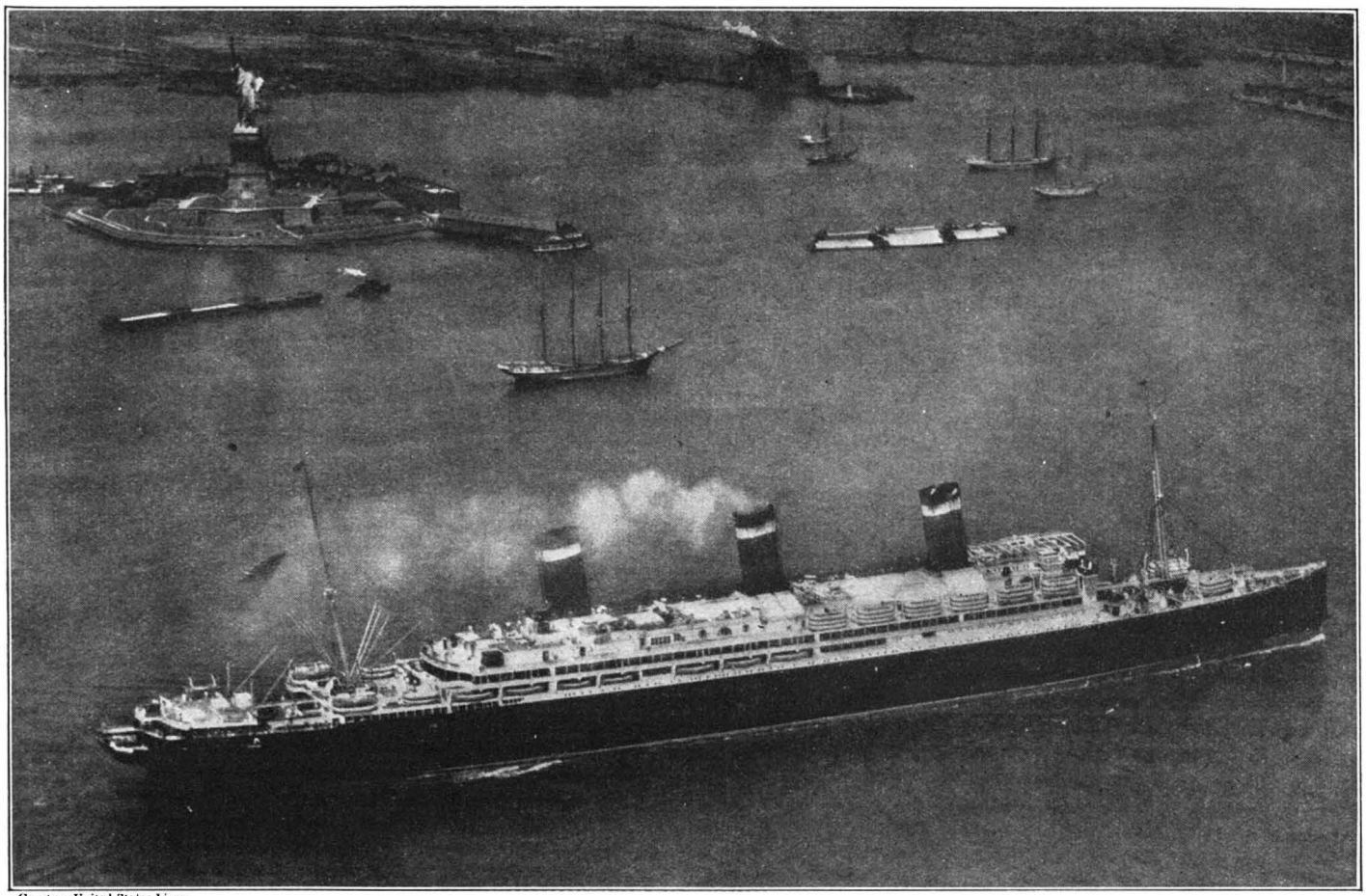




Courtesy *California Highways and Public Works*

Growth of the Highway

ON this particular section of the Santa Monica-Oxnard, California, highway, which was formally opened to traffic in 1929, many difficulties were encountered and overcome. A glance at illustration Number 1 will show why it was necessary for surveyors and workmen to be suspended from above like Alpinists, prior to the beginning of work and during the early stages of construction. Since there were no shipping points between Santa Monica and Oxnard, a long expensive haul was required. Water for construction purposes had to be obtained from a city over 12 miles away, through a specially built pipe line. Seawalls could not be built to keep back the waves; therefore huge rectangular blocks of concrete were lowered into the ocean and then filled with concrete. Illustrations 2 and 3 show construction stages, and Number 4, the completed highway. Construction of the seven most difficult miles at this point cost 1,000,000 dollars.



Courtesy United States Lines

THE "LEVIATHAN," AMERICA'S FINEST, PASSES THE STATUE OF LIBERTY, INWARD BOUND

American Ships and American Prosperity*

A Discussion of the Weak Link in Our Transportation System and the Need of Public Support for a Greater Merchant Marine

By E. M. HERR

Vice-chairman of the Board, Westinghouse Electric and Manufacturing Company

AS A DIRECT result of the sound economic policies which have been pursued by both American industry and the American government, the people of the United States have enjoyed unprecedented prosperity during the past few years.

The extensive use of power in industry, the development of the system of mass production for a large number of manufactured articles, and the rapid practical application of the discoveries of science and research, have greatly increased our national productivity and our national wealth. This added wealth, contrary to what has often happened in the past, has not been largely absorbed by a small group, but practically all who have had a hand in its creation have shared in it, so that wages have risen, the purchasing power of the majority of our people has widely extended, and the standard of living in this country has reached the highest level ever known. Finally, there is every reason to believe that those disastrous financial crises, which have periodically wiped out a large proportion of the savings accumulated in prosperous times, have been eliminated by the Federal Reserve Banking System.

Never before, in fact, has so much been accomplished for the good of so many people in such a short time.

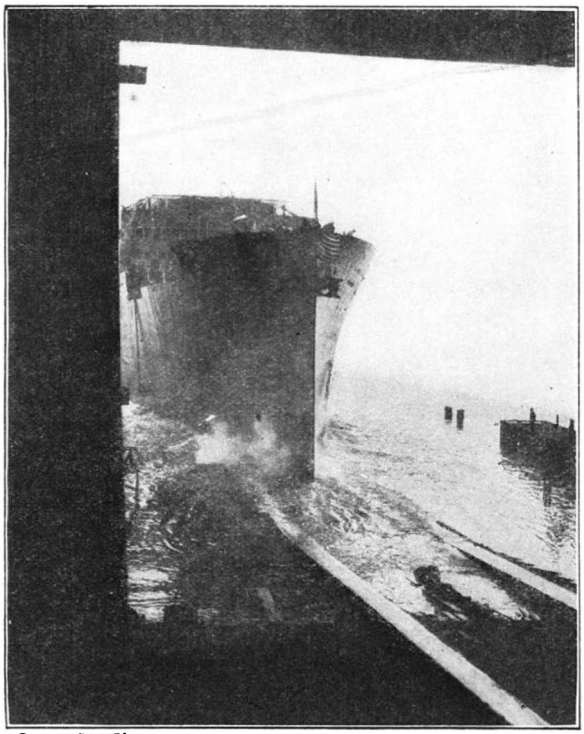
But, although the American peoples as a nation are prosperous and content, there is a minority who are actually being injured by the very processes that are benefiting their fellows. Although society as a whole gains whenever a new type of labor-saving machine is placed in operation, or research discovers a better way of performing some operation, certain individuals invariably suffer loss by being thrown out of work. Experience shows that unemployment due to this cause is

THERE was a time, not so many decades ago, when American clipper ships carried a large proportion of the world's commerce. Then came a decline which lasted until after the World War. Now our foreign commerce leads the world and we need more ships for the same reason that one department store does not employ another store's trucks to deliver its goods.

New ocean mail routes will greatly stimulate shipbuilding, for the construction of 29 ships, two of them super-liners, is to be specified in the contracts. But this will be only a start.

Mr. Herr's accompanying article puts us to shame for our apathy in respect to our merchant marine. It is hoped, therefore, that his discussion will aid in renewing that old feeling of pride Americans possessed when our flag floated above some of the finest and fleetest ships in the world. —*The Editor.*

*Reprinted by permission, from a monograph



Courtesy Grace Lines

LAUNCHING THE "SANTA CLARA"

usually temporary, since the wealth created by the new improvement always creates a demand for labor elsewhere; but this does not ameliorate the immediate distress of the unemployed, and on more than one occasion during the past five years, our industrial progress has taken place so rapidly that thousands of families were in want for long periods of time.

To this group, which our general prosperity has failed to touch, must also be added the American farmer. Whereas the agricultural industry has made progress during the past 50 years and the average farmer of today is much better off than was his grandfather, the status of the industrial worker has improved so much more during this same period that the farmer's economic position is relatively lower than it was formerly. Hence there is justification for the discontent that pervades many of our rural districts.

IT is typical of the spirit that now dominates American affairs that these weak spots in our otherwise highly satisfactory state should command widespread attention. We can confidentially believe that, insofar as it can, our national government will work out practical plans for farm relief, arrange work on public undertakings so as to reduce unemployment in times of depression, and carry out other constructive measures. But while vast good can thus be accomplished, it must be recognized that government is a remover of obstacles rather than a creator of economic opportunities, and that only economic remedies can permanently cure economic ills—and then but slowly.

What we chiefly need is an ever widening market for our goods. If we could constantly increase the demand for both our manufactured and our agricultural products by even a few percent per annum, much of the slack in our production system would be taken up, unemployment would be kept down to a minimum, and a much needed stimulus would be given to agriculture. In other words, one of the most effective things that we can do at this time to widen the scope of our prosperity is to build up our foreign trade.

We have never, as a people, been "foreign-trade minded," like the British, for example. Although the value of our foreign commerce in 1927 was in the neighborhood of nine billion dollars, it represented only about 10 percent of our total business, and this small proportion has been maintained very closely for many years. We have in this field almost unlimited opportunities for commercial expansion but as a nation we have not taken advantage of them. The time has now arrived, however, when we must embrace all opportunities to increase our overseas markets.

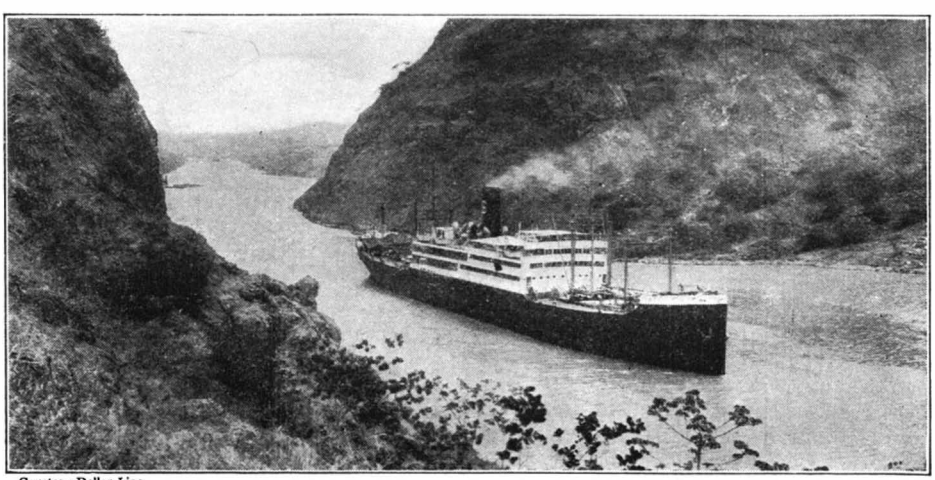
MUCH of the task of extending our foreign trade will, of course, devolve upon commercial, industrial, financial, and political specialists, but there is one phase of it which is the concern of the American people as a whole. If we want to maintain and extend our prosperity by developing foreign trade, we must strengthen a serious weakness that now exists in our transportation system.

Transportation and production are inseparable. If there is a free flow of goods from the producers to the consumers, the greater the quantity of useful articles the producers can turn out, the better off everyone concerned will be. But interfere with this flow anywhere and everyone will suffer loss; stop it, and civilization will disintegrate.

Fortunately for us, our transportation system as a whole is splendidly developed. Our railroad system is larger and more efficient than any other in the world. We own 78 percent of all the automobiles in existence and spend billions of dollars every year for new cars and trucks and for road improvement. Our aviation system is at present in its infancy, but, in view of the present public interest in this subject, no one can doubt that we shall in time be supreme in this field also.

EVEN in what might be called the minor branches of transportation, our position is satisfactory. We have an adequate fleet of lake-going, coastwise, river, and harbor craft, which is being increased as needed by vessels of the most modern types; we have added nearly 100,000 buses to our already extensive urban and interurban railway system; and although electric traction has had to mark time for several years because of the extremely rapid development of the automobile, it is now entering into a new era of active progress and promises to be one of the most important factors in solving the serious problems created by traffic congestion in our cities.

In striking contrast to all this is our international transportation system. While on paper our sea-going merchant fleet totals 11,000,000 tons and is second only to Great Britain's, 50 percent is probably useless and perhaps 50 percent of the remainder is obsolete or nearly so. As to new ships, without which the efficiency of our fleet cannot be maintained, only 3 percent of the ocean-going ships built since 1923 belong to us; and during 1928 we did not spend a single cent on ships for foreign trade. The percentage of our imports and exports carried in our own ships



Courtesy Dollar Line

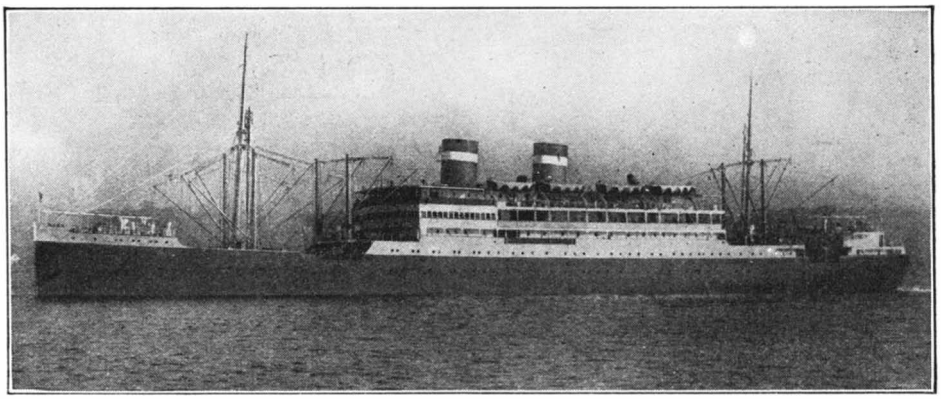
THE "PRESIDENT POLK" PASSING THROUGH CULEBRA CUT, PANAMA CANAL

has been slowly but surely declining since the high point of 1920, so that we are obviously in danger of slipping back into our old-time position of almost complete dependence on foreign ships for handling our sea-borne commerce.

We should, indeed, be ungracious if we were to criticize the shipping service that foreign nations have rendered us in normal times; nevertheless, blood is thicker than water, and a ship is always bound to its mother country by strong political and economic ties. On more than one occasion we have been left in the lurch, with our products, many of them perishable, piled upon our wharves because ships of foreign register, on which we were depending for transport, were suddenly drawn elsewhere for some reason that was no concern of ours.

A CLOSELY parallel situation would exist in our domestic transportation system if the great majority of our freight locomotives and trucks were under foreign ownership and control and were liable at any time to be withdrawn from our service and sent to Canada or Mexico. Obviously, under such circumstances, it would be impossible to develop that fine adjustment that now exists between our production and our transportation; and our internal commerce would be but a fraction of what it is at present. And yet, if we were thoroughly accustomed to this method of handling our traffic, we would perhaps find it difficult to realize what we were losing by not taking it under our own control. We would undoubtedly, from time to time, consider the question of substituting our own rolling stock for that supplied by foreign capital, but the cost of the operation would stagger the average man, and, because of the numerous invisible factors involved, he would probably be quite unable to understand how so great an investment would benefit him personally.

For similar reasons, the American people have been slow to appreciate the value of a merchant marine of their own. As long as less than 10 percent of our business is seaborne, it does not matter very much who handles it; but if we wish to develop a large volume of foreign trade, we must have an adequate number of the right kind of ships under our own immediate control and serving primarily our own national interests, for without them we shall not be able to insure that reliability of transportation service which is essential for the success of such an undertaking.



Courtesy Grace Lines

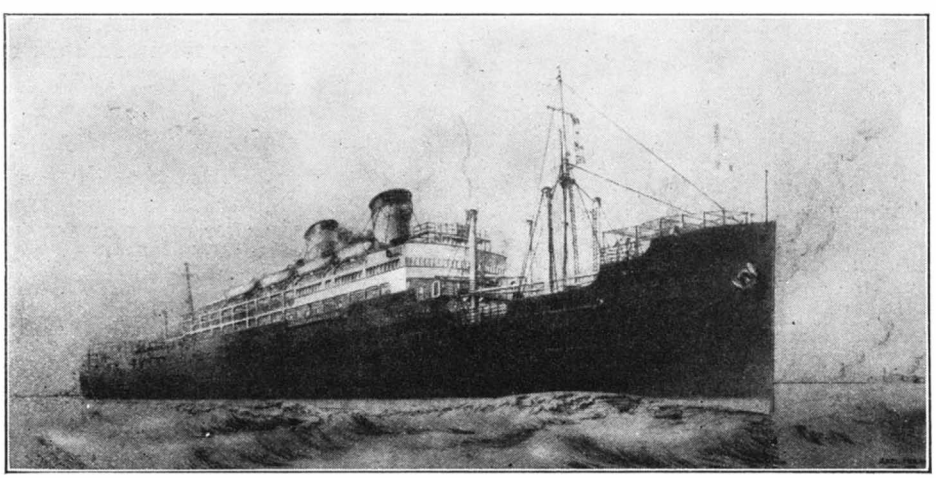
MOTORLINER "SANTA MARIA," ONE OF A LARGE AMERICAN-OWNED FLEET

Another highly beneficial result of the building up of an American merchant marine would be the revitalizing of shipbuilding in this country. Prior to the war, there were 23 shipyards in the United States building sea-going vessels; today there are but 12, and several of these are barely maintaining their existence on the odds and ends of repair work. Great Britain, on the other hand, has 57 yards, and Germany has 18.

If an adequate amount of business could be given to our shipyards, a goodly share of our surplus labor would be immediately absorbed; a demand would be created for large amounts of steel, machinery, and other of the innumerable supplies needed for ships; the producers of these materials would give employment to other workers; and thus an ever-widening circle of prosperity would be started. Moreover, we would save from extinction an industry that is absolutely vital to our national safety. We cannot afford to let our shipbuilding machinery decay and our technically trained shipbuilding staffs disintegrate. If we become unable to build ships to meet our needs in emergencies, we shall lose our grip on sea power, and then our seaboard, our island possessions, our commerce, and our prosperity would be at the mercy of any maritime nation that chose to attack us.

The situation is more promising today than it has been for a long time. Within the past year, Congress has passed certain legislation in the interest of our shipping and shipbuilding, and there is every reason to believe that work on a number of new sea-going vessels to fly our flag will be started in the near future. But without that widespread popular interest and support which created our railroad and our automotive transportation systems and which at present is playing so important a part in developing American commercial aviation, we shall have no merchant marine.

THIS whole subject is a matter that concerns all of our people—merchants, manufacturers, public utility operators, professional men, farmers, and workers—for even a moderate increase in our overseas commerce and our shipbuilding activities will result in a marked increase in the demand for labor, materials of every description, power, internal transportation, and all other varieties of service, and this will benefit everybody. Our industrial and political leaders can, in fact, do few things more useful than to create public understanding of the value, to every American individually, of foreign commerce and an adequate merchant marine.



Courtesy Grace Lines

TURBO-ELECTRIC LINER "SANTA CLARA," AS SHE WILL APPEAR WHEN COMPLETED

¶ *In constructing the new vehicular tunnel under the Detroit River from Detroit to Windsor, Canada, new engineering methods were used and problems were overcome. The interesting story of this work will be published in these pages at an early date.*

OUR POINT OF VIEW

California Sees the Light

QUALIFIED scientists, engineers, architects, builders, and real estate men of California have for many months been laboring over a uniform building code due to appear in the coming spring. This code will take frank and, it is stated, full recognition of existing earthquake risks in that state as determined—or as nearly as existing knowledge permits determination—by the science of seismology.

Such a code is past due. The lesson of the San Francisco earthquake has been wearing off. San Francisco itself not long ago reduced its own specifications for earthquake resistance in its building code.

As Henry D. Dewell, a consulting engineer, reports to the Seismological Society of America, an earthquake catastrophe first arouses a lethargic public, building regulations are made more stringent, codes are revised to match the advice of technical advisers; and then the cycle of events pursues its course: people become forgetful, familiarity with what science alone seems to realize is only a temporary let-up in earthquakes begets contempt, and building codes are allowed to lapse. Then comes another disastrous earthquake.

The time of *least* danger of earthquakes is directly after an earthquake—just when building codes are stiffened.

The time of *greatest* danger comes years later when earth stresses, temporarily relieved by the earthquake, have again accumulated—just when building codes are being weakened.

There must be some way to bridge this characteristic blind spot in human nature and provide stronger buildings at the proper time instead of at the wrong time. This is what science and engineering are now doing in California. It is, of course, only common sense, but common sense is a quality not too often noted in connection with public matters of this kind. Therefore the action deserves praise from all scientific people.

The Naval Conference

THE recent rebuff our Secretary of State, Mr. Stimson, received from the Soviet Government indicates the great difficulty one state has in understanding the reaction its policy will meet abroad; certainly Mr. Stimson's action was inspired by innocent motives but it raised Russia's resentment and encountered the thinly veiled hostility of Japan. The three directly interested parties were Russia, China, and Japan; China appealed to the powers when she became unable to sustain her position by force; Russia believing her cause was just and knowing her soldiers could maintain her position refused to leave the decision to outsiders; Japan disliked the idea of a concert of powers interfering in Manchuria lest a precedent be established that could be used in some future Manchurian problem in which she might be involved.

Television and the Cathode Ray

ALTHOUGH television, seeing at a distance, is a subject that incites the mind to fanciful flights into the future, the practical development of the art has been exceedingly slow and, so far, unproductive of satisfactory results. In 1889, Paul Nipkow, a German experimenter, devised an "electric telescope" and in his patent application he laid the foundation for all future disk-type television transmitters and receivers. Since that time progress has consisted almost solely of refinements and developments based upon Nipkow's original apparatus. Now, however, comes the hope that in the near future cumbersome scanning disks and drums, capricious neon tubes, and difficult-to-synchronize motors may be eliminated from the television reception field and replaced by the comparatively simple cathode-ray tube in which no moving parts are employed. A description of the cathode-ray television system appears in the SCIENTIFIC AMERICAN Digest of this issue, and it is our sincere hope that other experimenters will take up the work of Dr. Zworykin and thus bring successful practical television nearer to the average person's home.

In much the same manner, France and Italy have become fearful of a possible Anglo-American agreement relative to cruiser strength, and their attitude may cause the failure of the London conference. In addition, France has a real naval tradition and is reluctant to accept a naval position inferior to Japan; France regards the control of the water route to Algeria as vital to the effective strength of her army which contains a large African contingent; and while France will support Italy against a supposed Anglo-American combination, she will bitterly oppose an equality with Italy for with colonial possessions only exceeded by Britain, she considers her needs are much greater than Italy's. Finally, France must retain her submarine strength as a counterpoise to Britain's superior surface fleet.

So the complexities of the situation the London conference will face are becoming more and more evident; on the other hand President Hoover and Premier MacDonald have skillfully avoided many pitfalls in handling the preliminary measures; they are supported by an overwhelming public opinion in favor of reducing armaments and it only remains for conciliatory statesmanship to find the solution.

The country approves the President's action in surrounding our civilian members of the conference with experienced naval advisers, and the previous records of Rear Admirals Jones, Pratt, Moffett, Pringle, Yarnell, and Hepburn insure that the civilian members will be furnished the necessary technical assistance. Our President is too sagacious to ignore the necessity of expert advice. We feel sure that the presence of these Flag Officers in London assures the safeguarding of American interests, and we fondly hope the collective wisdom of the assembled delegates will find a solution that will further world peace.

Now is the time to limit armaments, for much of the hatred of the World War has evaporated while the memory of the suffering it caused is still fresh. No thoughtful person believes that eternal peace can be established in the present era; but some causes of war can be removed entirely, others may be neutralized, and war perhaps deferred until civilization is better able again to withstand the shock of arms. If the conference only succeeded in postponing one small war for a decade, it would deserve well of the world, and any success it may have will encourage succeeding generations to carry on the task of seeking peaceful solutions of world problems.

Our Permanent Prosperity

MOB psychology is a peculiar thing. When stocks first began to drop in the recent stock crash, many thousands of people frenziedly unloaded, like so many sheep following the leader, and almost caused an industrial collapse from which it would have taken months to recover. The stampede forced stocks to a very low point despite the fact that business was basically sound.

President Hoover understands mob psychology and so took immediate

steps to circumvent its destructive influence. He knew that if the man in the street could not see figures in black and white, this man would cry "hard times" and would curtail his expenditures; the cry would be taken up by others; and the mob's pessimistic belief would become actuality. Mr. Hoover therefore called upon all state governors for facts as to their states' projected work for 1930. The responses were most favorable; it was found that state construction on highways and public works for this year will run into hundreds of millions of dollars.

As early after the stampede as the first week in December, C. W. Nash, of the Nash Motor Car Company, stated that his company had found no cause for worry; their sales had been maintained on a par with, and in some cases showed an increase over, preceding years. Henry Ford, shortly after having reduced prices on all models of Ford cars, announced a general increase in the wages of all employees. Recently the United States Shipping Board certified a program of ship construction for our merchant marine which calls for the building of 29 vessels based upon ocean mail subsidies. Several of these will be begun almost immediately, thus assuring much business for our shipyards, employment of many men, and the use of much steel—and steel production is referred to as "the barometer of business conditions!" The *Engineering News-Record* recently published a survey showing that the cost of construction for 1930 will total around ten billion dollars.

Many other facts and figures could be quoted to show that 1930 will be a busy and prosperous year—we could cite the increase in bank deposits recently, and in stamp sales, the latter also called a business barometer—but the case is already proved. Yet the same old mob psychology, still pessimistic in tone, tends to hang on. There is thus the necessity for constructive optimism on all sides, plenty of hard work, and the free circulation of money so that business and industry may boom and a stabilized prosperity be ours permanently.

To such criticisms of our financial structure as that voiced, with puerile acerbity, by the Soviet press relative to the market crash: "So this is what can happen in a capitalistic country!" let us point to our 1930 program and say, "*This* is what *will* happen." Then let us forget criticisms and critics along with pessimism and other unpleasant things.

Swan Song

IN January, 1927, we published an editorial which stated that the average annual increase in the number of installations of electric household refrigerators from 1920 to 1925 was 100 percent, that the year's increase in 1925 alone was 350 percent, and ventured a prediction as follows:

"Imaginary conversation in 1977—*Grandpa*: 'When I was a young man, they actually brought ice into peoples' houses to keep their food cool.'

"Laughter.

" 'Grandpa, wasn't that in the days of the candle?' "

An Industrial Antarctic?

TO those of us who studied geography long before the World War, the problem of relearning the map of Europe after its remolding was indeed a difficult one. It is possible, or rather probable, that in a few years it will be necessary—if, of course, we wish to keep up with the times—for us to familiarize ourselves with the map of an entirely new continent: the Antarctic.

Already with several notable and well-known achievements to his credit, Commander Richard E. Byrd is now exploring by air and mapping in photographic detail this last great unknown and puzzling part of the world. In the SCIENTIFIC AMERICAN Digest of this issue we publish a map of his recent flight to the South Pole and give an idea of some of the facts that may be learned by him in the Antarctic. Besides the valuable data mentioned in that item, however, perhaps he will bring back other information that may lead to commercial exploitation of natural resources which some have predicted may be discovered there.

Who knows but that in the years to come there will be numbers of year 'round base camps, similar to Byrd's Little America, scattered over the Antarctic and peopled by hundreds or thousands of workmen who extract from the mountains there such natural wealth as gold, diamonds, oil, coal, or iron? Airplanes or airships might transport the more valuable of these from the interior to shipping points and methods might be found to ship the more bulky. The question, of course, is: Does the Antarctic contain any minerals of value or is it simply a barren, rocky land? Byrd will doubtless give us some information on that point and others will help our enlightenment. We may yet see the Antarctic a thriving industrial continent.

We thus gave a conservatively long time for the supplanting of the old ice refrigerator by the modern electric one. Since 1927, however, increasing use of the latter has been so marked as to indicate that the imaginary conversation may be possible in much less time than the predicted 50 years. And yet there are die-hards who either are myopic and thus cannot see the handwriting on the wall or are so deeply concerned financially that they are fighting the change with the frenzy of despair. We have no sympathy with the former because they are of the type that drag the wheels of progress but for the latter our feeling is somewhat similar to that we had for the buggy makers when the automobile made its appearance. We are simply sorry that, in time, they will have to turn to other things.

In this latter class we would place a certain association of ice manufacturers which, after we had published the article "Ice By Wire" in our October, 1929, issue, informed us that the article was fundamentally, essentially, and technically wrong, and demanded that we retract. Unfortunately for them they posited a weakness on our part which we do not possess. The article was not hastily prepared; on the other hand, it was presented only after careful consideration and study of the situation and then under the guidance of refrigeration experts. What, then, is there to retract? Nothing.

We can pass over this association's criticism that our title "Ice By Wire" was incorrect for obviously it was not to be taken literally. Likewise, we cannot retract our statement that, as a refrigerant, sulfur dioxide has very little danger either as a poison to human beings or as a corrosive agent for the pipes or interior of the refrigerator. It is admitted that the electric refrigerator is not actually electric but the term "electric" is as descriptive here as when used with such appliances as electric vacuum cleaners, electric dish washers, et cetera. We reiterate that there is less spoilage of food in electric refrigerators due to the lower temperature and to the lack of moisture.

We were of the opinion that ice manufacturers, faced by the competition of the electric refrigerator, have expanded into new fields and actively promoted their business. For that reason, we were rather surprised at the association's statements that "From the standpoint of economy, efficiency, and service, the ice industry has nothing to fear from mechanical refrigeration competition," and that "—the small ice machine"—with which name they choose to heap indignity upon the apparatus under discussion—"would not have reached its present degree of use had it not been backed by the enormous financial power of——; coupled with the fact that dangers and disadvantages of small ice machines have been studiously hidden from the public." And yet they did not enumerate these vital facts that have been *studiously hidden from the public.*

The association's argument reminds us of the little boy on a gloomy road at night, whistling to cover his fear, and of Hamlet's rebuke to one who thus practiced dissimulation: "The lady protests too much, methinks."

How Old Is the Earth?

How Geologists, Physicists, Geophysicists, and Other Scientists Are Pooling Their Knowledge for a Combined Attack on This Ever-fascinating Problem

By ALFRED C. LANE, Ph.D., Sc.D.
Chairman of the Committee of the Division of Geology and Geography on Estimation of Geologic Time by Atomic Disintegration, National Research Council

LOOK with a pocket lens at the luminous numbers of the dial of a wrist watch after you have been sitting two or three minutes in the dark. The figures do not shine with a quiet, steady glow but quiver with light. If the lens defines sharply you will find that the light comes from showers of sparks, like bursting rockets; or, it may be, more like that of fireflies on an August night. Each flash is made by an exploding atom.

We know now that the atoms of the chemical elements are not the "indivisible" units they were thought to be when that name was given to them, but according to one conception they are complex aggregates of positive protons and negative electrons. The outside electrons of an atom are pictured as whirling around the central nucleus with a velocity so great that they may be thought of as being practically "all over their orbit" at once. In the heavier atoms the number of outside electrons becomes very large, up to 92, and for some of the atoms the arrangements are too complex to be stable, so that once in a while they explode. Sometimes the explosion merely gives off an electron — sometimes it gives off what amounts to an atom of the light gas helium.

WHEN an atom explodes, the particle goes off with tremendous energy. We can imagine how great the energy is, from the fact that the particles have been going around their orbits many millions of times each second. When such a particle is set loose, like a stone from a sling, and strikes the white powder of an impure zinc sulfide, it causes a flash. Thus each of the flashes seen in the luminous paint on the watch dial represents such a collision.

Now if we were watching a pop-corn machine and counted how many kernels popped in a minute we could tell, provided the rate of popping was uniform, how long the machine had been running. Even so, with our popping atoms the physicist generally tells us that, so far as he can find out, the number of atoms of a spontaneously disintegrating element that explode per second depends only on the number that are present; and that this number is uniform, regardless of temperature and pressure, and regardless of other substances present. The experiments upon which this statement is based have ranged throughout the whole variety of conditions that might be present near the surface of the earth.

There are a number of these popping elements. Radium is the one in which this property was first recognized. While the rate of disintegration of radium is relatively rapid, incidentally causing it always to be warmer than its surroundings, the radium is half gone—its atoms half exploded—after some 1580 years. This is not, however, so fast that, like some of the other elements, radium vanishes under the chemist's fingers.

ANGEL TERRACE, YELLOWSTONE
By measurement of rate of decay of radium in these deposits it was possible to date the time since the recession of glaciers

By measuring the rate of decay of the radium contained in certain deposits, Schlundt of Missouri and Moore of Purdue estimated the time since the ice extended down to the geysers of the Yellowstone Park during the Great Ice Age. It was done in this manner: The water of the geysers contains radium, and the deposits of tufa laid down by the geysers are also radioactive. The older these radio deposits are, the less active they become. The older deposits of Terrace Mountain have a radioactivity of only 1 percent of the more recent ones and are overlain by boulder clay deposits of the glaciers. If, then, we assume that the original activity took place at the same rate as now, we can estimate the age of these deposits by the degree to which they have lost their original radioactivity. If radium loses half its volume during the first 1580 years, and half its remaining volume during the next equal period, and so on, it will be reduced to 1 percent of its original radioactivity in about 10,500 years.

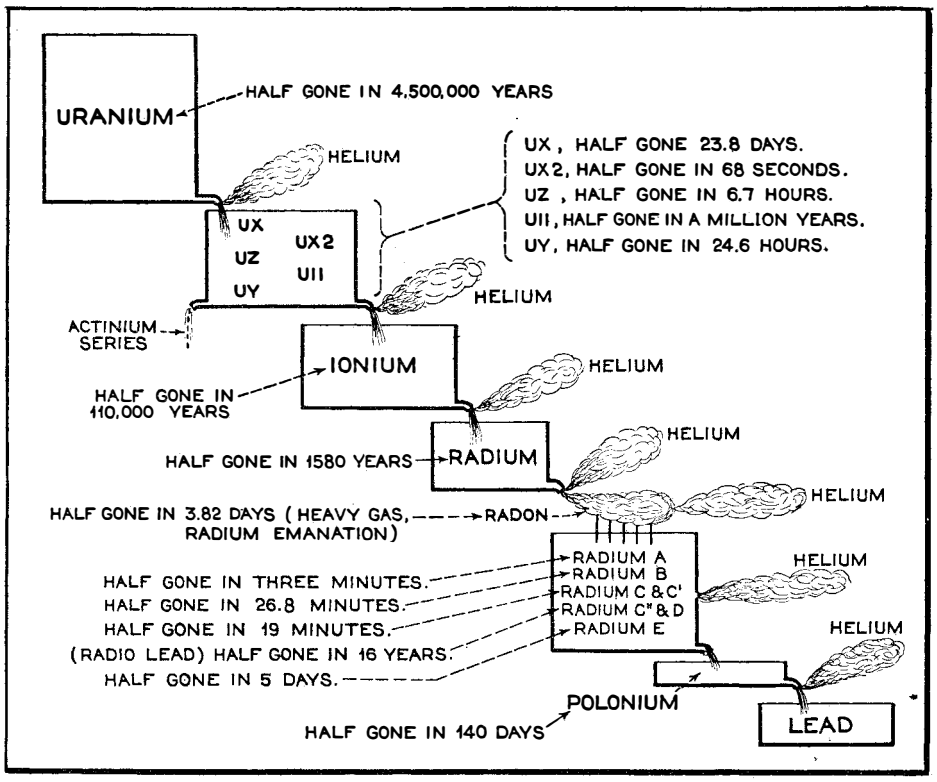
However, the most suitable element for computing the great lapses of time since the earth's crust began to be practically at its present temperature and pressure is not radium but uranium. Incidentally, there is a very small amount of closely similar elements called "isotopes," that are grouped together under the name of uranium and distinguished as U I, U II, U X, U Y, and U Z, and so on. Ordinary uranium is mainly U I.

URANIUM is the source of radium, but its atoms are so much less explosive than those of radium that it would take 4,500,000,000 years for it to be half gone. In a milligram of uranium, which is about the quantity that would cover a circle as big as the letter *O* with a layer as thin as a piece of paper, there will be about 2,540,000,000,000,000,000 atoms. From this quantity of uranium we might see something like 11 flashes per second. From a mineral containing only ½ of 1 percent of uranium I have counted flashes at the rate of four a minute. As there are 31,556,926 seconds in a year, it is easy to see that if 11 atoms disintegrated per second per milligram, the uranium would be gone in 8,000,000,000 years. However, since the number of atoms which burst depends upon the total number present, the rate constantly diminishes. But

we can easily allow for this factor.

If, then, we know how much uranium there was in the rock when it was formed, we can tell by the amount left how long a time has elapsed since that event. We can ascertain the amount originally present by measuring the residue left, for each atom of uranium ultimately leaves a residue of lead. I say ultimately because there is a complication. The disintegration of uranium is not quite as simple a process as the popping of corn, although in both cases, to be sure, gas and energy are set free. In the uranium explosion the result is an atom of another element which is much less stable than uranium and explodes in its own turn. In it the number of explosions per number of atoms present is much greater, and the time when the atoms are half gone is proportionately shorter.

This new atom derived from the explosion of an atom of uranium in turn changes into another, and this into another, until we have a whole staircase of descent in the course of which eight atoms of helium are given off. At the bottom of the staircase is lead. Ionium, radium, radium emanation, and polonium are among the elements formed in this process. In all there are about 17 of them.



ATOMIC DISINTEGRATION SERIES SIMPLY ILLUSTRATED

In this diagram the atomic disintegration series is illustrated by water running down through a series of tanks. It shows what happens while radium is being transmuted into lead in nature

We may compare the process, as shown, to the flow of water from a great tank of uranium, through a series of smaller tanks with outlet pipes of various sizes. The larger the outlet pipe in a tank the less water will remain in it at the end of a given period of time. The lowest reservoir is lead—"radio-lead"—differing from ordinary lead in no obvious respect. But its atomic weight is 206, whereas for ordinary lead this atomic weight is 207.18.

Thus any mineral or rock which contains uranium has always some lead as well as radium in it and, while the ratio of uranium to radium approaches a fixed value, the older the mineral the greater will be the proportion of lead present. If we multiply by the fraction 238/206 we will get the original amount of uranium present—provided we can assume that all the lead came from the uranium; otherwise we should get a greater figure for the age of the earth than the true one. In this way Professor Henry Norris Russell of Princeton figured that the solid crust of the earth could not have been solid for over 10,000,000,000 years. This quite accords with the astronomic estimates that the earth as daughter of the sun can not be over 1,500,000,000 to 5,000,000,000 years old, as given by Jeans and Jeffreys of Cambridge; and by Holmes of Durham University who gives three ways of estimating it.

However, part of the lead may be original, part derived from actinium or from thorium, for there is another family of radioactive elements whose grandparent is thorium, and thorium decays about a third as fast as uranium. If we could tell just how much of the lead was derived from uranium, how much from thorium, and how much was of other origin, we could then check up on our estimates. Aston of Cambridge has shown a way of determining this, although it is not yet very precise.

To make sure that the lead is derived from uranium its atomic weight must be determined. Even then we have to be reasonably sure that there was not originally uranium lead present. For certain crystals it is not likely that there was more than a trace of original lead of any sort, and Davis of Reno and Hall and Richards of Harvard showed that for the oldest rocks of the Black Hills of Dakota—older than any well defined fossils there—the radio lead is nearly one quarter of the uranium left. This means an age of 1,667,000,000 years. Assuming that the uranium disintegrated in the past at the same rate as at present, Ellsworth of Ottawa has shown in the same way that the oldest rocks in Canada are over a thousand million years old.

Miss Gleditsch of Oslo, Norway, who has worked with Madame Curie, and Ellsworth; also Riss and Kirsch of Vienna; Holmes; and writers cited by these scientists—all have shown similar great ages for the oldest rocks in various parts of the Old World, and it is in some such way that Sir Edgeworth David, Professor of Geology at the University of Sydney, Australia, estimated the ages of the rocks to which he has recently called public attention.

As we have stated, uranium contains more than one element and the presumption is that these different elements would disintegrate at different rates. Therefore those which did so most rapidly would the soonest disappear. This leads us to infer that the present rate of disintegration is less than in the past. Probably some allowance is to be made on this score, but reason will be given for the belief that this will not shorten the time by more than a small fraction of the total, and that the ages of rocks and minerals will be relatively the same.

Radioactivity and the radium discovered by Madame Curie were first studied in the products of a mineral known as pitchblende, from Bohemia. In this mineral the ratio of radio lead to uranium is but 0.028. This would imply an age of something like 200,000,000 years—not much over one tenth of the age of the consolidation of the crust. A number of tests of minerals from various places—minerals which were formed during that great series of crustal disturbances that ended the Carboniferous Period and formed the Appalachians; also crumpling the coal beds from Alabama to Rhode Island and from Wales through Belgium to Russia—point to similar ages. On the other hand, R. C. Wells, of the United States Geological Survey and M. F. Conner have recently shown by the lead-uranium ratio that the

close of the Cambrian Period or "age of trilobites" was something like twice as far removed in the past.

That these estimates of great geologic times are justified is indicated by the results obtained from other methods of computing the earth's age. If, for example, we liken the estimation of geologic age by comparing the amount of uranium and lead to the estimation of the time that a pop-corn machine has been running, by determining the proportion of popped and unpopped corn, we may also liken estimates of the age of the rocks by the amount of helium gas which has been generated as described, to an estimate which should correctly measure the steam given off by the explosion of popped corn. Of course, helium gas thus generated is likely to diffuse away and give us estimates which are too low. Yet even these estimates give ages of several hundred million years. Dean Moore (Purdue), and Bennett are using this method.

A STILL more interesting method which is employed might be likened to seeing how battered up the pop-corn machine was, or counting the dents in the machine made by the flying corn. When an atom of a radioactive element explodes it sends the helium particle flying with a velocity which may carry it several inches. In solid substances, however, it has a much shorter range. The more frequent the explosions, the more violent they are, and the greater the range of the helium "bullets."

Now these helium "bullets" can do a good deal of smashing up and discoloring of molecules, especially toward the end of their flight when they have lost a good deal of their velocity, even as a rifle bullet with a high velocity may make a clean small hole in a window pane but at a low velocity may shatter it. The result is that a minute particle of a radioactive mineral embedded in mica, for example, is likely to be surrounded with a halo. Careful investigation may disclose not merely one darker ring but several, each corresponding to one particular element of the series shown, which in its explosion sends off helium bullets with its own particular velocity.

A photograph of these rings in the fragments of a very old Canadian rock, from a paper by Dr. Kerr-Lawson of the University of Toronto, is reproduced. The diameter of these rings matches very well the diameters which would be formed at the present date, and this is one reason for believing that a more rapid decay of uranium in times past is not likely to be very important in our calculations; for if it were it would show more in the diameter of the rings. Joly, of the University of Dublin, one of the greatest of the observers in this field, does believe there is a slight difference, in that the older rings are larger. But if so the amount is only some thousandths of a millimeter, and another explanation has been suggested even for this.

As yet no definite ages have been obtained by means of the ring method just described, since we do not know exactly how much radioactive material there may be in the minute specks which produce the halos. However, estimates even for the small fraction of all geologic time that has elapsed since the Devonian Period, give us a possibility of hundreds of millions of years.

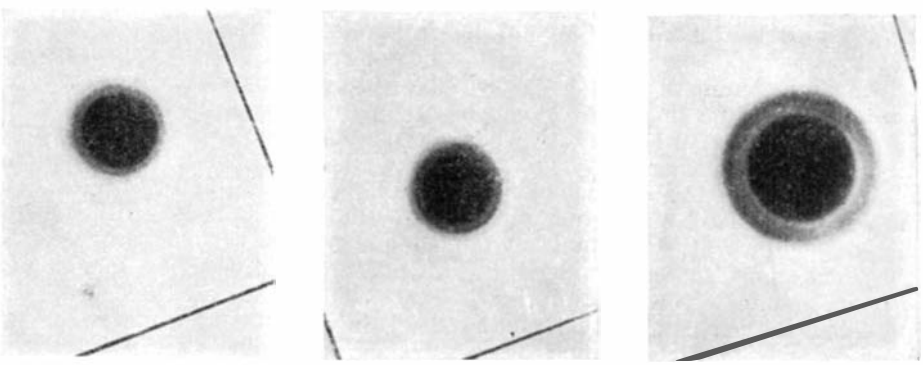
The radioactive elements give us the most trustworthy estimates of ages, because, so far as we know, the rate of change seems to be the least variable of all the common methods of estimation. Most of the other forty-odd methods give us much shorter estimates of the duration of the geological periods. Here, however, we know that the rate of change is variable, and in many of them it is very imperfectly known.

Take, for example, the method by which the age of the ocean, stated as some 90,000,000 years, was estimated by the time needed to accumulate the salt in it at the present rate at which the rivers are bringing salt into the ocean. We doubtless know within a few percent the amount of salt in the ocean and the amount of water that yearly goes into it, but the analyses of the water are very uncertain both in their accuracy and especially, as Collins of Washington shows, in that they do not represent fairly the amount of water which goes off in floods. This is a very large proportion of the total run-off. The analyses have not been weighted in proportion to the amount of run-off they represent, and the estimates of the average percentage of salt in the river water may be two or three times too great. Moreover, the continents are now, as the Yale geologist Schuchert tells us, much larger than they generally have been in the past. Again, in the Ice Age which ended (or apparently ended) only a few thousand years ago, a lot of unleached rock was exposed to leaching. Finally, man, with his many activities and his salt mines, adds salt to some of the rivers and, in fact, may be traced by the extra salt he introduces into the water.

Thus, it may be assumed safely that the accumulation of salt in the ocean is now going on more rapidly than it was in the past. The 90,000,000 years just mentioned would be surely a minimum, except for the fact that we do not know how much salt there may have been in the ocean in the beginning.

THIS brings up another kind of uncertainty. In our estimates of geologic time we start at the present, and the farther back we go the more unlike present conditions the conditions then must have been. This applies to all the "hour-glass" methods; that is, those that depend on actions that go in only one direction. These are "one-way streets." We can tell the age of a horse by the amount that his teeth are worn down; we try to tell the age of a mountain range by the way the folds of the strata have been eroded away; we can estimate the time taken for Niagara to cut a seven-mile gorge at the rate of five feet per year. But each of these actions represents but a comparatively short fragment of geologic time—too short a fragment for accuracy.

Those of the earlier estimates of geologic time which were arrived at by considering the cooling of the earth and sun, have ceased to be thought worthy because most of them assume a cooling from some particular uniform temperature. But probably these temperatures never were uniform. Modern astronomy leads us to think that the temperatures may have been much higher at the earth's center than those outside near the circumference, or than those assumed by Lord Kelvin. The higher the temperature, the longer would be the duration of cooling. Moreover, these methods have ceased to be of value because the radioactive disintegration which we



After D. E. Kerr-Lawson

DISCOLORATION HALOS ON MICA, PRODUCED BY FLYING ATOMS

Such halos are microscopic and, as seen on paper or on a thin sheet of mica, are really cross-sections of spheres or concentric shells produced by the helium atoms shot out at differing (hence the different rings) speeds. They are often called "pleochroic" halos, also

have mentioned furnishes a source of heat which indefinitely prolongs the cooling process. In fact, if there were as much radioactive material throughout the whole earth as in the surface granites the earth would heat up and would be likely to melt and explode.

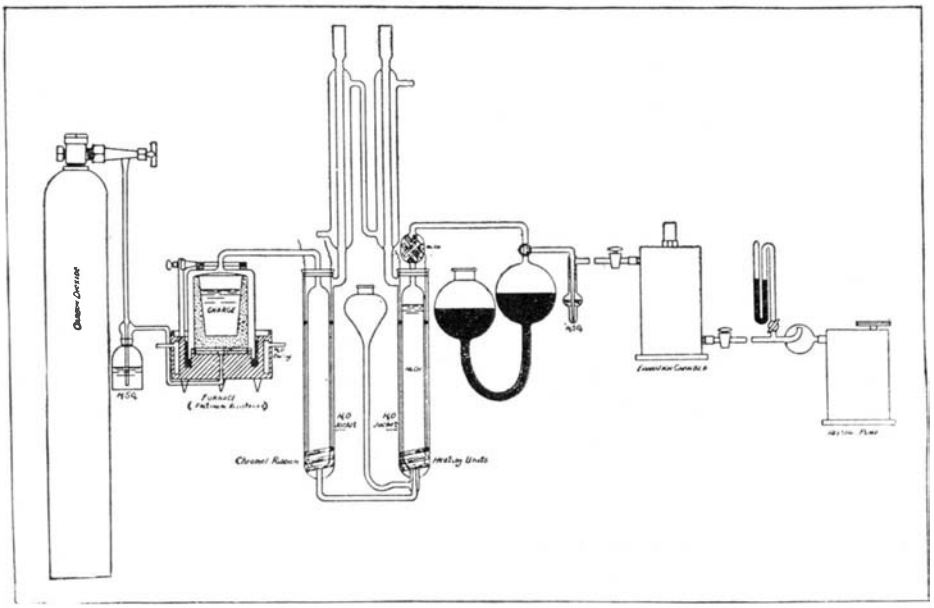
This brings us to a most interesting and recent method of estimating the age of the earth. It is not probable that the earth is as radioactive all through as at the surface, for meteorites, which are believed to correspond in composition with the interior of the earth, are not nearly as radioactive as granites, which correspond to the outer rocks of the continents. Yet it is quite possible that an excess of heat is produced within the earth, above that which is constantly leaking through the crust. This heat accumulates and weakens the crust until there is a rather sudden yielding, then the excess heat comes out in a comparatively short time in a volcanic outburst and in the upheaval of mountain ranges. This would be something like the intermittent escape of steam from the lid of a tea kettle; or more like the discharge of the heat which slowly accumulates at the bottom of a geyser tube and discharges, say, once an hour.

Professors Holmes of Durham and Joly of Dublin have estimated that such paroxysms occur about every 20,000,000 years.

THE question then arises; how many such paroxysms can the geologists recognize? Holmes believes he can identify 20 in the better known part of the geologic rocks. We have here a method of measuring geologic time by cycles, due to a combination of a progressive action with paroxysms nearly at regular intervals. But we do not know how regular the intervals are.

It would be ideal if we could associate geologic time, as we do the ordinary time of history, with regular astronomic cycles. For a short and recent duration this has, indeed, been done. Professor Ellsworth Huntington of Yale, lying on his stomach all one summer, measured the rings of the big trees of California. These rings are larger in rainy years. Thus he has carried back their annual record of climate to the famine which took place in the days of Elijah. Professor De Geer of Stockholm and his students, Antevs, and others, have similarly studied the banded, that is "varved," clays with an alternation of coarser clay deposited in spring, summer, and fall and very fine clay settling under the ice in winter, and has thus carried back the tale more than 12,000 years to the time when Sweden was mantled in ice.

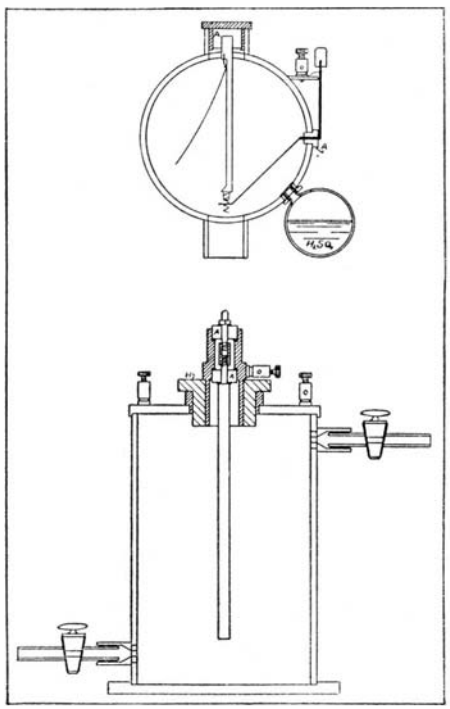
It would be an interesting thing if we could recognize in the strata of the earth, varves due to the effect of changes in climate that take place in longer astronomic cycles than a year.



Courtesy *American Journal of Science*, after Piggot

DIAGRAM OF APPARATUS FOR DETERMINING THE RADIUM CONTENT OF ROCKS

Rocks are heated in furnace, carbon dioxide picks up the radium emanations, the gases pass through the scrubbing towers and are dried and collected over mercury. A detachable gold-leaf electroscope (shown in the diagram below) on top of emanation chamber determines the ionization of the air, hence the degree of radioactivity of the particular rock samples chosen



THE ELECTROSCOPE

At bottom is the emanation chamber, vacuum-tight, with insulated brass rod in center, and above it the detachable electroscope head. Within this is a continuation of the brass rod; also the gold leaf. The little lever at right is for charging the electroscope by temporary contact with the rod

At present when it is summer in the northern hemisphere the earth is farthest from the sun; it is nearest when it is sumer in the southern hemisphere. Some 13,000 years from now the reverse will be true. Gilbert and Kroll have studied the possible climatic effects, and more recently the Englishman Stamp thought he found in the Miocene Epoch strata of Burma a change in the character of beds which was due to this 26,000 year cycle. Thus he computed over 2,170,000 years for the time taken to form a series of beds that represent but a fraction of a later period of geologic time.

Again, at present the earth's orbit is nearly circular, so that from the September equinox to that of March is only three days shorter than from the March equinox to the September equinox. But there are times when the difference is more than a month, and the earth's orbit is much more elliptical. It is conceivable that one may detect the effect on climates and on the strata laid down when these changes take place in a much longer cycle. It is also conceivable that the whole solar system, traveling through space, might periodically pass so near to some star that the event would record itself in the story of the rocks.

HOWEVER, with a possible exception of the 26,000 year period—our so called "precessional period"—no such cycle has been identified, though Luyten, the Harvard astronomer, has been studying the distances and the motions of the nearest neighbors of the sun.

The continuity of life and the balance of the earth's climate between the two exterminating extremes in temperature is one of the marvels of the geologic story that suggests a guiding intelligence. The identification of longer cycles, either astronomic in nature or produced by the periodic accumulation and discharge of heat due to radioactivity, is a task for the coming generation of geologists and astronomers. But it is certain that we have millions of years—hundreds of millions of years—in which to study.

Rats

The Rat Is Such a Common, Familiar Animal That His Psychology Has Almost Been Overlooked. But Even a Rat Is Interesting

By CALVIN P. STONE, Ph.D.
Professor of Animal Psychology, Stanford University

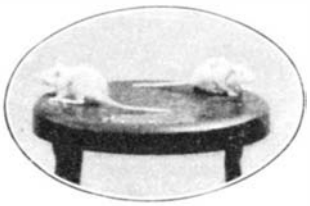
BIOLOGICALLY if not esthetically speaking the common rat is an admirable creature. Its ability to live in all parts of the world and for the most part against the will of man certainly entitles it to a high rank among the more efficient chemical engines of nature.

But hardiness and adaptability possessed by a pestiverous animal like the rat seldom win favor in the layman's thinking. While admitting the rat's efficiency for keeping in touch with his store of edible foods, at the same time he harbors an unqualified intention of lambasting him with a club whenever it is possible so to do.

In biological laboratories, however, rats have found complete asylum from those who would annihilate them when in the wild state. Strange to say it was by virtue of those same qualities that made of them the efficient pests of man, that they have now become the ideal subjects for many psychological and biological experiments. To increase the range of their usefulness scientists have found it to their own advantage to learn more of the psychological as well as the physiological make-up of rats. These psychological investigations have revealed facts that are most entertaining as well as useful.

ONE puts no great strain upon the imagination when he says that rats have coats of many colors but that they are totally unaware of it. By selective breeding tints, shades, and hues that are seldom or never encountered in the rat's native habitat have been produced. Of these the black and orange or straw yellow are probably the most striking and attractive. Esthetically speaking many people prefer the albino or the hooded strains, of which those with white bodies and black, brown, or yellow heads and similarly pigmented stripes along the back are the most common varieties. The pure albino, being the gentlest of all strains so far isolated, is for that reason a favorite in experimental laboratories. According to results of special investigations, rats are insensitive to what in ordinary terms is known as color. They can, however, discriminate with fair acuity small differences in shades and tints.

By native endowment the rat is fitted for a diversified education in a relatively complex and changing environment. Not only does he come into possession of a large repertoire of instinctive responses before or soon after the suckling period has ended, but in the course of a lifetime he forms and retains hundreds of habits and skills which enable him to cope with the individual characteristics of the native habitat. Some idea of the quality of the native equipment may be had by considering certain special phenomena of reproduction.

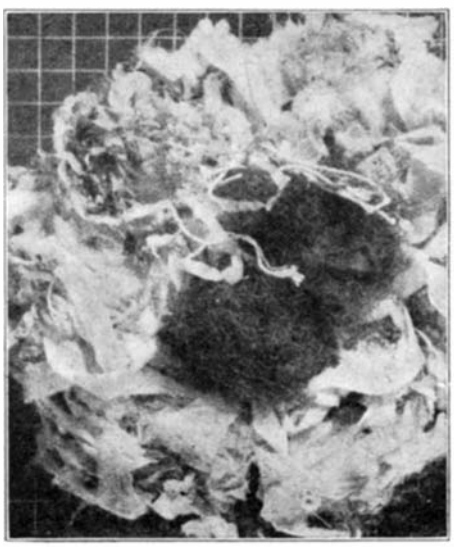


STRAW-COLORED RATS

By the common method of artificial selection rats of several colors have been bred

A farmer whose cribs and barns have become rat infested has ample reason to believe that the rat is psychologically and physiologically equipped for prodigious fecundity. Nevertheless the range of error in a conjecture of this character is unbelievable. Given ten virgin females and a couple of males, selected from a first-rate stock of well-nourished rats, an animal breeder, properly equipped and schooled in the moderns methods of husbandry, might reasonably expect to have 1500 healthy offspring on hand one year from date.

Within a year and a half this number could certainly be doubled, so strong are the reproductive instincts and so efficient the well-fed mother's care of young. Monthly increments and totals of animals on hand throughout the first year are shown in the chart. After all, however, adverse climatic conditions, unbalanced rations, food shortage, disease, and natural enemies probably are still man's greatest allies in withstanding the ravages of wild rats.



HOME ADDRESS OF RAT

Nest constructed by females for the care of their young. A bird builds a more systematic nest than this hodge-podge

Under favorable nutritional conditions the amorous life of both sexes awakens at the end of the second month of life. This, in terms of relative life span, corresponds roughly to the age of early childhood in man. The male is not a lazy drone in affairs of the heart, for his incessant philandering keeps him active from early adolescence to late senility. With the female, receptivity usually ceases before two thirds of her life course is run. Males are polygamous and females polyandrous. Incest is never a sex barrier. All provisions for the infants' care and nutrition are made by the female until the offspring are able to shift for themselves; thereafter family ties are speedily broken and forever lost.

WHEN not in captivity domesticated rats perform a wider range of activities in connection with the birth and care of their young than is usually found in the maternity wards of rat laboratories. This may be attributed primarily to lack of appropriate stimuli in the laboratory situations, rather than to a deficiency in the innate endowments of the mother, for when the latter is given a variety of nesting materials, allowed some latitude in the selection of nesting site, and permitted to avoid certain hardships and distracting stimuli of the surroundings her repertoire of maternal responses greatly expands.

A variable amount of nesting behavior is characteristic of all young adult rats of both sexes living in the wild state. Nesting contributes to the heat regulation of the body by conserving radiated energy when the temperature drops below the more comfortable ranges. To illustrate, an adult male which had always lived in a well-heated laboratory with no occasion for nest building was observed to build a nest for himself when his cage was temporarily put into a refrigerator for a period of approximately two hours.

Comparative studies of virgins and prospective mothers show that there is a great wave of nesting activity associated with or attendant upon the birth of their young. At this time nesting is more vigorous and persistent than at any other time of the animal's life. Even in the summer time when room temperatures are higher than

those required for comfort of either the newborn or the mother it may be seen in all its characteristic vigor.

The nests are loosely constructed from whatever portable objects the animal may find. Upon analysis it is usually found, however, that the materials are poor conductors of heat. A sample nest mass constructed by a female from strips of various kinds of cloth, twine, hemp rope, and hair under laboratory conditions is shown in one of the illustrations. The supply permitting, a female carries new materials to the nest site daily and heaps them upon the total mass without attempting to place the individual pieces in any particular order or arrangement. Later she burrows into the mass and with fore-paws and mouth rearranges the materials about her until there is a fairly well formed pocket for herself and young. With only a limited supply of materials available an open top nest is usually constructed and maintained.

UNDER laboratory conditions many rats drag the food dishes to the nest site and push them upon the mound. On several occasions when the halves of condensed-milk cans were being used for food receptacles this tendency of the female presented some rather mysterious phenomena that we came to understand only after a bit of surveillance of the females' activities. Milk cans were found inverted over the mouths of the nests and young rats from five to ten days of age were closely packed into them like sausages of certain well known brands.

Our curiosity upon making this discovery raised the question as to whether the mothers were capable of this dexterous manipulation of young and, if so, what useful purpose it might serve either mother or young. Observation completely unveiled the mystery. The mother simply carried the can to the nest and rolled it upon the mass of shavings and paper of which the nest was built. If the open mouth of the can came to rest over the rim of the nest, the young, which crowd together like young pigs at a trough, crawled into the cans until all available space was occupied.

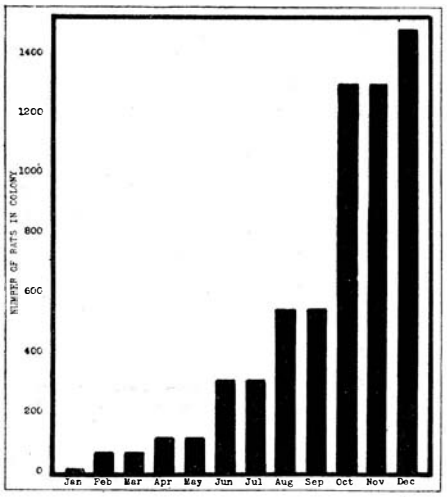
Another phenomenon strikingly absurd to the casual onlooker is seen among female rats whose nesting materials are very limited in amount. At times during the day, but more often at night, the female leaves the nest site and engages in search for more materials to enlarge or repair it here and there. On these occasions she sallies forth to all parts of the cage in search of bits of shavings, paper, or other portable materials.

Even when there is nothing more to be had, the search is continued for many minutes. It is then that the female, having gone to the farther wall of the cage, turns partially around and notices her tail lying on the floor before her. Picking it up in her mouth she starts for the nest, turning around and around until she reaches her destination, where it is deposited and shoved into place with her fore paws before starting on another forage for materials. Such stereotyped activities have been seen to be repeated over and over again in a single evening.

MANY actions of this type strongly suggest the presence of a strong inner driving factor back of the repertoire of maternal responses which finds expression in an abortive manner even though objects normally provoking these responses are absent and only poor equivalents are to be had.

In test situations female rats with new-born young show a remarkable range of ability to adapt their maternal behavior to sudden exigencies of the environment for which they have had no previous training or experience. When given the opportunity to choose between excelsior and pulverised dirt for the next site, the former is usually chosen. Likewise wood shavings are usually preferred to fine dirt. On the other hand dirt is usually selected when the only alternatives are fine sand or sawdust. Generally speaking, materials which admit of making the most stable nests are chosen.

If permitted to elect an illuminated



OPTIMUM RAT PROGENY

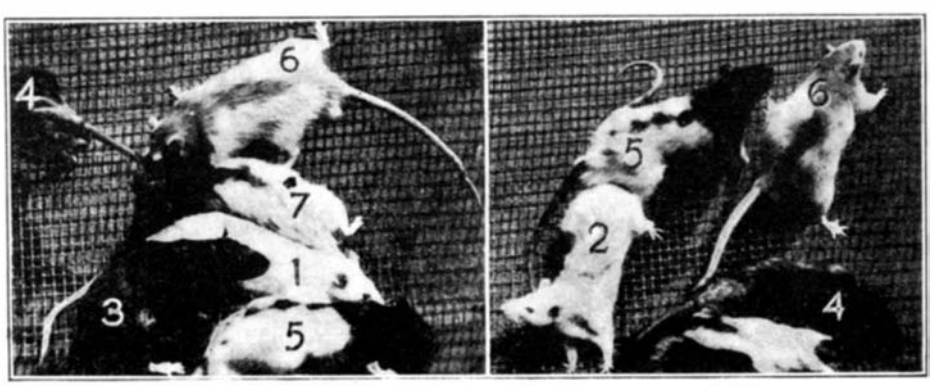
Result from ideal breeding test, starting with ten selected females and two males

or a semi-dark nest site, the latter is usually chosen. Among wild rats, hardly any exception to this rule is found. Both wild and albinos will frequently, although not invariably, move the nest and young back to the dark site daily if they are moved out into the light by the experimenter. You may recall that one seldom finds a wild rat's nest lodged in a well lighted place, as is the case with many of the well known ground birds. They hide their nests and young just as they themselves tend to hide from people and from animals which prey upon them.

Under experimental conditions mothers will usually move their nests and young from strong currents of wind directed upon them, if cage facilities permit of such maneuvers. When air currents are daily directed upon the nests in their new locations, females will usually move nests and young to a quiet zone in relatively short order. Similarly, mothers repeatedly move their nests and young from a source of heat that is much too hot for bodily comfort.

EXPERIMENTS of the foregoing nature are of special value because they indicate the scope and quality of those inborn potentialities of rats, by virtue of which they are able to adapt themselves to very complex life situations. Facts of this nature, seldom coming to the attention of casual observers, help one to understand why the rat is able to perpetuate its kind the world over, even against a perennial host of adverse conditions which temporarily though never permanently hold it in check.

Bases for appreciating the marvelous adaptability of the rat also are to be had by considering it from the standpoint of its educability. Through experiments of this character we can plumb the rat's psychological makeup even better than by a consideration of its instinctive equipment.



A RAINBOW OF VARIEGATED RATS BRED TO ORDER

Number 1 is an albino; 2 is straw yellow; 3 black; 4 brown or agouti; 5 black hooded; 6 yellow hooded; and 7 agouti hooded. Apparently the rats themselves are color blind

The Radio and the Spectroscope

By HENRY NORRIS RUSSELL, Ph.D.

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

THE average citizen has probably never had much to do with the spectroscope, but he is likely to have a fairly good acquaintance with an instrument which is really of very similar nature; namely, a radio receiving set. Different as the two devices may appear, both are designed to separate from a multitude of radiations traversing the ether and falling upon the apparatus those of any desired wavelength, and to record their intensity and behavior.

The radio enthusiast demands two things above all of his receiver: it must pick up sufficient energy from the feeble waves which come from distant or low-power stations to give a clearly intelligible record, and it must be as free as possible from interference between stations operating on nearly the same wavelength. These two qualities, distance-reception and selectivity, are familiar in tens of thousands of households, and exactly the same things are what the astrophysicist desires in his spectroscopic outfit.

"DISTANCE" for him means the capacity to observe faint stars or nebulae. For stars this is primarily a financial question. The bigger the telescope which collects the star's light and feeds it into the slit of the spectroscope, the fainter will be the stars that can be reached with a practicable exposure time; so the great reflectors have this field practically to themselves. To get faint nebulae is a different matter. They are *patches*, not points, of light and a large telescope, although it collects more light, spreads it out into a large image most of which falls outside the spectroscope slit. Success here has come partly by ingenious design, concentrating the photographed spectrum on a small area, and partly by patience in making very long exposures.

Resolving power, as the spectroscopist calls the capacity to separate radiations of neighboring wavelength, is quite another story. To secure it one must design one's instrument so that the number of successive light waves which at any given instant are actually traversing the working part of the instrument is large. That is, if we use a prism it must be of considerable thickness at the base; if a diffraction grating, this must be big enough to have a large number of lines. Practically speaking, then, high resolving power demands a large spectroscope.

When enough light is available, as in solar work or in the laboratory, spectroscopes are often made very large, and spread out the spectrum so widely that the red and the violet are many feet and even yards apart. With the stars, of course, this is impracticable, and a compromise must be struck between the intensity and resolution of the spectrum. A great telescope may have half a dozen auxiliary spectroscopes. The faintest stars will be observed with a small instrument giving a spectrum perhaps a quarter of an inch long, showing a dozen or two of the strongest lines; the brightest with one which yields spectra more than a foot long, on which thousands of lines can be distinguished.

In actual selective power even a small spectroscope surpasses the wildest dreams of the radio enthusiast. It is a poor instrument that will not clearly separate the yellow sodium lines which differ in wavelength by about one part in a thousand. If radio sets could be made as good they would not be seriously troubled by interference between two stations working on wavelengths in the broadcast band different by half a meter, and the tasks of the radio commission would be much less perplexing than they are now. A really powerful spectroscope will do a hundred times better than this, and may be likened to a radio device which would permit of the inclusion of all the present American broadcasting waves within a single kilocycle. (Certain complications obvious to the radio expert which arise from modulation of the waves in broadcasting would make any such result unattainable in practice, however perfect the receiving and sending sets.)

WITHOUT this high resolving power there would have been no hope of observing more than 20,000 separate lines in the solar spectrum, each carrying its own message concerning its origin. Some of the 57 elements which have been identified in the sun are revealed only by faint lines which, with an instrument of low resolving power, are so "fuzzed" out as to be lost altogether. Others are detected by lines which lie so close to stronger neighbors that only a high resolving power will separate them. Even so, there remain many blends of lines which lie too close together for our best spectroscopes to separate. In stellar spectra, where less power can be employed, such blends are often the rule rather than the exception. It is no wonder therefore that observers never cease to desire instruments of still greater resolving power.

We know, however, that nature will sometime set a limit to such an advance. Could we make receiving instruments ten times as powerful in this respect as the best set we have now for working on the sun we would not gain proportionally. For there comes a time when we must consider what the sending instruments are doing.

These "instruments" in the sun or the stars are the innumerable atoms which compose the heated gases of the upper atmosphere and absorb from the

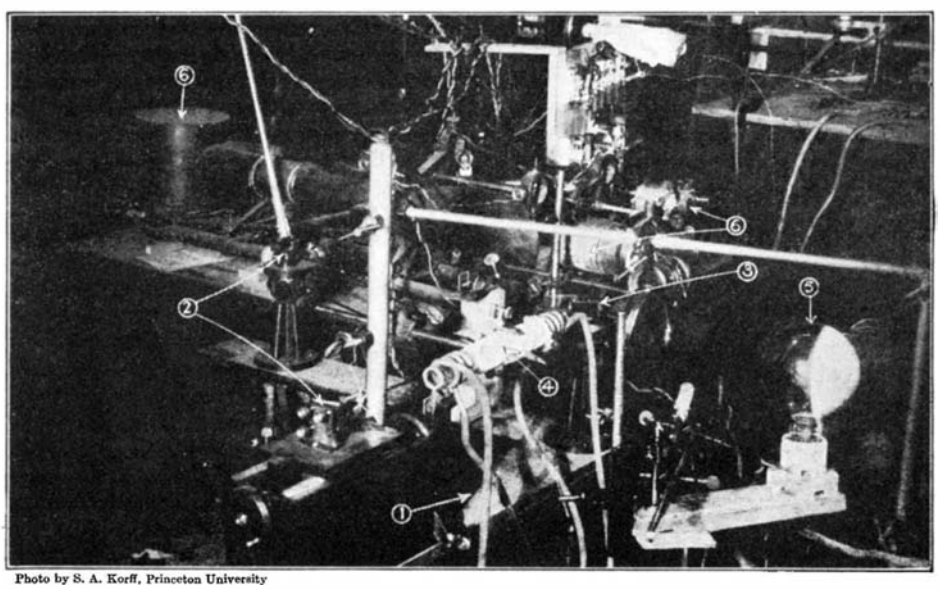


Photo by S. A. Korff, Princeton University

APPARATUS FOR STUDYING WIDTHS OF LINES

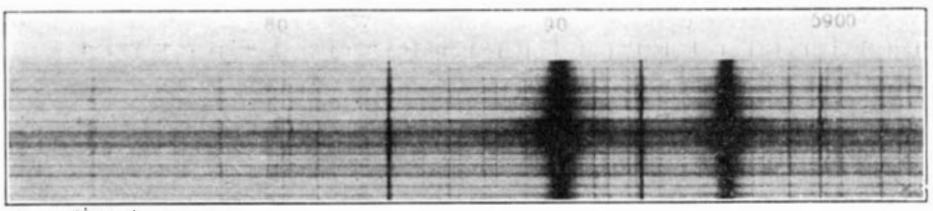
1, Base of Michelson interferometer; *2*, its end mirrors; *3*, its center mirrors; *4*, tube containing sodium or other vapor to be studied in absorption, with central heating coil and water cooling to protect end windows; *5*, source of light, a 1000-watt bulb; *6*, spectroscope for observing or photographing lines. Apparatus employed by Prof. J. Q. Stewart at Princeton

radiation of the hotter layers below the upper atmosphere those wavelengths which correspond to the observed dark lines. The waves which they absorb are of just the same nature as radio waves, but an atom is by no means like the oscillating electric circuits of a radio receiver.

INDEED, no physicist dares today to say very much about the processes which happen when an atom absorbs light waves or gives them out. There is good reason, however, to believe that in the net effect an atom behaves very much like a tiny receiving and sending set of the simplest imaginable sort. We may picture such a set as a simple electron free to oscillate under the varying electrical forces of the light waves, but "tuned" in such a way that it responds naturally to radiation of one particular wavelength. The behavior of such an ideal "oscillator" is much like the more familiar one of an ordinary radio receiving set. We all know that, when a set is correctly tuned to the wavelength of a powerful station, the response comes in loud and strong. Our set is absorbing a large amount of energy (relatively speaking) from the incident waves. But if we put our set a little out of tune with the station we do not lose the response wholly. It fades away gradually as we turn the dial and sometimes remains strong enough to interfere seriously with weaker signals of somewhat different wavelength; that is, our set still absorbs some energy from waves for which it is a little out of tune, although less and less as we go farther out.

The better designed our set is, the narrower will be the band of interference on each side of the wavelength of the powerful station. But perfect tuning is impossible. Even the ideal oscillator, consisting of but a single electron, must have its own region, although very narrow, in which it responds to and absorbs radiations to which it is not exactly tuned. Atoms in a star's atmosphere therefore, even if they behave as well as the idealized systems just described, should not give an absolutely sharp absorption line. Exactly at the right wavelength for which they are tuned they will absorb very strongly and give a very dark line, but a little to each side they will still be absorbing—although ever more weakly—and the observed line will therefore not be sharp but bordered by "wings" gradually fading away into the bright background.

Now all the stronger lines in the solar spectrum (where we can use resolving power enough to make sure that our spectroscopes are not to blame) actually show this winged appearance. For the heaviest, like the great H and K lines of calcium in the violet, the effect is conspicuous on ordinary photographs, and it is easily visible for many others in spite of the fact that spectrum photographs have usually been exposed and developed in such a way as to secure the sharpest detail—that is, to cover up the effect under consideration.



Courtesy Mount Wilson Observatory

A GOOD EXAMPLE OF "WINGED" LINES

A section of the sun's spectrum near the D lines of sodium. The Fraunhofer lines run up and down and the horizontal streaks may be disregarded for the present purpose. The two strongest lines are due to sodium. Their great width is due to "broad tuning" and to the fact that sodium is relatively abundant. In 1924 Stewart calculated that the number of sodium atoms concerned in these lines is of the order of 10^{16} per square centimeter column in the solar atmosphere. The less intense lines are due to atoms of other elements

IT was formerly thought that this widening of the line was due to rather high pressure in the sun's atmosphere (since in the laboratory the lines produced in gas at high pressure are widened). But more careful study showed that under pressure some lines of iron, for example, are far more widened than others of equal strength, while this is not at all the case in the sun. It appeared, in fact, that the widened or winged lines in the sun's spectrum belonged to just those elements which there is good reason to believe are the most abundant, and that the strongest lines of each element are the most heavily winged. This made it clear that these wings depend mainly upon the number of atoms which are at work in producing the line, and this is exactly what should be expected on the basis of electrical analogy. The more atoms there are at work on the line the more will be working a greater amount of time, and hence the more light will be absorbed at a given distance from the center of the line, and the wider the wings will be.

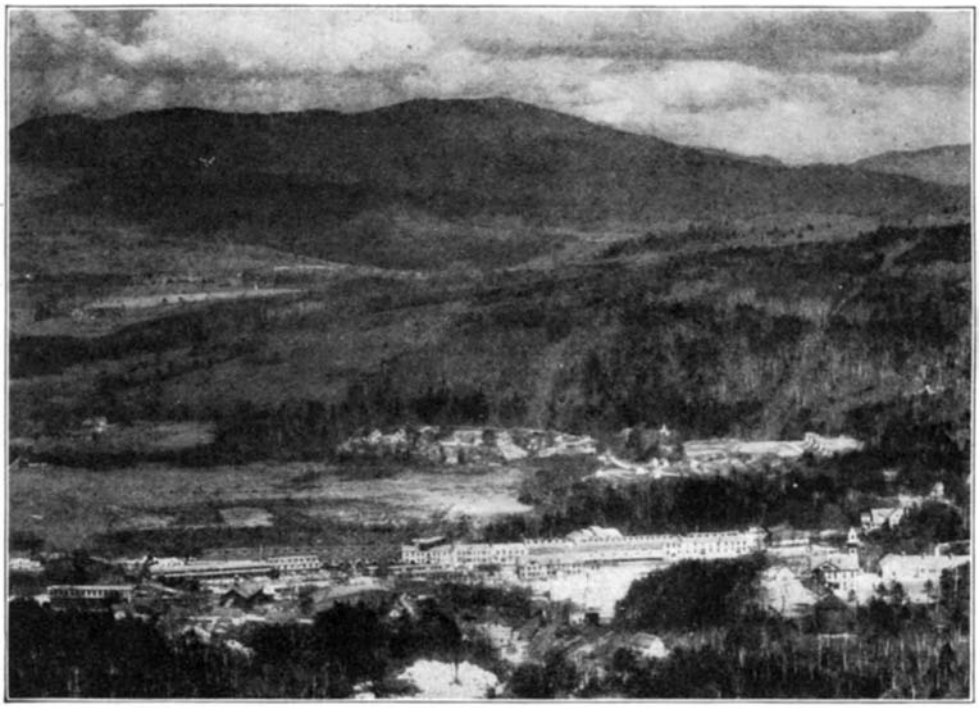
Here then is a new way of studying the sun's atmosphere. It is not merely possible to explain why some lines are wider than others but to calculate how many of the tiny idealized oscillators would be required to produce a line with wings of a given width. The calculations, which were just made by Stewart at Princeton and extended in fuller detail by Unsöld, show that the width across the wings of a line (measured for example from the points where 10 percent of the light is absorbed) should be proportional to the square root of the number of oscillators which were at work. This prediction can be tested, for there are a number of pairs of lines, such as the D lines of sodium or H and K of calcium, for which we have good theoretical evidence that twice as many atoms are at work producing the stronger line of the pair as in the case of the weaker. We should therefore expect the width of the wings to be 41 percent greater for the stronger line.

THE actual widths of the lines are very different, indicating that the numbers of atoms—or at least of "effective oscillators"—which are at work are very different. To produce the strongest lines of all, H and K, Unsöld finds that 27×10^{18} (27 billion billions) of atoms should be required above every square centimeter of the solar surface. The strongest lines of sodium and aluminum demand only about a thousandth part as many. These numbers of atoms are enormous but a cubic centimeter of air under standard conditions contains 27×10^{18} molecules. So the calcium vapor in the sun's atmosphere, if compressed so as to be comparable with air under standard conditions, would make a layer less than half an inch thick, and the vapors of sodium and aluminum vastly less.

In the latter cases allowance must be made for the fact that these elements are largely ionized. But even so, the conclusion seems inevitable that the whole quantity of these metals which are among the most abundant in the sun's atmosphere would, if taken together, make a layer of gas under standard conditions only a few inches thick. As the actual atmosphere of the sun is hundreds of miles deep it must be of extraordinary tenuity.

There is plenty of other evidence to prove this, but none more convincing. There is indeed no need of elaborate calculations or advanced physical arguments. Sir Norman Lockyer more than 50 years ago pointed out that stronger absorption lines are produced by passing light through a flame less than an inch thick and containing a very small percentage of sodium vapor than appear in the whole spectrum on account of the action of all the sodium vapor in the sun's atmosphere.

Sodium lines are nevertheless among the strongest in the solar spectrum (excepting H and K). Lockyer's conclusion that the sun's atmosphere must be of very low density, although forgotten for many years, was entirely correct. — *Pontresina, Switzerland.*



THE VALLEY OF MARBLE

The Green Mountain area contains some of the finest marble quarries in the world. They are now developed with the aid of powerful electrical and other machinery and production is on an efficient basis. Some of the marble comes from a depth of 320 feet below the surface

Quarrying Marble, the Token of Eternity

Ancient As the Everlasting Hills, Marble Furnishes a Lasting Material for Building Construction and Memorials

By A. E. HOLDEN

WHEN man first sought to perpetuate the memory of a great deed, a noble life, a sincere devotion, he turned to the everlasting hills. There he found no useful stone more inspiring, more beautifully simple, or more enduring than marble. The world's oldest statue and its oldest inscription tablet are of marble. The first, believed to be the replica of an ancient Babylonian king, was discovered by Dr. Edgar James Banks of Chicago University among the Bismya ruins of the Mesopotamian desert. George Byron Gordon discovered the marble tablet, its inscriptions still intact after nearly 60 centuries, in the ancient Chaldean city of Ur.

The tradition of the excellence of marble was ancient when the "Golden Age of Pericles" and the reign of Augustus in Rome achieved those classic works of art and architecture which have set standards of design for all the modern world. Nations, states, and families, illustrious and humble, still carry on the tradition by using this pure, inspiring stone for memorials which will pass on to succeeding generations the record of their noblest devotions.

Geologists claim that at one time the whole Green Mountain area from the St. Lawrence to the present site of New York City was under water. Then the shell fish and lime-producing animals began the work of building marble beds. Ages afterward there came a wrinkling of the earth's crust, which displaced the water with mountains and valleys and gave to the Atlantic a new shore line. Thus was Vermont marble formed and buried in the earth. For ages it lay undisturbed.

Before the Revolutionary War, someone split the first slab of American marble from the ledges of Vermont and used it for a fire-place hearth; others heard about the new material, and carried away, in ox carts, the attractive, heat-resisting stone. In the old churchyard at Bennington, Vermont, is a marble tablet which has weathered the storms since 1768—a space of 160 years. It was raised in memory of John Pratt, and unquestionably was one of the first pieces of Vermont marble to be placed in the cemetery.

IN those days, the marble trade was handicapped through a lack of suitable machinery, transportation facilities, and other trying obstacles, until in 1870, there entered the field a man who took a slipshod mill and a half-developed quarry and organized the Vermont Marble Company.

Let us start with the unopened quarry and trace the methods of raising the marble from the Vermont mountains and making it ready for the market. The experienced quarry hunter, when he finds a promising spot, calls for the coring machine, with its revolving drill, pointed with diamonds, which may be sunk to practically any depth. By this means, a cylinder of stone two or three inches in diameter may be taken out, which shows the structure and quality of marble through which the drill has passed. When the conditions warrant further development, a varying amount of waste must usually be removed before sound marble can be reached. The cost of this work frequently amounts to 50,000 dollars.

After more or less dirt and rock have been dislodged and carried away—a process which calls for careful and systematic blasting, the marble floor is ready for the channeling machines. The channeler runs on a movable track, and cuts a groove about an inch in width. When it approaches the end of the track, it is automatically reversed. Thus it goes on cutting its way downward until the groove has been lowered to a depth of several feet. The work is done by five chisel-pointed drills, clamped together in a row and attached to the end of a long bar. The resistless up-and-down motion of the bar forces the row of drills into the heart of the marble bed.

When the quarry floor has been lined with parallel grooves of the required depth, the channelers are run

across at right angles, dividing the strips of marble into squares. The quarry blocks thus formed are known as "key" blocks and are broken off at the bottom by drilling and wedging. After the key courses have been cleared away, the remaining blocks in the floor are split out, at both the sides and the base, by the same process of drilling and wedging.

There are several ways of removing blocks from the quarries. At Danby Mountain, the marble is brought down over a mile of cable track, a drop of about 900 feet. At the West Rutland quarries, a part of the blocks are raised by derricks; others are drawn over an inclined cable track. This track is 500 feet long, and rises at an angle of 45 degrees. On the quarry floor, 300 feet below the surface, it connects with under-ground electric roads which extend 800 feet into the tunnel.

Once the marble is loaded on cars, it is ready to go to the mills. The modern marble mill is constructed of steel. A track, over which the stone is brought in, runs from end to end of the structure. The adjoining space is divided into stalls, any one of which will accommodate a large quarry block. Sawing is done by smooth iron bands, set in a moving horizontal frame, and acting in conjunction with sand and water.

WHILE the soft strips of iron drag to and fro across the marble, the water pours over the top of the block, bringing the particles of sand which serve as teeth for the saws.

In the days of the old mill, a few teams could haul all the sand that was needed. When the business increased, a short cableway was constructed, but the buckets soon began to come back empty. Finally, the cable was extended for two and a quarter miles over the mountain to a larger sand deposit. It now brings in sand at the rate of 500 pounds every 28 seconds.

On leaving the mills, some of the marble goes directly to the monumental shops, some to the building department. If it comes out in the form of thin slabs, it will probably be used for interior building work. Within the shops it may go into one of the large lathes—for marble, like iron and steel, can be accurately turned—or it may be taken to one of the planing or molding machines.

If it is too large, it can be placed under the diamond-disk saw. The rim of this saw contains approximately 125 diamonds, and will cut the hardest marble, if it is well supplied with water. By far the larger part of the marble is delivered at the rubbing beds. There it is held in a fixed position on the surface of large revolving iron disks. The sand and water, which are spread over these disks, take away the roughness and irregularity from the marble faces. Then it is ready for the cutter and polisher.

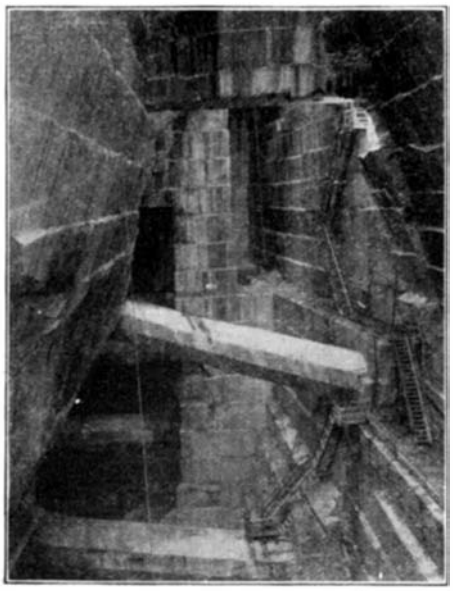
The marble cutter of today can do almost anything with pneumatic tools. He still uses the hammer and mallet now and then—there are times when they are safer and more satisfactory—but ordinarily, the modern workman, even the carver who executes the finest of sculptured work, turns to the chisel that is driven by compressed air.

MARBLE is available in a variety of finishes, and much of it is finished entirely with pneumatic tools. This process often takes the place of sand, hone, or polish. Marble for the interior of the building is usually given a high polish. Large flat surfaces can be polished by machinery. Curved and molded faces must be rubbed down by hand. The polishing machine is a small whirling plate attached to a movable arm. These plates are of several kinds. Like the saws and the rubbing beds, they must be given plenty of water, but they use no sand. The one first employed is coated with carborundum; the second has a face of aloxite; the third is made up of fine hone-stone. The hone finish, which is a sort of dull gloss, is one that is often specified, especially for monumental work. The last plate is covered with felt and is used in connection with polishing putty. In hand polishing, the process is much the same, although more time is required to complete the work.

The "Wellhole," a comparatively recent opening on the West Rutland vein, has, as its name implies, a small opening at the top through which the blocks are raised to the surface. Quarrying in the West Rutland deposit began about the year 1844. The financial results at first were not encouraging. In fact, it took over 30 years to bring these quarries to a satisfactory state of development. In recent years from 400,000 to 600,000 cubic feet of marble have been removed each year, and there is still an almost unlimited quantity available.

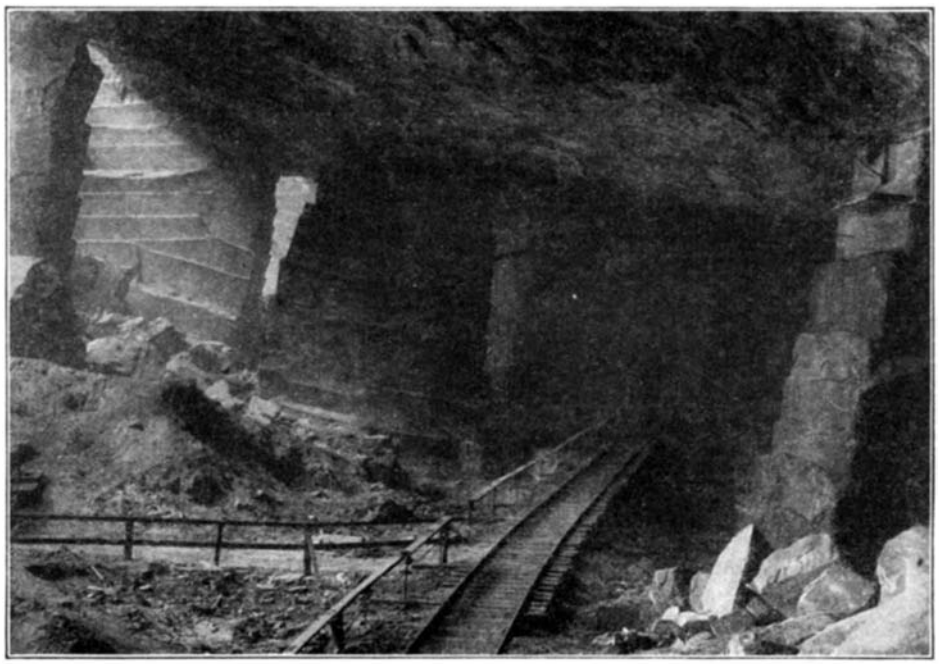
Not counting the various grades of blue marble which lie to the west of the white deposit at West Rutland, this remarkable vein produces 15 different grades of marble for monumental and interior building purposes. These range from the almost pure white to the dark greens.

The obstacles surmounted in the



FOLLOWING A VEIN OF MARBLE

Here marble is quarried at a depth of 320 feet. The lateral pressure is resisted by immense reinforced concrete struts as shown



IN THE UNDERGROUND QUARRY

Huge piers serve to sustain the roof while the electric railway brings the quarried marble to the "Wellhole." It took 30 years to develop these quarries for profitable production

GLACIAL SCRATCHES

This outcrop of marble is interesting on account of the glacial scratches which show that the marble was in place before the great ice cap scraped the hard stones over the soft marble

Pittsford Valley quarries at Florence, Vermont, are suggested by the illustrations. Following a comparatively narrow vein of marble to a depth of 320 feet, the tremendous lateral pressure is held in check by immense reinforced concrete struts. These quarries present to the architect and engineer one of the most interesting developments of the Vermont region.

The Pittsford Valley quarries produce large quantities for cemetery memorials and several varieties of interior and exterior marble. The quarries are notable for the large sizes which are obtainable. Blocks for monolithic columns measuring 32 feet long and over four feet square have been readily secured, the hoisting of pieces of this size being the major problem.

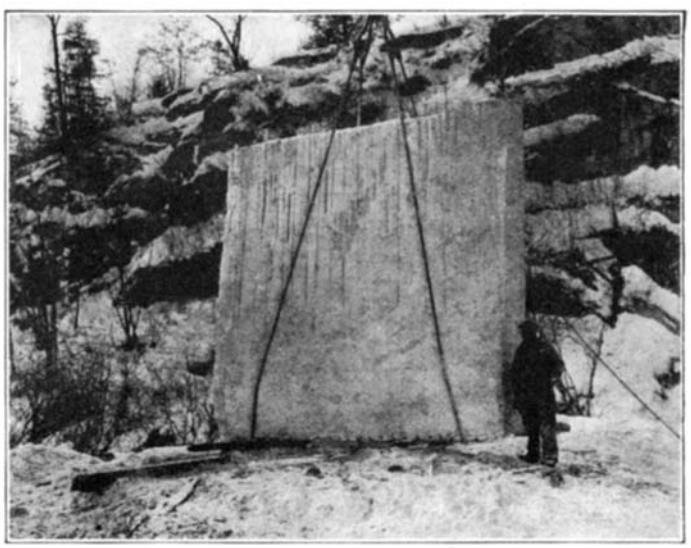
For the Bridgeport Savings Bank, the Pittsford Valley deposit furnished two of the largest caps ever finished in Vermont marble, each containing 117 cubic feet. The pilasters for this structure were made up in three sections, each piece containing 116 cubic feet. One of these blocks weighed 52 tons, another 55 tons.

Verde Antique is the standard dark green marble of America, and was first produced about 1850. The original quarry, located at Roxbury, Vermont, was operated in a limited way until 1893. The earlier methods were crude in the extreme and the quantity of marble produced was very small in comparison to the present output which, in 1924, was over 12 times that in 1901. During the last ten years, several new quarries, all in central Vermont, have been developed. Verde Antique occurs in isolated masses which, roughly, are of the shape of a double convex lens standing on edge. The marble is of such extreme hardness that the quarrying presents a difficult problem. The machinery is the same as that used in other quarries, but specially tempered cutting steel is provided. The finishing also presents an unusual problem. The bulk of this work is done at an especially designed and equipped plant at Swanton, Vermont. There at the lower falls of the Missisquoi River, where water power is available, are 24 saw gangs and a large finishing plant.

The early settlers in the vicinity of Danby Mountain discovered its deposits of marble and, from the outcroppings in the valley, split off pieces for memorials to their dead. Headstones bearing dates as early as 1765 are still standing, their crude lettering sharply defined in spite of the passing years. In 1836, at Erie, Pennsylvania, there was erected from the Danby quarries the first marble public building in America of which there is any record. Constructed originally by the United States Bank of Pennsylvania, it was purchased by the Government in 1850, and is now used as a Custom House. It is still well preserved.

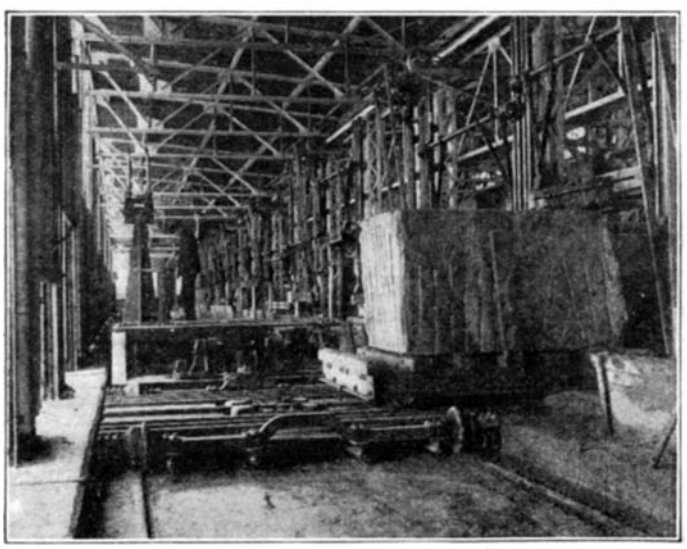
As the demand for marble increased, quarries farther up the mountain side were developed, the blocks at first being drawn down by teams. This crude and dangerous method of handling finally gave way to an inclined railway, operated by immense cables. The steam cutting machines, which were first used, were replaced by modern electric channelers, and there was finally evolved the remarkable quarry development of the present day.

Tunnels have pierced this mountain to a distance of 400 feet, and lateral branches have been added until more than two acres of quarry floor with an average depth of 30 feet, are now furnishing blocks. The quantity production of marble whose quality has been proved by over a century of use is now possible. Storage yards always contain upwards of 15,000 blocks.



A 63-TON BLOCK

It is rarely feasible to quarry just what blocks are required for current orders but there are some exceptions and here is one



A MARBLE MILL

Giant lathes and planers machine the blocks and slabs for building or monumental purposes. Pneumatic tools are very largely used

Sea Safety Inventors Receive Their Reward

THE actual bestowal of the SCIENTIFIC AMERICAN Gold Medal, which had been awarded to Professor Reginald A. Fessenden by a committee formed by the American Museum of Safety, took place in New York City on November 7th last. A distinguished assembly composed of the Trustees of the Museum, the Committee, and invited guests witnessed the simple ceremonies. Mr. Arthur Williams, President of the Museum, presided, and the actual presentation was made by the Hon. Frances Perkins, State Industrial Commissioner. Unfortunately, Professor Fessenden was in Bermuda, owing to illness. In his absence, his son, Major R. K. Fessenden, received the medal and the framed citation signed by all the members of the committee. Referring to his father, Major Fessenden said:

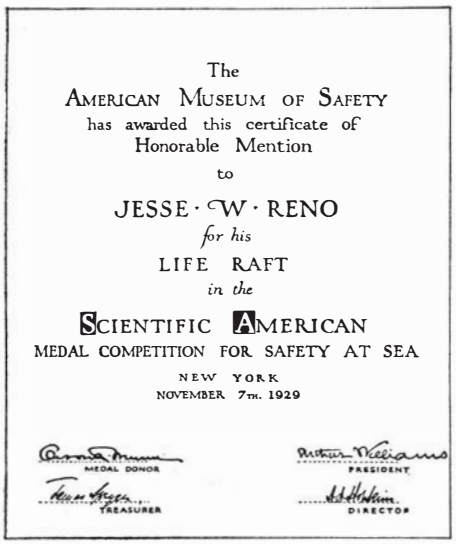
"His brain is as active as ever, but the strain of 40 years of invention forces him to conserve his energy."

Citations of honorable mention in the contest for the medal were presented to A. P. Schat of Utrecht, Holland, Jesse W. Reno, and J. Lyell Wilson, the latter two being present.

Other speakers included Louis S. Treadwell, representing the donor of the medal, which has now been awarded nine times since 1908 and three times for the promotion of safety at sea, and is soon to be competed for in another contest. Messrs. James Speyer, treasurer of the American Museum of Safety; W. D. Baldwin; Robert A. Franks; H. J. W. Fay; and Captain E. T. Fitzgerald, vice chairman of the committee of award, were among those also present.

THE MEDAL BESTOWED

The medal was actually presented to Maj. R. K. Fessenden, son of the inventor, by the Hon. Frances Perkins, State Industrial Commissioner of New York

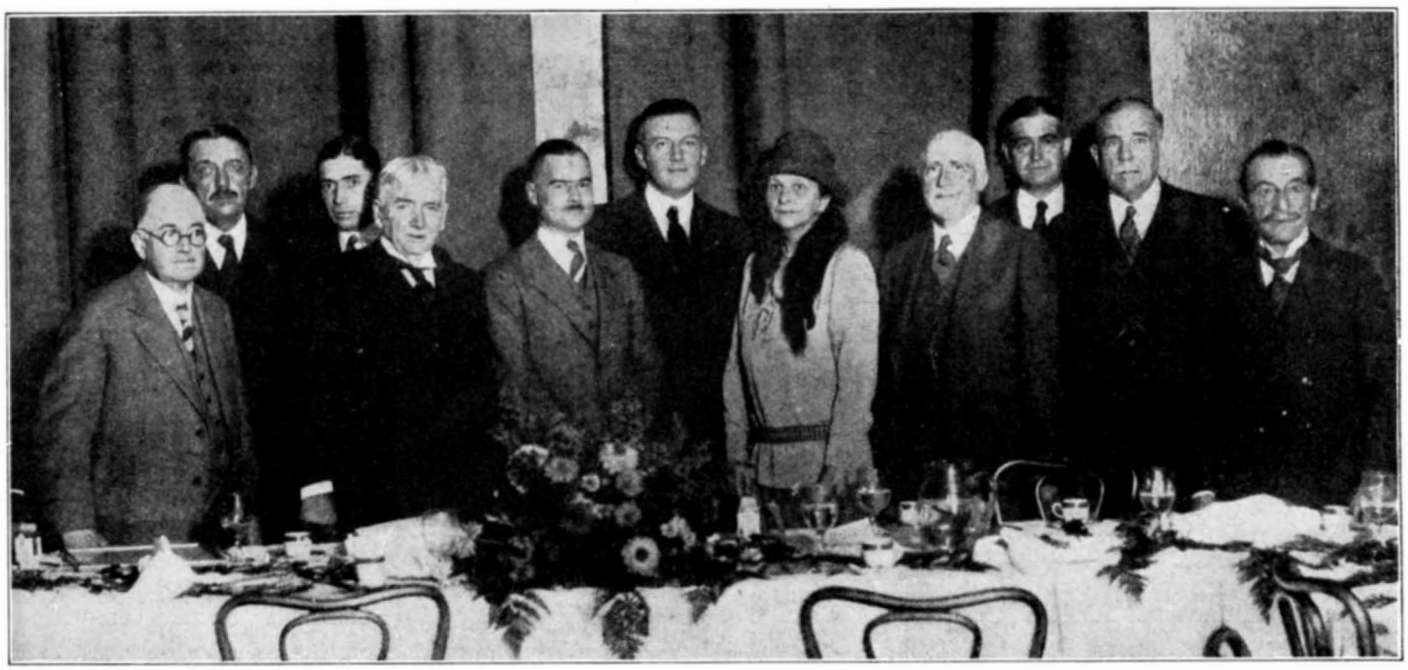


The
AMERICAN MUSEUM OF SAFETY
has awarded this certificate of
Honorable Mention
to
JESSE · W · RENO
for his
LIFE RAFT
in the
SCIENTIFIC AMERICAN
MEDAL COMPETITION FOR SAFETY AT SEA
NEW YORK
NOVEMBER 7TH. 1929

MEDAL DONOR — PRESIDENT
TREASURER — DIRECTOR

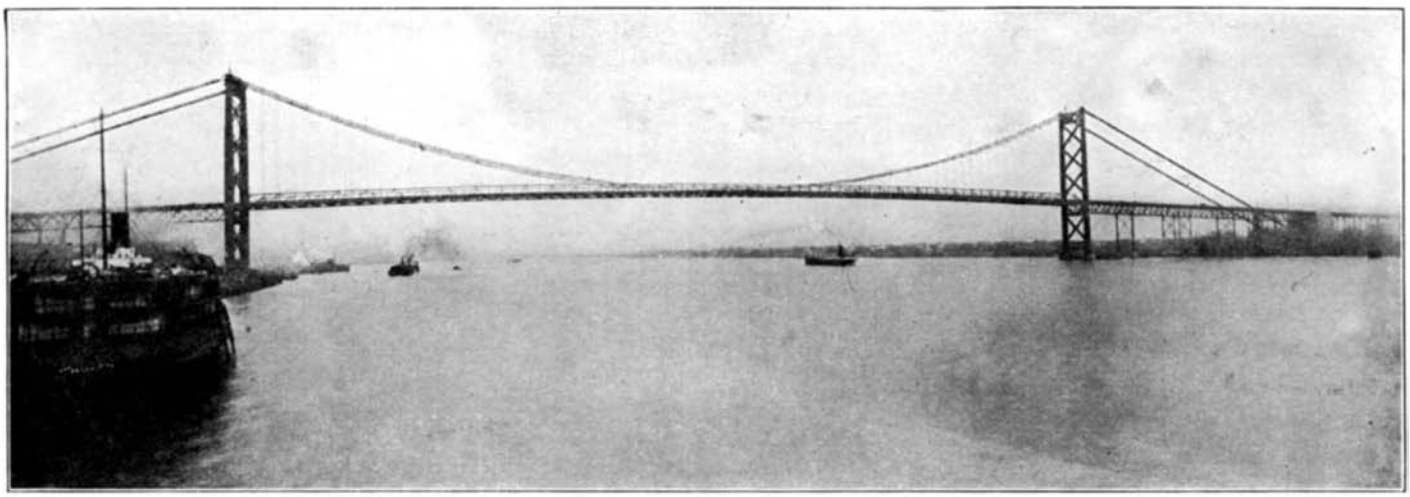
HONORABLE MENTION CITATION

One of the three Honorable Mention Citations. These honors were conferred at the luncheon. The winners are shown below



A GROUP OF DISTINGUISHED GUESTS

From left to right: Mr. A. A. Hopkins, Secretary of the Committee; Mr. H. J. W. Fay; Mr. A. Methofer, Consul for The Netherlands; Mr. Arthur Williams, President of the American Museum of Safety; Mr. J. Lyell Wilson; Major R. K. Fessenden; Hon. Frances Perkins, State Industrial Commissioner; Mr. Jesse W. Reno; Mr. L. S. Treadwell, Vice-President SCIENTIFIC AMERICAN; Mr. W. D. Baldwin; and Mr. James Speyer, Treasurer of the American Museum of Safety. The luncheon took place in the Union League Club, New York City



"BECAUSE OF, AND FOR, AUTOMOBILES"

Tremendous increases in automobile traffic, by ferry, between Michigan and Canada made this bridge necessary. It connects Detroit with the great Ontario peninsula between Lakes Ontario and Erie and cuts many miles from the trip north to Niagara Falls

The Detroit River Is Spanned

At An Extremely Important Point, Economically, a Beautiful Bridge at Detroit Has Largest Span in the World

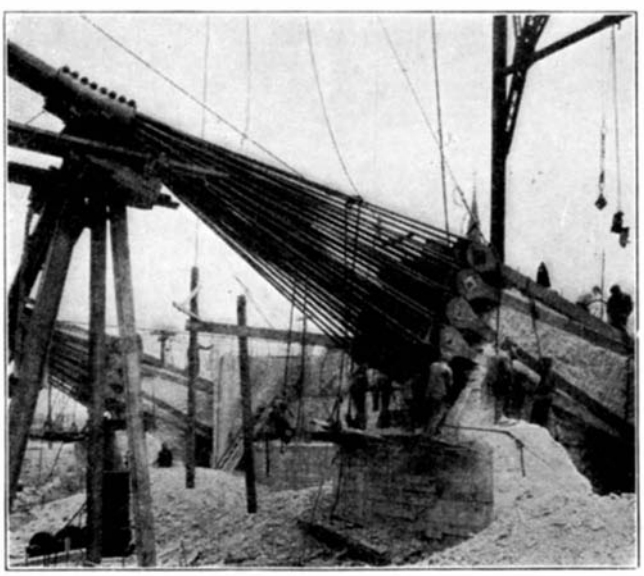
BY F. D. McHUGH

BRIDGE engineering has reached such a stage of design today that one expects to find a certain massive beauty in any new span that rises. Slim skeletons of steel pointing skyward from river or river bank piers and holding high their thin webs which, in turn, support a gracefully curved floor, all seemingly conscious of the combined estheticism and utilitarianism that have been worked into their design by skillful engineers, grip the imagination and give rise to a feeling of pride in the works of man.

When, however, such a structure becomes also a new tie to bind two great peoples into a closer friendly relationship, when it serves to promote the exchange of raw and manufactured products, and when it removes another section of the physical barrier between one country and its best customer and source of outside supply, it has an added significance; it is a "most important contribution to international amity." Such a bridge is the appropriately named Ambassador Bridge over the Detroit River between Detroit, Michigan, and Sandwich, Ontario, which has just been completed and was dedicated on November 11, 1929.

WITH the longest main span of any suspension bridge in the world at the present time, the Ambassador Bridge was built because of and for automobiles. In the olden days the missionaries Brebouf, Chaumonot, de la Richardie; the explorers Joliet, LaSalle, and Cadillac; the chieftains Pontiac and Tecumseh; and the generals Brock and Harrison had to cross the natural barrier of the Detroit River in boats. With the rise of the so-called border cities there was much agitation for the bridge. Just prior to construction of the present bridge, a bridge to include a deck level for railroads was contemplated and almost decided upon; but this, along with other bridge ideas, had to be abandoned because of the tremendous increase of automobile and bus traffic. The completed bridge provides primarily for automobiles and incidentally for pedestrians.

The location of the new bridge is unique in that three great general trade routes intersect at this point. These are the Canadian routes from the north and west which terminate in the east in Montreal, Quebec, and other eastern Canadian points; the American trade lines from east to west across the peninsula and eastern Ontario; and the Canadian-American trade route connecting the Canadian east with the American middle west, far west, and south. Thus it will be seen that the location has the economic significance of the famous caravan cities of the ancient Oriental countries.



TWO ANCHORAGES

Cutting away the concrete from around the cable terminal eye-bars. This shows the manner in which cable terminals and eye-bars are finally embedded in massive concrete

DURING a recent six months' period, customs figures show that 135,000 tourist cars crossed the border at this point while the estimated total, including holiday and week-end visitors, was 675,000 cars. With an average of four and a half persons per car, this would give a traffic of around 3,000,000 passengers during that period of time. It is anticipated that completion of the bridge will tend to increase this traffic to a very large extent because of the fact that from any point north of Chicago, the bridge route to

Niagara Falls is very much shorter than the route by Cleveland, as shown by the following table:

From	To Niagara Falls Via Bridge	Via Cleveland	Saved
Detroit	254	391	137
Chicago	543	578	35
Grand Rapids	401	505	104
Battle Creek	369	446	77
Kalamazoo	393	470	77
Fort Wayne, Ind.	422	432	10

Many problems were encountered in preparing the plans for the new bridge. Early surveys were inaccurate; clearance of the bridge above water was first made too low, inasmuch as ship's masts have lately been made higher due to the demands of improved radio equipment; the span of the bridge was originally planned to be 1770 feet.

THE main span of the bridge is 1850 feet and the suspended floor clears the water 150 feet at the center and 135 feet at the towers. The bridge itself is 9000 feet long from the end of one approach to the other, 7400 feet of this being structural length. The Canadian approach is 2420 feet, while that on the American side is 1480 feet. The approaches on both sides spread out into wide plazas and each approach has nearly 30 customs and immigration gates for expediting traffic and preventing traffic tie-ups. There are two towers approximately 380 feet high above mean water level, each resting upon two 38-foot concrete cylinders. The dead load on each cylinder is about 20,000 tons.

Two great cables, each 19⅜ inches in diameter, support the roadway and stiffening trusses. These cables are swung on 67-foot centers and rest upon massive rocking cradles on the tops of the towers, these cradles being designed to take care of any expansion due to temperatures up to 120 degrees.

FROM THE CANADIAN TOWER

Cables, suspender ropes, catwalks, and floor can be seen in this view of the bridge

The total width of the suspended roadway is 55 feet, 47 feet of this being divided into five vehicular traffic lanes and the remaining 8 feet being a sidewalk.

Construction on the bridge began on May 7, 1927 and proceeded so rapidly that it appeared it would be completed long before the scheduled date of August 16, 1930. Then the unforeseen occurred.

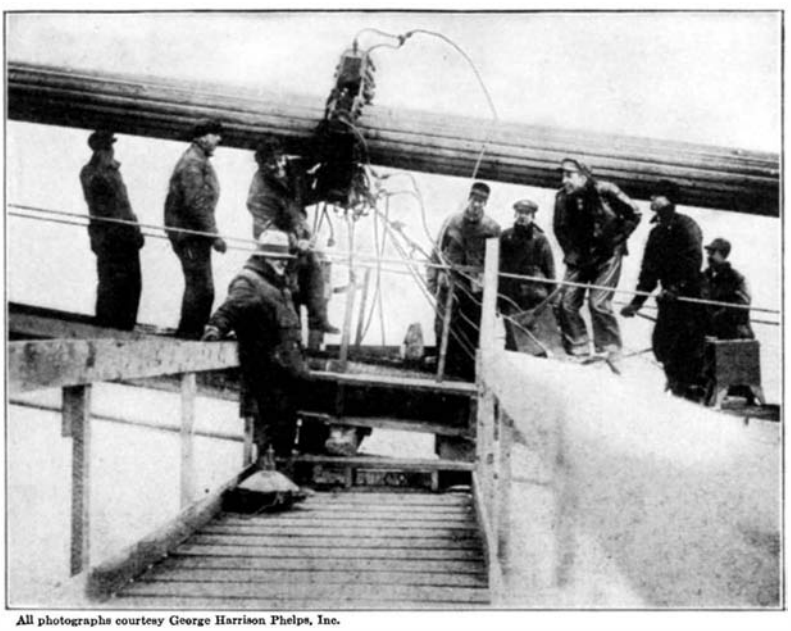
The great cables had been erected; the two foot-walks used in spinning the cables had been removed, cut into sections, and the sections used as suspenders for holding the bridge floor; and a part of the roadway structure had been erected when news of breakages in a similar structure, the Mount Hope Bridge, was received. No important breakages had been found in the cables of the Ambassador Bridge, but they were assembled from a new steel wire exactly the same as that used in the cables of the Mount Hope Bridge and produced by a special heat-treating process. Therefore it was decided to scrap the cables before something serious did happen and replace them with cold-drawn steel wire that was known to be dependable for suspension-bridge work.

Riveted girders that had been placed at the roadway were taken down, new cables to hold two new catwalks were made ready, and the catwalks themselves put up. Then when the suspender cables had been removed, everything was ready for the work of dismantling the cables.

THE cables themselves were composed of 37 compacted strands of Number 6 galvanized wire, each strand containing 206 wires. Back at the anchorages the concrete was broken away so that the end of a strand could be gripped and pulled from the cable by means of a hydraulic jack. The removed strand was then cut with an oxy-acetylene torch into lengths of about 30 feet which were, in turn, hauled along the catwalk to the towers and then lowered by crane to be carried away and sold as scrap.

The cold-drawn wire of which the new cables were to be spun was ready when the process of disassembly was completed. This work of destruction had taken but 20 days. Spinning of the new cables proceeded rapidly and the bridge was completed long before the date originally scheduled for its completion. It was dedicated, as stated above, on November 11, 1929 and was opened for traffic on November 13.

The Ambassador Bridge is the property of the Detroit International Bridge Company. It is expected that tolls will pay for the structure within a comparatively few years.



All photographs courtesy George Harrison Phelps, Inc.

COMPRESSING THE STRANDS

A compressor similar to the one described in a previous bridge article, with radial hydraulic jacks, press the strands into a round section

WRAPPING THE CABLES

This machine wraps a binding of soft iron wire around the cables, 300 miles of wrapping wire being used

AN OLD MASTER'S CONCEPTION OF HELL

Christ's Descent Into Hell, by H. Bosch, a Flemish painter (1462–1516). Early writers who wished to depict a horrible hell and thus frighten the common herd into better morals would doubtless have used with avidity the modern scientist's knowledge of heat and cold

A Modern Inferno

What the Civilized World Owes to the Scientific Research of the Modern Chemist

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

CHEMISTRY is a branch of knowledge especially wrapped in the cloak of mystery which that non-existent individual, the average man, is inclined to throw about any matter which he considers difficult or profound. Until recently very little has been popularly known about it. Despite the dramatic horrors of the World War and later widely advertised discoveries of tremendous business importance, the word "chemist" still evokes mental images of the owner of the corner drug store.

Although the realm of chemistry is one of the most fascinating and absorbing fields of human thought, one can as a rule obtain little general attention to it. It has had, so to speak, no "sex appeal."

IT still remains for some one to do for it what H. G. Wells has done for history and Will Durant for philosophy. It shares with astronomy the honor of being the oldest branch of man's knowledge of nature and none has had a greater influence upon the course of civilization. The history of the human race is more truly reflected in the story of the progress of science than in the narrative of political biographies and names and dates of military conflicts that has long held the name.

In the records of the earliest Egyptians it is found that simple chemical experiments were communicated from generation to generation of priests who practiced them as a form of magic to befuddle the uninitiated. One frequently hears the science referred to as the Hermetic Art, from an old priestly devotee, Hermes Trismegistus. The

Courtesy Linde Air Products Company

6300 DEGREES HOT

The oxy-acetylene flame cuts through solid metal like a warm knife through butter. What would early science have thought of it?

Greeks had systems of natural philosophy which included chemistry and these, too, have transmitted their cultural influence to our own time. The commonly used phrase "exposed to the mercy of the elements" refers to an early conception of the chemical elements. The problem of the nature of matter is still a fundamental one.

A belief of the same period was that all matter is composed of four primal things, or elements: earth, air, fire, and water. Aristotle was struck by the inadequacy of such a conception to explain the existence of the varieties of matter which he saw about him. He invented a fifth element, the "quinta essentia," the sublimated essence of everything, to account for the very apparent discrepancies. It survives in the word "quintessence."

ONE might be inclined to think that it hardly required a monumental intellect to decide that a silver coin was not made of earth and fire even though they were employed in its manufacture; but the ancients and especially the Greeks were lacking in the methodical experimentation which is the cornerstone of modern science.

Most of the knowledge of the ancients was acquired more or less by accident. If it had practical value it was practiced as an art by rule-of-thumb methods. Nevertheless they

were remarkably efficient in many things which are today regarded as highly technical operations—the manufacture of glass and porcelain articles, the metallurgical processes and the fabrication of swords and implements with cutting edges. Some things which they knew have become lost arts and have not yet been rediscovered. It is highly doubtful that the modern "mortician" could embalm a body so that it would remain in the truly remarkable state of preservation for thousands of years exhibited by the mummies in museums.

We could, if space permitted, trace the story of the science of chemistry among the Romans, the Arabs, the Chinese, and during the Middle Ages, and point out fascinating little bypaths for reading — such widely unrelated things as that the caliph Al Mansur, of Arabian Nights fame, was a patron of the alchemists, the medieval ancestors of the modern chemists, and that the romantically mysterious cult, the Rosicrucians, had vaguely chemical aspirations. Incidentally, the private lives of a few of the chemists would rival the pages of the daily tabloids for human interest.

IT is the modern science of chemistry which is the greatest miracle and its story begins about 1770 with the great French chemist, Lavoisier. It begins to differ from its ancient forbears by the introduction of the so-called "scientific method." This is a system of logical thinking, characteristic of all modern sciences, the result of a slow process of growth during a relatively short time, the last 200 years. Like many another thing it is a matter which, from the everyday viewpoint, is more clearly and easily illustrated than defined. It consists chiefly in the careful observation, classification, and explanation of the facts of nature, with laboratory experiment under regulated conditions. Largely by the genius of Lavoisier was such systematic method introduced into chemistry, and the French people showed their appreciation of his work by sending him to the guillotine during the Revolution.

But there were many at the same time and later to carry on his work, men whose names have become household words in the science—Scheele, Priestley, and Berthollet who made fundamental observations, Dalton who formulated the basis of the modern atomic theory, probably in its present form one of the noblest and most daring bits of speculation ever developed by man. Then, too, there was Faraday who studied the nature of electricity, which has since progressed to where the following old joke has lost its point: A professor of chemistry was lecturing on electricity to his class and happened to notice a student in a rear bench who was apparently fast asleep. He waited for a few moments to make certain of his observation, in the true spirit of science, and then addressed the impolite undergraduate very sharply:

"Mr. A., what is electricity?"

Jolted suddenly into consciousness, A. rose slowly to his feet and, mustering all the resources of a college education to a situation which was probably not unusual, answered the unheard question with a stammering:

"Er . . . I knew this morning, but I have forgotten."

"What a pity," replied the professor, "the only man in the world who knew what electricity is and now he has forgotten."

The modern chemist and scientist can tell, however, what electricity is with a degree of confidence. Electricity is matter. Matter is also electricity. The two are reduced to one, although we do not know which one it is, and that too is an interesting story.

Then there were Davy, Berzelius, Liebig the father of agricultural chemistry, Dumas, Kékulĕ, Mendelejeff, Ostwald, Perkin, the Curies, and a host of others who laid the foundations of the many branches of modern chemistry.

Within the last 30 years chemical knowledge has grown like a snowball rolling downhill, until the chemist's laboratory is the land of marvels. One of the foremost reasons for this has been the increase in the methods by which the scientist is able to control the conditions of his environment. Examples are too numerous to give in detail, so let us choose merely one as an illustration—temperature.

High and low temperatures enable us to produce many things that are not to be found in the heavens above, the earth beneath or the waters that are under the earth. About us we find a relatively narrow range of variation. In the habitable portions of the earth's surface the thermometer rarely goes below −40 degrees in winter and above 115 degrees in the summer. For centuries the temperature of ice, 32 degrees, and that of an open fire, about 1600 degrees, remained the greatest variation that man could produce for himself.

EARLY LABORATORY METHODS

An early method of heating laboratory apparatus, from "A Compleat Course of Chymistry," by G. Wilson, London, 1709

YOU recall the poet Dante's immortal story of his visit to Hell, and of the souls of the historically famous and infamous damned who were being tortured there by exposure to the torments of the extremes of ice and fire. The grandeur of the poetry will probably never be surpassed. But the modern scientist's only comment upon the scene it pictures is upon the poverty of the omniscient imagination which would employ such altogether ordinary temperatures to produce the desired effects. The scientist has liquefied air by cooling and compressing it and allowing it to expand repeatedly. The product is a pale blue liquid which resembles water from a distance but has a temperature of −310 degrees. In comparison, a cake of ice is literally red hot. By a similar process applied to helium he has produced a temperature below −458 degrees or less than 1 degree above absolute zero, the lowest temperature which can possibly be attained.

On the other hand, going up the scale, he can burn a mixture of ordinary illuminating gas and air in a blast lamp and obtain a temperature of 2700 degrees; with an oxy-hydrogen torch, 3600 degrees; and with an oxy-acetylene flame, 6300 degrees. The latter will cut through a quarter-inch steel plate with about the same ease that a hot knife goes through a cake of butter. Then in the electric arc

he can produce temperatures which are limited only by the resistance of the furnace itself as it melts and breaks the circuit, the highest temperature so far being about 9000 degrees or more than half the estimated temperature of the sun.

Picture for yourselves the sublime heights of torture which could be attained in an inferno properly designed and equipped with up-to-date heating and cooling devices by the scientist, and compare it with the feeble attempt of the theologist. For the scientist, of course, these are merely the tools with which he works, but with them and others he achieves the wonders which distinguish the present world from any which precede it.

The extent to which this age is indebted to the chemist and the science of chemistry is boundless. There is no phase of man's activity which has not been profoundly influenced. In an age of machines and tremendous engineering attainments he supplies the materials—iron, steel, concrete—of which they are made in an endless stream, improves old ones, devises new ones to take their places, and makes processes of manufacture ever cheaper and cheaper.

IF the true test of human greatness is, as has been said, that of making two food plants grow where there was only one before, then here, too, the chemist has a just claim. By study of the soil and the growth of plants he has been able to double and triple the productivity of a given piece of land. With the help of the engineer he has been able to make the desert blossom as the rose, and render altogether unproductive areas fertile. He has delayed to a much later date Malthus' mournful prediction that within a comparatively short time the increase in the population of the earth will starve the human race to death. By scientific methods a very small portion of the United States could today feed the entire world.

In politics, too, the chemist quietly plays a prominent part. Histories of Europe of older days recorded the interplay of political forces as an attempt to maintain very delicate balances of power. Today a much more important matter is that of maintaining a balance of steel production, and one can better understand the desires of nations for disputed bits of territory if he consults a map of the location of iron ore and coal deposits than by consideration of vague feelings of racial fraternity. Military power itself is maintained more by high explosives, poison gas and flame, and the materials for producing and employing them than by the mere number of available soldiers. These are all essentially chemical problems.

Sociology seems to be as far away from the activities of the chemist as anything reasonably could be. Even here one of the pressing questions of the day is the solution of the drug and narcotic difficulty. It has been said, and many believe, that the synthesis of morphine recently reported will solve it, and one can be hopeful when he considers the achievements of the past.

America's great contribution to civilization has been a democracy that works. Here chemistry plays a major role. Chemistry is the great agent of democracy. You can declare men equal by legislation but that which really makes them equal in their own eyes is equal opportunity to satisfy their desires. Although closely related, men value the ability to enjoy the luxuries of life above mere cold equality before the law. Chemistry has placed the luxuries of life within everyone's reach. There was a time when a certain purple dye was so expensive that it could be purchased only by the very rich, and the wearing of the purple was synonymous with wealth or noble birth. The chemist has analyzed Tyrian purple and made it so cheaply that all may have it, then discarded it for others of greater beauty and more lasting value. So has it been with precious stones as the ruby and sapphire, and with the more beautiful of the textiles such as silk.

At present we are writing another interesting and important chapter in the story of chemistry—Chemistry in America. Many are the marvels of applied science but these are based upon the discovery of the principles of science itself—pure science as it is called. This in turn rests upon the abilities of men who in the quiet and isolation of their laboratories devote years to the researches which will never be rewarded by the plaudits of the crowd or the luxuries of riches. Rarely does the pure scientist also discover the practical application for which these are the compensation.

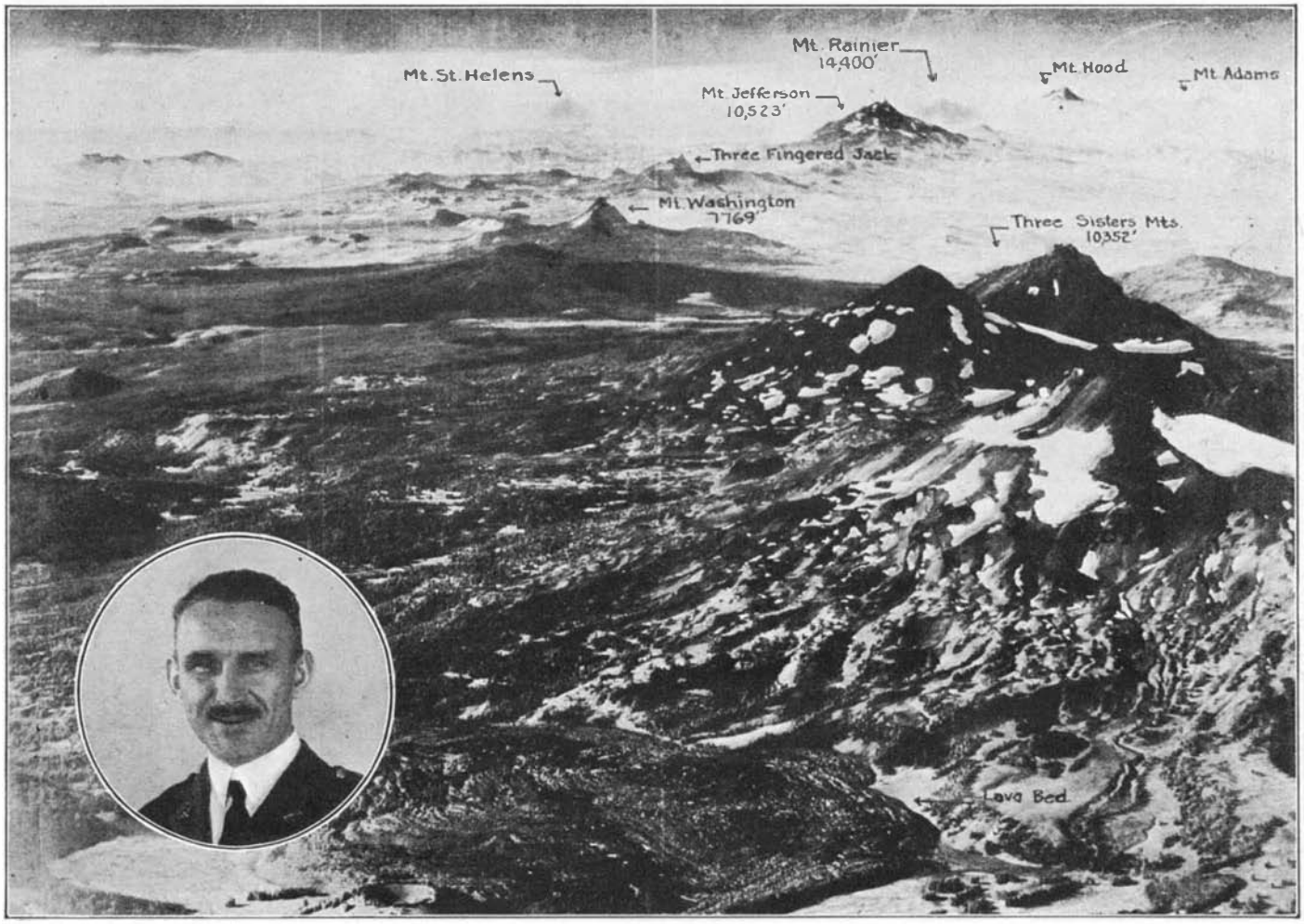
Yet it is upon the labors of these men that the progress of science depends. This is a matter to which it would be well to devote serious thought. A famous educator recently deplored the loss of able scientists from the universities and colleges to industry which can pay better salaries. The fact is true, but one is inclined to doubt the reason. If human experience proves anything, rarely have the feet of genius been led from the path of loyal devotion by poverty or physical suffering. Again, in many branches of science such work today is more highly paid than similar work in industy.

The statement may be interpreted as a serious criticism of the home of pure science itself—the colleges and universities. Often the positions of rank and eminence in their departments are held by men not at all distinguished by achievement, intellect or culture, but rather by the possession of that qualification so aptly described by Cabell as a much surer means of advancement. As a result, to the delicate sensibilities which always mark the man of intellect the situation frequently means intellectual suicide. He goes into industry because, whatever may be the unquestioned faults of the dollar as a standard of value, it has at least the advantages that it is impersonal and objective, two attributes imperative in the scientist.

Courtesy Linde Air Products Company

TEMPERATURES EARLY CHEMISTS NEVER DREAMED OF

"Picture for yourselves the sublime heights of torture which could be attained in an inferno properly designed by the scientist, and compare it with the feeble attempt of the theologist"



Illustrations courtesy Eastman Kodak Company

AERIAL PHOTOGRAPH SHOWING PEAK 227 MILES FROM THE CAMERA. INSERT: CAPTAIN STEVENS

Army Flier Secures Record Photograph

USING a special camera equipped with film sensitized to the infra-red rays that penetrate smoke and haze, Captain A. W. Stevens, of the Army Air Corps, recently photographed Mount Rainier, in the state of Washington, from a point 227 miles away. Flying at an altitude of nearly 17,000 feet above a landmark that could be identified on a map, Captain Stevens pointed his camera in the direction of Mount Ranier and took his pictures despite the fact that he could not see his objective. When the photographic negative showed that Mount Ranier had been recorded, the distance was measured on a map from the mountain to the landmark over which the record-breaking picture had been taken.

Captain Stevens is head of the photographic branch of the Air Corps stationed at Wright Field, Dayton, Ohio. His pilot was Lieutenant John Corkille, also of Wright Field. Last winter the same fliers made a picture from an altitude of 37,854 feet, higher than a camera had ever been used before, using the same type of equipment. The War Department authorized the flights because of the valuable contributions to military photography that are expected to result from Captain Stevens' experience.

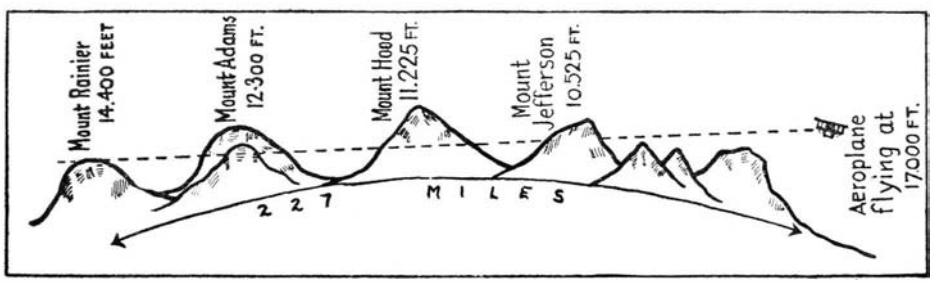
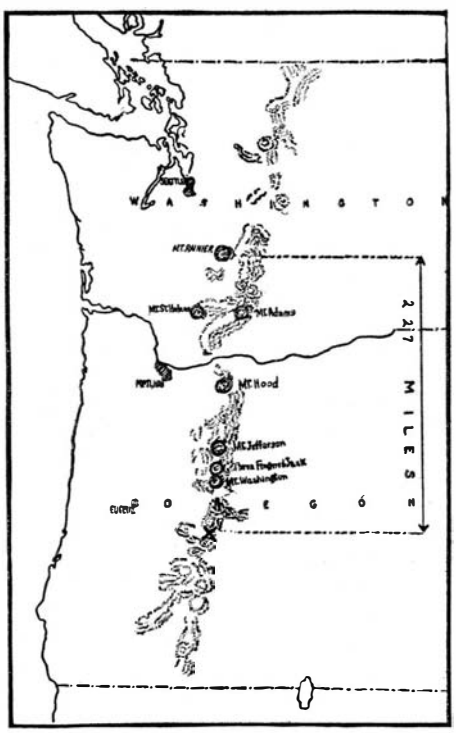


DIAGRAM SHOWING CURVATURE OF THE EARTH

Although Mount Ranier has an altitude of 14,400 feet, it seems to be lower than Mount Jefferson, which has a height of 10,525 feet. This is due to the curvature of the earth



TOO FAR TO SEE

Although the mountain was invisible, it was recorded on the sensitized film

Painting With Light in Barcelona

Spectacular Electrical Lighting Effects Enliven the Spanish International Exposition

THE Barcelona International Exposition, located near the outskirts of the city on the slopes of the mountain of Montjuick, occupies nearly a square mile. Taking advantage of the exceptional natural position of this mountain side, the planning architect, Don Carlos Buigas, worked out a system of illumination which surpasses all that has been done heretofore in exposition lighting.

The idea dominating the entire project is the absolute suppression of direct lighting. Illumination is obtained in all cases by indirect means, either by concealing the lamps and reflectors in corners, or in decorative "motifs" of the buildings' piazzas and façades. By mounting lights within luminous crystal elements of attractive design, fantastic imitations of flowers or plants are obtained.

In addition to the light obtained by such methods, additional illumination is produced by colored lights submerged in the innumberable fountains and cascades located within the decorative area.

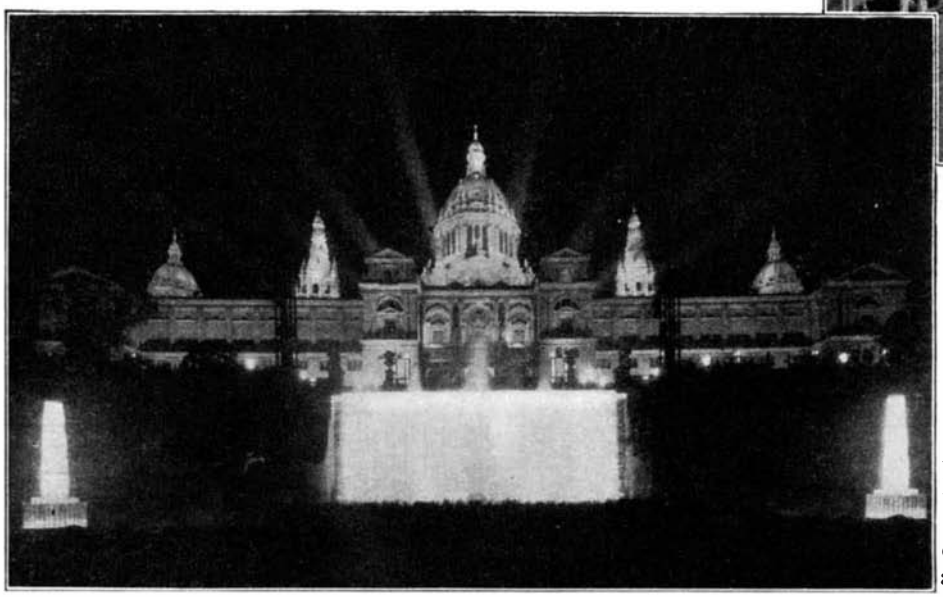
As in other electrically illuminated fountains in America and abroad, the lighting effects are made to vary in intensity and color to suit the fancy of the operator.

Control of all illumination at the exposition is centered in a tower at the main entrance. This arrangement was adopted in order to make it possible for a lighting expert to look out over the entire decorative area and "paint" the exposition grounds with any color effect he might desire. The controls are operated from a switchboard of special design.

One of the most effective displays is a mobile lighting program, automatically controlled, which consists of waves of colored light, flowing in rythmic succession over the entire exposition grounds. For example, a white wave appears at the National Palace, progressing slowly through the various cascades and fountains toward the Plaza de Espana. As the white wave reaches Reina Maria Cristina Avenue, a yellow wave leaves the National Palace and follows the path of the first, at the same rate of speed. The wave of yellow light is succeeded by one of red, and finally by another of blue. The waves progress at the rate of less than ten feet per second,

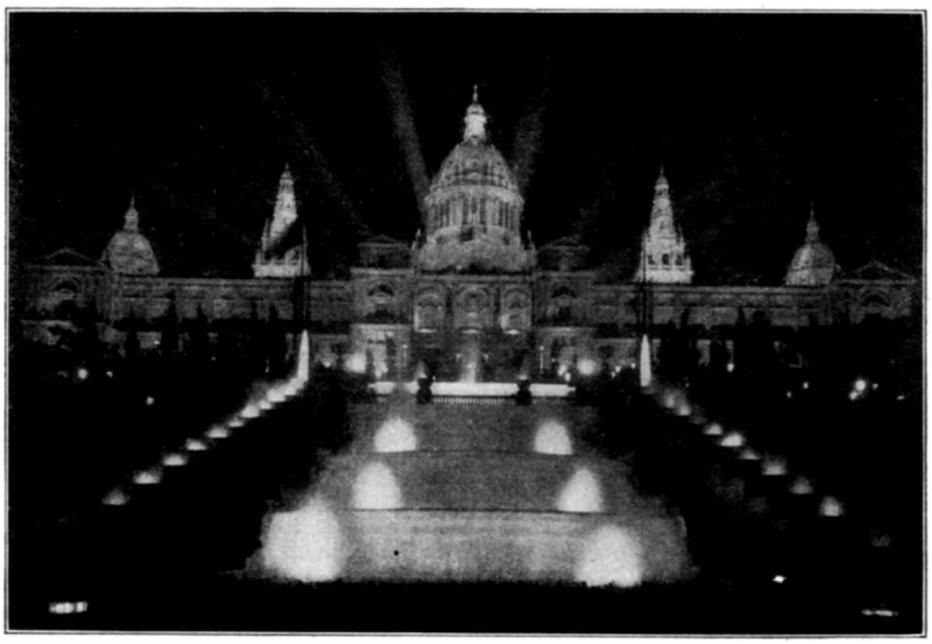
THE EXPOSITION GROUNDS

Looking up the principal avenue toward the Palace, art center of the exposition



ABLAZE WITH COLORED LIGHT

Fountains and cascades in ever-changing colors dominate the decorative display



THE "NATIONAL PALACE"

The Palace against a black background with an aurora of colored light beams

and the entire program lasts about ten minutes.

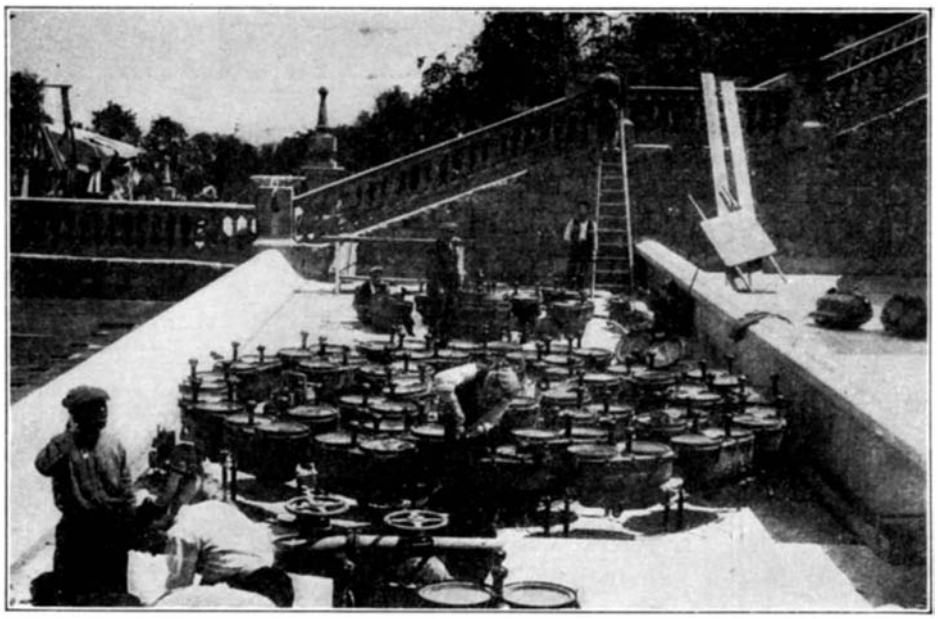
The total electricity required in the decorative area for illumination and lighting effects is about 5232 kilowatts. It would have been almost impossible to regulate this current by direct means, since it would have been necessary to use cable of inadmissible size, and control apparatus of undesirable dimensions. By means of a system worked out by lighting engineers of the Westinghouse Electric and Manufacturing Company, the entire illumination system is powered and controlled by comparatively simple means.

The plan utilized in this system provides indirect control by means of pilot lines of extremely small diameter. This is made possible by using special three-coil reactors, wound on iron cores. The two outside coils are connected in series for carrying the load current, and the middle coil is connected in a direct-current circuit regulated from the control station in the tower.

When no current flows in this direct-current coil, the two alternating-current coils possess a high reactance in series with the light. The whole is so calculated that, when there are enough lights in circuit to correspond with the full load of the reactors, the lights are practically extinguished. Upon passing current through the direct-current coil, the flux in the core of the transformer will increase, and upon reaching saturation point, the outer coils will have practically no effect and the lights will have their full brilliance. Between these two extremes, any intermediate degree of brilliance may be obtained.

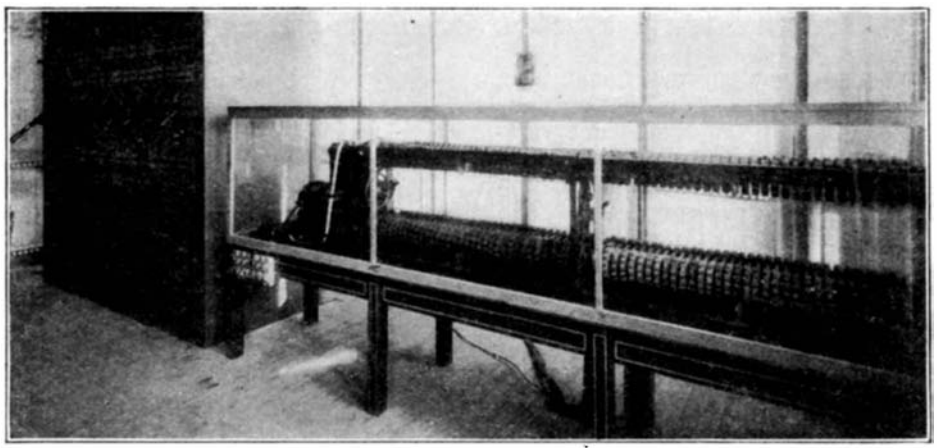
By this means, since the current absorbed by the direct-current coil is very small, it is possible to control a large amount of power with a small rheostat and very fine wires. The reactors used in these controls are the largest ever built, varying in size from 16 kilowatts, 125 volts to 200 kilowatts, 6000 volts. All of the reactors are oil-insulated. A total of 200,000 cubic meters of water is used each day in the fountains and cascades. Powerful electric pumps are used to circulate the water.

The largest of the fountains plays a stream 200 feet into the air, and the smaller sprays and streams surrounding the main stream are so arranged that it is possible to change the effects into 32 different shapes.



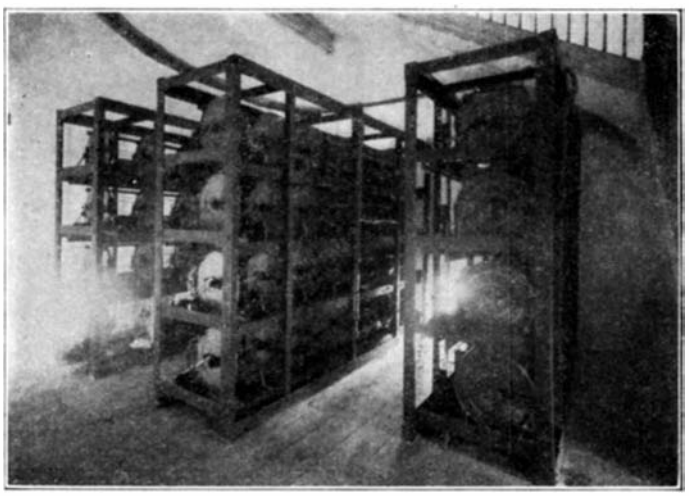
REVEALING THE SECRET OF THE ILLUMINATED CASCADES

Construction photograph showing the operating units of one of the cascades; when in operation these spray and lighting units are submerged beneath several inches of water



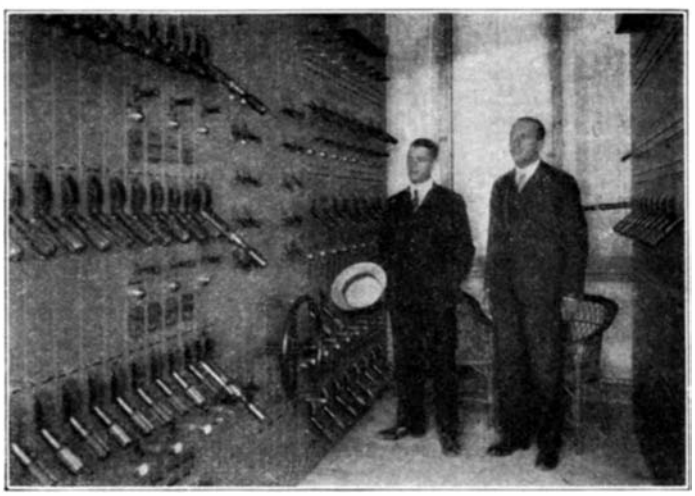
"FLASHER" CONTROLLING WAVES OF COLORED LIGHT

This automatic control unit regulates the movement of successive waves of colored light, which start at the National Palace and progress slowly over the entire decorative area



AUTOMATIC DIMMER BANKS

View of the individual electric motor-driven dimmer banks used in the mobile lighting program, regulated by the flasher illustrated above; the waves of light move at the rate of ten feet per second



SWITCHBOARD FOR LIGHTING EFFECTS

American engineers designed this special switchboard, by means of which a lighting expert can "paint" the entire decorative area of the exposition grounds with any effects he may desire

The Winning Design in Our Light-Plane Contest

A Detailed Description of the Tandem Biplane With Steel Fuselage That Won the Scientific American Medal

American Airmindedness Proved

SO often is the aphorism repeated "Americans are gradually becoming air-minded," that we are entitled to scan the facts for proof.

A recent questionnaire sent to our subscribers in a geographical cross-section of the United States, shows that 75 percent were alive to the importance of the developments in aviation and 24 percent actively use this service, while 27 percent are potential airplane owners.

In the SCIENTIFIC AMERICAN competition for the best light airplane designs, 80 individuals were interested enough to write in for specifications and 19 complete designs were finally submitted in the contest. Considering the amount of work necessary to draw up detailed calculations, draft the three views and extend the tabulation of specifications for the particular design, it will be evident at once that widespread and sincere interest in the art has been demonstrated in places and among persons who hitherto had not revealed themselves to general public cognizance. Also, there is a decided interest shown in articles on aviation, particularly from the investment standpoint. Like all developments that have an appeal to the heroic or mystical element in us all, investment in aviation has probably attracted more people than is realized, for surely the flotation of aviation stock has gone on apace; in fact the industry itself has outsped the preparation of a market for the output.—*The Editor.*

THE SCIENTIFIC AMERICAN announced in the March, 1929, issue a light-plane contest and through the generosity of Colonel R. Potter Campbell, President of American Cirrus Engines, Inc., it offered a prize of 500 dollars and gold medal, a silver medal, and a bronze medal for the best three designs of a light two-seater airplane.

The object of the contest was to interest the public in the possibilities of a comparatively undeveloped field in aeronautical design, as we believe a light two-seater for training, sports use, and private ownership built to sell for a reasonable price without sacrificing aerodynamic efficiency, is the type needed to give additional impetus in this new industry.

The country with its ever growing airports, its unlimited resources, and its large market should lead the world in the light-airplane field.

The contest rules called for a plane to be designed about the Cirrus Mark III engine, an air-cooled, 4-cylinder motor designed by Maj. Frank B. Halford, principally for use in the De Haviland Moth, a low-powered two-place biplane. It has also been installed in the Avro Avian, the Great Lakes Trainer, and many other light planes and in the last few years has established an enviable record. This engine has been supplied to all the light-airplane clubs subsidized by the British Ministry. It also holds such records as Lady Heath's famous flight from London to Cape Town, a flight from England to India, the light-airplane altitude record, the light-plane non-stop record, and the distance record for a pilot unaccompanied. So it was selected as the one around which the design for this contest should be drawn.

THE rules of competition were, essentially:

1. The design was to be one for a plane which would be most suitable either as a training plane or as a sport plane for private ownership.
2. Minimum equipment allowed by the Department of Commerce in the way of instruments was required.
3. The fuel system had to provide for five hours at full throttle.
4. Provision for 50 pounds of baggage and a baggage compartment.
5. Minimum gliding speed of 40 miles per hour. Maximum speed to exceed 95 miles per hour.
6. No restrictions were placed on the type of design. The fuselage was to be of metal construction, but the wings could have been of wood construction.
7. Each competitor for the prize was required to submit the following information:
   (a) Three views of plane and main dimensions and characteristics.
   (b) Detailed weight estimate.
   (c) Balance diagram and stability and control considerations.
   (d) Preliminary performance calculations.
   (e) Preliminary stress analysis.
   (f) Drawing showing power-plant installation with gasoline system.
   (g) Drawing showing accommodations for pilot and passenger.
   (h) Sketches or preferably drawings illustrating the structure of the plane, wings, fuselage, tail surfaces, landing gear, and controls.
8. The designs were rated according to:

(a) General suitability of the plane for training and private ownership purposes and general excellency of the design	20 points
(b) Performance	15 points
(c) Power plant installation	15 points
(d) Construction and ease of maintenance	80 points
Total	130 points

The judges of the competition were:

Miss Amelia Earhart—representing woman's accomplishment in aviation.

Mr. George Palmer Putnam—private plane owner.

Professor Alexander Klemin of the Daniel Guggenheim School of Aeronautics, New York University.

It can be seen from the point rating that the plane's construction and adaptability to quantity production were of the utmost importance.

A large number of designs were submitted by students, draughtsmen, and salesmen and were received from every part of the United States and England.

The plans submitted showed almost every type of wind and fuselage arrangement: biplanes, high, mid- and low-wing monoplanes, and even a helicopter.

The judges found the designs excellent as a whole and after much deliberation chose the design by Mr. Rigby for the prize. [See page 45, January 1930 issue. Editor.] He was awarded 120 out of the possible 130 points. Mr. Rigby's plane is a tandem biplane with a steel fuselage and wooden wings.

The fuselage is of low-carbon steel (1025) using the full Warren truss and welded joints. The two cockpits are located out beyond the wing, giving good visibility and accessibility.

The gasoline tanks and the baggage compartment are located forward of the cockpits near the center of gravity. Thus the designer provided a small movement of the center of gravity under all possible loading conditions.

The wings are of the conventional wood and fabric type with built-up box spars, pinjointed at the fuselage. Ailerons are used only on the upper wing.

The landing gear is of the split-axle type using disk shock-absorbers and the tail skid using rubber cord.

The tail surfaces are of dural, having an adjustable stabilizer and fin. The rudder is balanced and all surface controls are of the cable type.

The performance for the winning ship follows:

Landing speed	39 m.p.h.
High Speed	95 m.p.h.
Climb	693 ft. per min.
Service ceiling	14,500 ft.
Absolute ceiling	16,500 ft.
Endurance	5 hours

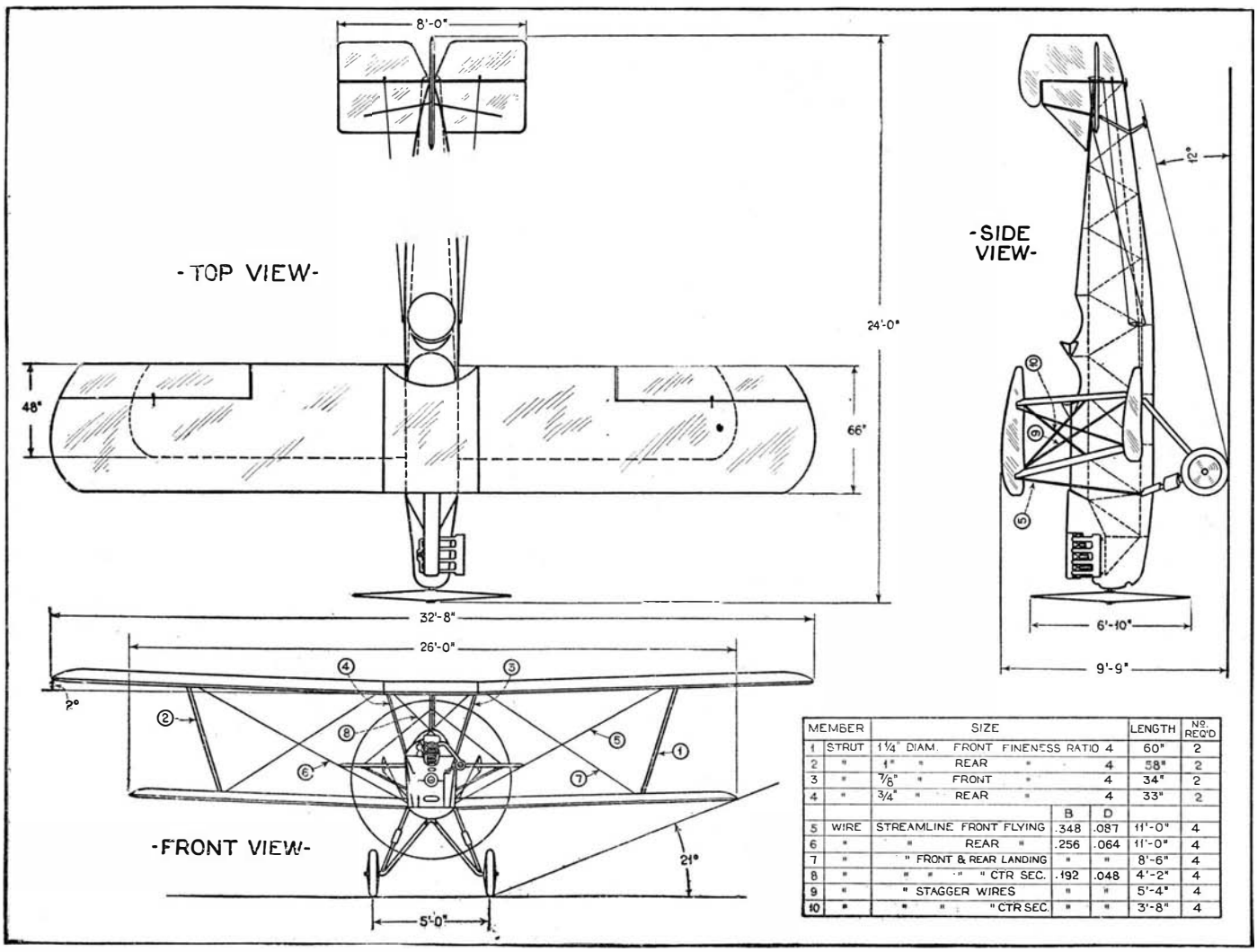
The structural specifications:

Type	Biplane
Span, upper	32.8′
" lower	26′
Chord, upper	66″
" lower	48″
Height	9′9″
Length	24′
Stagger	18″
Gap	60″
Incidence	0°
Dihedral	2°
Area, upper wing	165 sq. ft.
" lower wing	88 sq. ft.
" total	253 sq. ft.
Aileron area (upper)	24 sq. ft.
Area, stabilizer	16 sq. ft.
" elevator	12 sq. ft.
" fin	4 sq. ft.
" rudder	8 sq. ft.
Airfoil U. S. A. 27	

Mr. Huep was awarded the silver medal for his design of a low-wing, full cantilever monoplane with tandem seating accommodations. The unique feature of this design was the convertibility from an open cockpit to a cabin model with a slight increase in weight.

Mr. Beebe's design was awarded the bronze medal for a side-by-side, low-wing, semi-cantilever monoplane. The ailerons extending the whole length of the wing could be used as flaps or as differential ailerons.

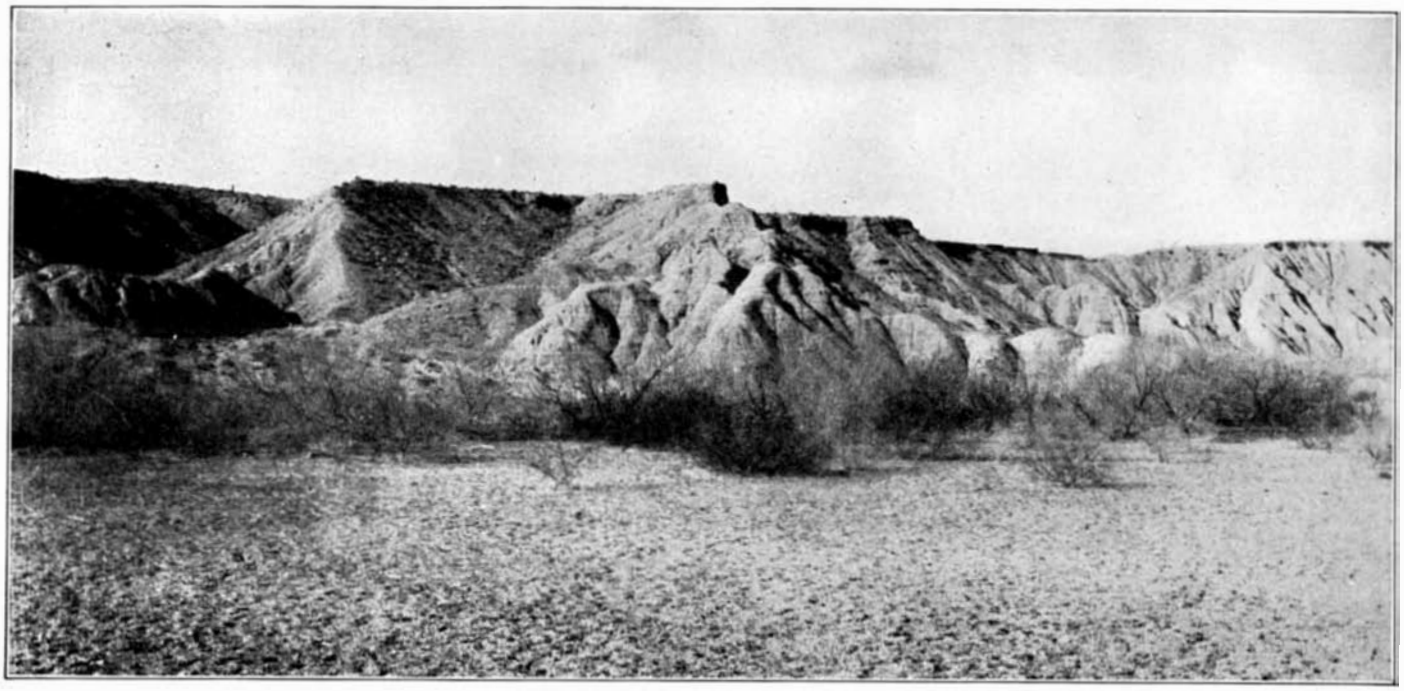
Viewed from all standpoints the contest is a decided success, as much interest has been aroused in the possibilities of the general development of the light airplane for use by persons of average airmindedness.



MEMBER		SIZE	B	D	LENGTH	NO. REQ'D
1	STRUT	1¼" DIAM. FRONT FINENESS RATIO 4			60"	2
2	"	1" " REAR " 4			58"	2
3	"	⅞" " FRONT " 4			34"	2
4	"	¾" " REAR " 4			33"	2
5	WIRE	STREAMLINE FRONT FLYING	.348	.087	11'-0"	4
6	"	" REAR "	.256	.064	11'-0"	4
7	"	" FRONT & REAR LANDING	"	"	8'-6"	4
8	"	" " " CTR SEC.	.192	.048	4'-2"	4
9	"	" STAGGER WIRES	"	"	5'-4"	4
10	"	" " " CTR SEC.	"	"	3'-8"	4

THREE VIEWS OF THE PRIZE-WINNING DESIGN

Out of a possible 130 points, this design was awarded 120, and so was proclaimed the winner. Note the clean appearance of the front view, and that ailerons are used only on the top wing. Details of the performance of this ship are given in the center column directly above



MESA HOUSE RUIN FROM THE FLATS BELOW THE MESA OR TABLE LAND

The ruin lies just back of the central point of the picture. The elevation of the mesa above the bottom lands of the river valley, in the foreground, is 120 feet. The steep slope, up which the attacking tribes must fight, made the defense of the chosen position relatively easy

The Last Stand of the Nevada Pueblos

In Southern Nevada Another "Lost City" of the Early American Indian Has Been Discovered, Throwing Light on Pre-Columbian History

By IRWIN HAYDEN

Assistant Archeologist, Southwest Museum, Los Angeles

THAT the peace loving Pueblo Indians who occupied southern Nevada at the opening of the Christian Era, hard pressed by hungry nomads, were finally compelled to build fortified villages on inaccessible mesas, is the mute testimony of ruins recently uncovered by a party of field workers sent out by the Southwest Museum.

A handful of Mormons and a small band of southern Piutes have inherited what was, when Jesus was born, a veritable Garden of Eden to these Pueblos, who lived and prospered by thousands in the lower valley of the Moapa River. There they built their houses, often in such large groups that these have been called cities. There they planted maize, squash, beans, and cotton in the fertile and friable soil, irrigating their crops with the waters of the stream which meandered lazily over the bottom lands between the high and barren mesas which form the eastern and western rims of the valley.

For many centuries they had lived there; first, apparently, a rude people who made baskets and used the dart-thrower, not knowing the bow and arrow, ignorant of the art of making pottery; then a people who not only had learned to cultivate maize and beans but to make pottery and to substitute for the dart-thrower the bow; and finally a people who knew the art of building rectangular houses consisting of single rooms, with vertical walls and flat roofs, of mud and stones and mesquite poles and thatch of arrow bush and arrow cane.

THESE people lived richly. The land smiled upon them, yielding bountifully the foods they liked best to eat, the maize or Indian corn and its "little sisters," beans and squash, which in the long ago other Indians had domesticated in the high plateau country of middle America. Their cotton-fields supplied material for their well woven textiles. In the neighboring highlands mountain sheep were plentiful; wild fowl teemed in the ponds and marshes. Fuel and water were there; and so were numerous sources of flints and obsidian for arrow points and spear heads, knives and scrapers. Pure rock salt for flavoring food, for ceremonials and trade; clay for pottery; magnesite for the clean white slip with which they coated the inside of the food bowl, red paint stone for the red slip; Spanish bayonet and iron stone for the paint used for the black designs on the bowls; turquoise for ornaments—all of these things and more they had, these early Pueblos, there in the Moapa Valley.

In that valley, as related in the SCIENTIFIC AMERICAN for July 1925, M. R. Harrington, with the help of Mr. Fay Perkins and others, discovered and explored in part the famous "Lost City of Nevada."

The results of that work, done under the auspices of the Museum of the American Indian, Heye Foundation, brought to light the ruins of a large settlement which was at the peak of its development in the early centuries of the Christian era, at a time when in all of North America there probably was no place more thickly populated or more "prosperous," as we of today would say, than that section of southeastern Nevada.

It was the good fortune of the writer to have been assigned the task of excavating another "lost city of Nevada," across the Moapa River from the Lost City, and some eight miles north. The task was assigned by M. R. Harrington, who was in the field as leader of

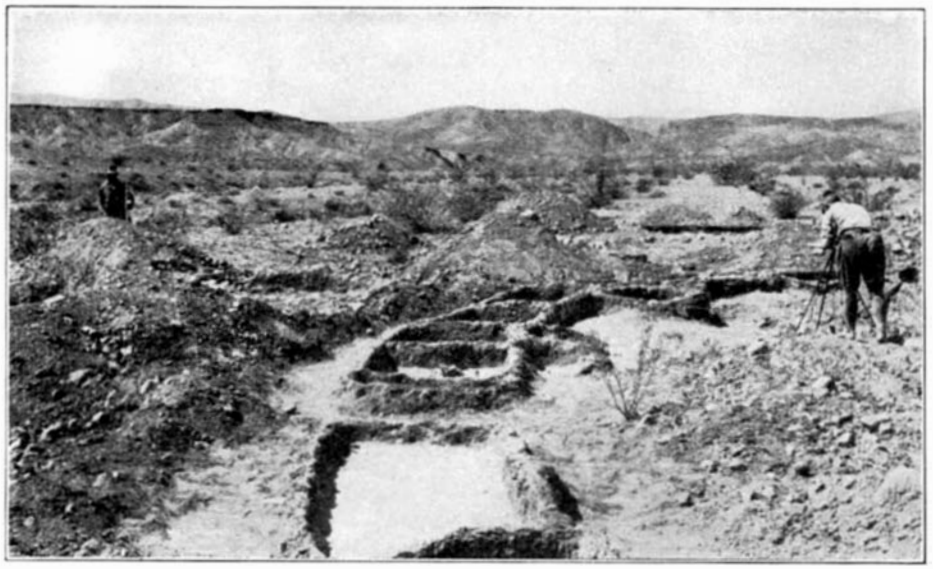
the Nevada Expedition, 1929, sent out by the Southwest Museum of Los Angeles, of which Mr. Harrington is now Director of Research. The Southwest Museum concerns itself primarily with the problem of early man in the southwest area of North America; and the scientists who are directing its research feel confident that buried in the earth and the caves of southeastern Nevada are many secrets, the uncovering of which will help materially in telling the story of the beginnings and the development of the great Pueblo peoples whose brilliantly colored life and history make the territory which includes Arizona, New Mexico, much of Utah, Colorado, Texas, and Nevada, so fascinating to tourist and scientist alike.

THE writer, assisted by his son, Julian D. Hayden, and by James G. Scrugham, Jr., son of ex-Governor Scrugham of Nevada, whose great personal interest in archeology has done so much toward aiding the work of exploring the Nevada ruins, spent three months in the complete and thorough excavation of the Mesa House ruin, about three miles north and west of the Mormon town of Overton. Meanwhile Mr. Harrington roamed the lower reaches of the Moapa River, locating and platting the many evidences of Indian occupation, from Basketmaker pit dwellings to early Pueblo village sites and southern Piute camping places. The lower end of the Moapa Valley is expected eventually to be covered by the waters impounded by the great Boulder Dam. and much of the very important archeological evidence will become lost forever unless it is collected within the next few years.

One very striking thing was brought to light by the exploration of Mesa House, when the situation there is compared with that at Lost City. The mute evidence of stones and fallen 'dobe walls found at Mesa House is eloquent in its story of a people brought to bay by human enemies. The ruins of the Lost City speak as eloquently of a people who were at peace.

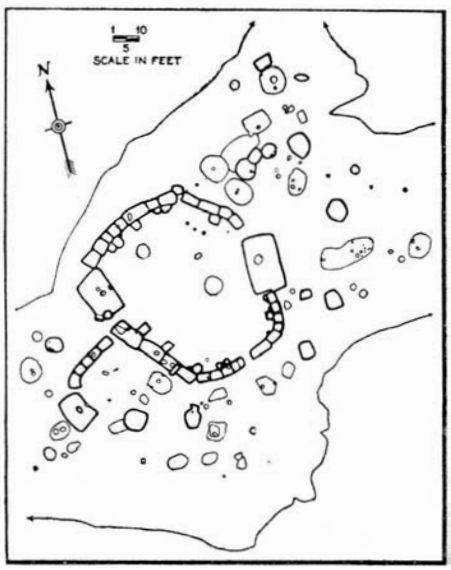
THE GENERAL LOCALITY

Both Mesa House and the Lost City are indicated at about the center of the map



MAPPING THE RUINS ON TOP OF THE MESA

The surveyor is bending over a plane table at the right, his rodman stands at the left of the picture, and a tape, dimly visible in the picture, is stretched between the two points



MAP OF THE RUINS

The enclosed figures on the map correspond with the walls, like, for example, those in the illustration shown above

Evidence gathered at both places indicates clearly that Lost City and Mesa House were built and occupied by early Pueblos. Mesa House, however, represents the last stand of these people in the Moapa Valley, before they moved into Arizona (or possibly Utah). The tradition among the southern Piutes who were in the Moapa Valley when the first white men settled there is that the builders of the pueblos went to Arizona and became the ancestors of the present Hopi.

Whoever visits Lost City and Mesa House (it would be well to do so before Lost City becomes inaccessible because of Boulder Dam, as it may) will observe the fact that Lost City houses are grouped in a free and easy way, with no apparent plan. But the houses at Mesa House are built around a central courtyard, in the form of a circle roughly drawn; and there are but three narrow gateways to this courtyard. Here, then, was essentially a walled town. Outside the walls, not too far away, were dwellings, arbors, storage rooms; but at the first alarm all could run into the "fort" and make effective resistance to raiding Piutes, Apaches, or whoever the enemy might be.

Lost City was built on low-lying promontories, near fuel, water, and farms. Mesa House lay on top of a barren mesa or table land, swept by the bitter winds from the Mormon mountains to the north, standing 120 feet above the bottom lands, from which food, water, fuel, and most of the building material had to be carried up pathways rising about two feet in one, so steep are the sides of the mesa.

AS a place to live, Mesa House was decidedly inconvenient. As a place to defend, it was ideal. To the east lay the open valley; to the north a broad cove in the mesa; to the west open country for several miles, in spite of the rising hills; and to the south and close at hand a high place where lookouts could command the entire country side. Indeed, on the very top of this high place were found the remains of ancient watch fires.

In comparison with Lost City, Mesa House produced a much greater number of "wicked looking" arrowheads. But, also in contrast with Lost City and village sites of the Lost City period (for miles up and down both sides of the valley there are ruins of villages identical in pottery with the Lost City), the people of the Mesa House were poor in worldly goods, for the graves at Mesa House contained very meager offerings, while Lost

A LOST CITY BURIAL, WITH POTS AND PET DOG

At Mesa House, however, only one grave contained anything of importance. The potsherds, or pieces of broken pots, tell the trained prehistoric archeologist almost as much as actual inscriptions, for the styles in pottery undergo many changes, thus affording a time scale

City graves, many of them, were rich with pottery, weapons, ornaments and other objects.

In fact, only one grave at Mesa House contained anything of importance. Some thirteen turquoise pendants, 24 arrowheads, several dozen gaming pieces, a flint knife with handle intact, and two very fine war clubs carved from elk horn, were included in the grave of an adult, who must have been, in his lifetime, a leader among his people. This grave was in the center of a great room, apparently built of "wattle and daub"; which means that posts were set up, scantling run across the sides and ends, against which a thatch of arrow cane or tules was laid, and the whole plastered with mud, both sides and roof. The room had been destroyed by fire, perhaps immediately after the burial of the great man.

HARRINGTON insists that Mesa House marks the wind-up of the early Pueblo occupation of the Moapa Valley. That Mesa House is of a later period than Lost City is made clear by a study of the potsherds so numerous in all of these ruins. Fragments of broken pottery vessels, the "shards" so useful to Job in his affliction, the "potsherds" of the archeologist, can be made to tell a great deal about the comparative age of different Indian villages and camp sites, provided always that they are found.

The potters of the Lost City period catered to fashion, just as our modern potters do; just as potters always have done and always will. The Lost City housewife demanded and made pottery which chiefly was either plain or decorated with black lines on a white or a red background. Occasionally some good housewife, as she coiled the rolls of clay 'round and 'round in the building of the pot or bowl, omitted the usual smoothing of the outside, leaving ridges or corrugations for ornamental effect. These corrugations were left straight or were indented or notched, according to the taste of the potter. Lost City potters only occasionally made this corrugated pottery.

Now at Mesa House two thirds or more of all the fragments of pottery found is corrugated. Ordinary plain pottery, or undecorated ware, is noticeably rare; and dishes bearing black designs on white background, the typical black-on-white of the early Pueblo period in the southwest, is infrequently found, while the black-on-red dishes are very rare indeed.

The relatively greater use of corrugated ware at Mesa House, as compared with Lost City villages, does not of itself indicate anything about the comparative dates of the two periods, Mesa House and Lost City.

It happened, however, that on another village site, which plainly was occupied by early Pueblos, the writer unearthed what seems to be a key to the situation. This ruined village stood on a tongue of the same mesa on which the Mesa House was built, and not more than 1500 feet from it. It was discovered by Mrs. Harrington on one of her scouting trips. There, in a layer of accumulated ashes and rubbish more than three feet deep, in spots where everything pointed to a long occupation, all of the broken pottery was of Lost City type, plain, with some black-on-white and black-on-red ware; except that in the uppermost six inches, and on the surface, fragments of corrugated ware appeared.

Lacking evidence to the contrary, then, Mesa House is dated later than the villages of the Lost City period.

Using the tentative time scale suggested by Dr. Alfred V. Kidder, Mesa House was abandoned sometime between 500 and 800 A.D.

PERHAPS thousands of years were covered by the development of these peoples in the Moapa Valley. But when did any sedentary, agricultural people, who insisted on peace as a prime requisite to happiness, ever succeed in enduring the constant irritation of raids from destitute, hungry nomads?

Apparently the early Pueblo fought only for defensive purposes. It is evident that his posterity, the present Pueblos, made no offensive wars. Dear to them as the Moapa Valley must have been, it was not sufficiently dear, apparently, to justify their fighting to hold it.

So, if we read the record rightly, they left it to the southern Piutes, who gave it over to a colony of Mormons which Brigham Young sent there to raise cotton.

• ANOTHER GENERAL VIEW OF MESA HOUSE

This shows clearly the type of masonry wall construction employed by the former builders and occupants of the ancient community. The houses were drawn up around a roughly circular court yard, but without much planning, as is shown by the map on another page

Opera Comes Into Its Own

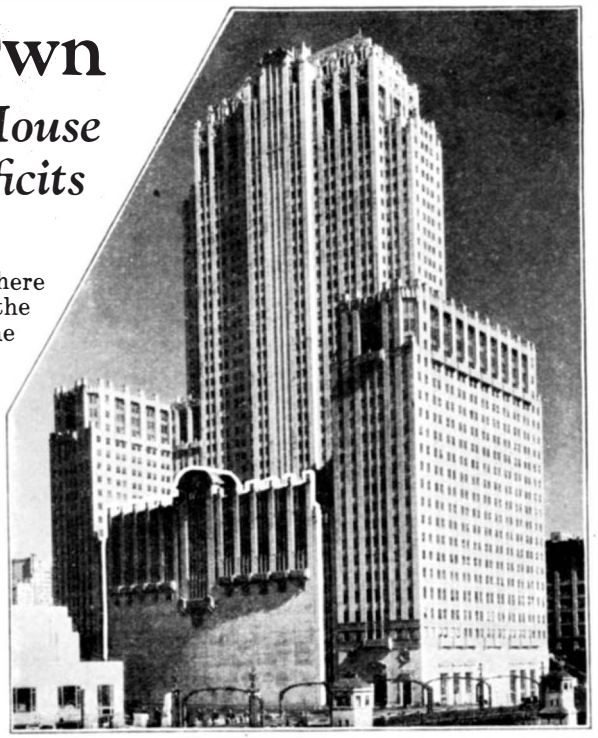
Combining Offices With an Opera House May Solve Problems of Perennial Deficits

By ALBERT A. HOPKINS

CHICAGO goes in for the grandiose and generally succeeds. She certainly has many things which can be classed as the "largest" and many as the best. This has largely been accomplished by a remarkable civic spirit which manifests itself in many non-commercial cultural enterprises of great magnitude. The World's Fair of 1893 gave Chicago a place in the sun, and she has worthily maintained it. It was a few years previous to this that Chicago built a real opera house, the Auditorium, with a modern stage with hydraulically operated bridges. But time makes all things obsolete, and so Chicago felt that her opera was so good that a new opera house was in order, and we shall tell some of the wonders of her 20,000,000-dollar structure which was opened recently with the unfortunate Aida's troubles.

The structure known as "20 North Wacker Drive" is 45 stories high with two 23-story wings. In this skyscraper are the Opera House and the Civic Theater accommodating 3517 and 878 persons respectively. The box-office has been separated from the main lobby so that persons with tickets do not have to mill around with would-be purchasers. The orchestra is so arranged that no late comer has to climb over more than four of his predecessors in order to reach his seat. The dress circle, the balcony, and the upper balcony have been brought forward over the orchestra so that the occupants of these seats are brought much nearer to the stage. There is no seat in the house where the whole stage is not in view. The last seat in the upper balcony is 185 feet from the stage. The chairs in the boxes are of two sizes, the taller ones for the men and the smaller for the ladies.

Every device which modern science has invented for the improvement of stagecraft and the speeding of scene changes demanded by modern opera is called into play. The technical director and stage director have at their command many devices which have never before been used on the stage of any theater in the entire world.

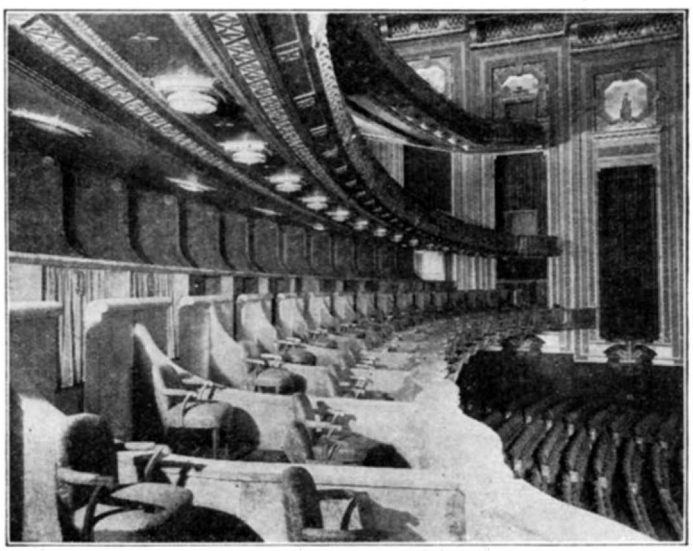


SEEN FROM THE RIVER

The new Chicago Opera House rises majestically 560 feet. The Opera House proper is outlined in white

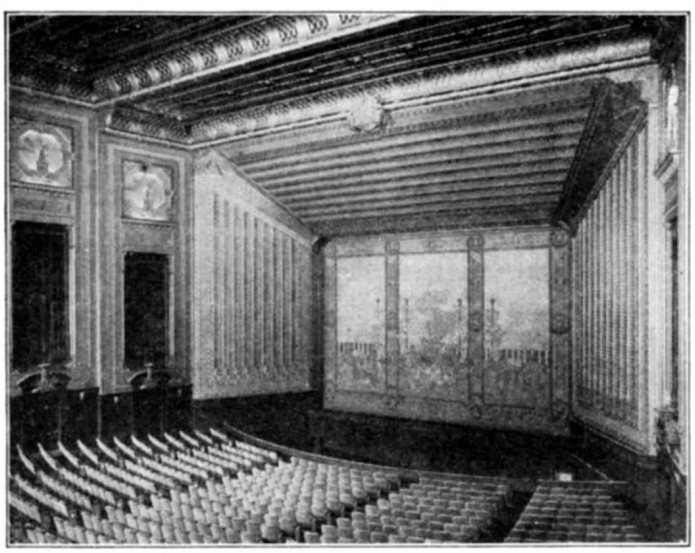
THE stage itself, while not the largest in the world, being exceeded in breadth by one or two stages in Europe, is considerably larger than anything in the United States. It measures 75 feet in depth and 120 feet in width at its widest point. The important element of height which governs the size of drop curtains, cycloramas, trees and foliage, buildings, and so forth, in outdoor scenes, has received special attention.

The stage measures 145 feet from floor to gridiron. The working stage, 50 feet in width, is divided into 20 sections which lift or lower, each of them being 25 feet long by four feet wide, and with a lift of 12 feet and a drop of 12 feet. They can also be tilted to a maximum angle of 35 degrees in either direction. The 20 sections, or traps, are mounted on hydraulic rams. Forty plungers in all are used, two for each trap. All are operated from the main control station at the right-hand side of the stage. Each plunger is fitted with a clamp, holding it secure at any level, and insuring against movement in case of leakage in the hydraulic system. All traps are covered with "roll-away" floors which can be placed in position when any trap is lowered. Between these movable traps and the footlights are three 50-foot traps with "roll-away" floors.



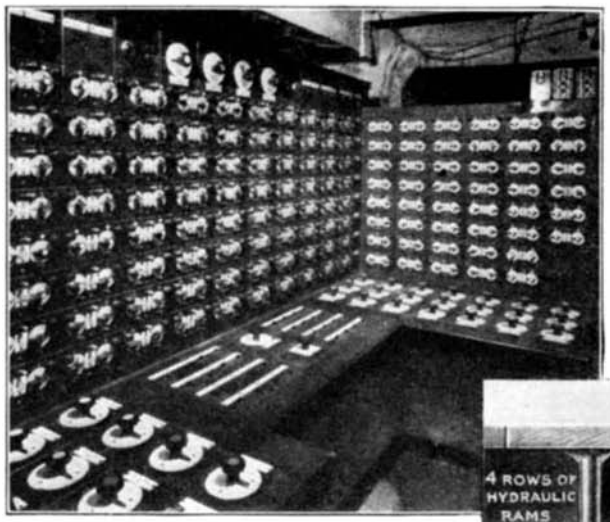
THE GOLDEN CIRCLE

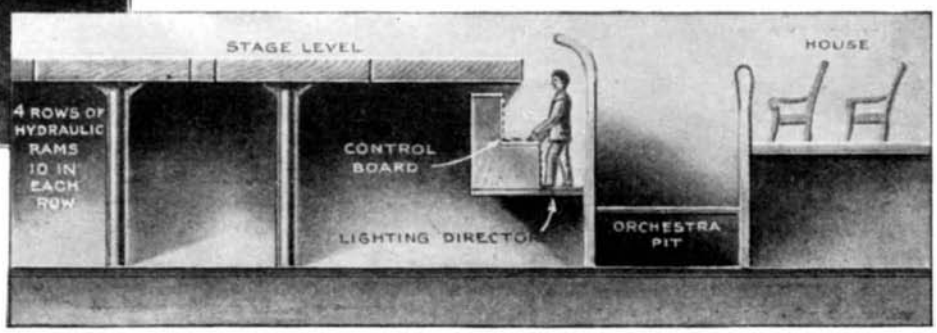
The luxurious box floor of the new Civic Opera House taken from the right-hand side of the auditorium. The chairs for the ladies are made lower than for gentlemen. There are no pillars to interfere



THE COMFORTABLE ORCHESTRA

The musicians are in a pit. The aisles are numerous, so access to any seat is simple. The hydraulically operated steel fire-curtain symbolizes many popular operas by means of pageantry





THE LIGHTING OPERATOR AT WORK

In front of the curtain, the "lighting operator" will control the stage and house lighting as easily as the orchestra conductor directs. The lighting control board is shown above

At the back of the stage is another trap, the giant of them all. It measures 75 feet in length by five in width. It can be lifted five feet above the stage level and dropped 35 feet below. In the vault into which this trap descends are located racks to accommodate the hundreds of drop-curtains required in a season's production of opera. Every rack is neatly labeled with the name of an opera. In all, storage for 2000 drop curtains is provided. The vault containing the racks is fire-proof and damp-proof, insuring complete protection of equipment.

Just back of the footlights a steam curtain is provided for scenic effects. There are two fast-working curtains immediately behind the proscenium, operated by horizontal hydraulic machines. One of these machines is used for the drape curtain and the other for the act curtain. Each is controlled from the right side of the stage.

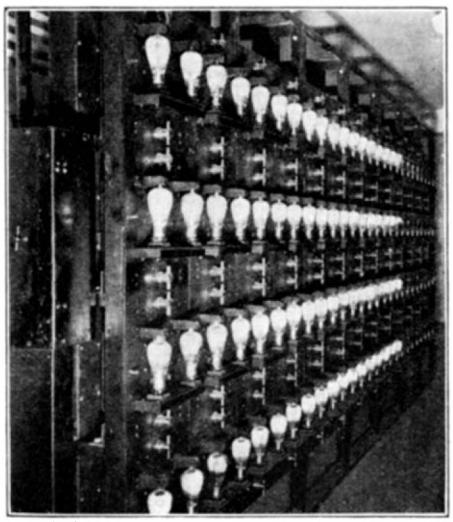
STILL another hydraulic machine operates the huge steel curtain, which can be controlled from either side of the stage. The curtain weighs fifteen tons, and consists of flush steel plates on its face, braced and trussed at the back. It is covered with vitrified asbestos, and the face is decorated with a symbolic painting harmonizing with the decorative scheme of the auditorium.

Drops for from three to ten operas might be hung at one time on the scenery "pipes" of the new theater. They are 106 in number, each 70 feet long, and with a clear lift of 144 feet. At the sides and rear of the stage are three cyclorama frames, eight inches apart, extending from within about five feet of the proscenium opening to within three feet of the back wall, and completely surrounding the stage. They are 240 feet in length and 115 feet high. The frames lift 38 feet above the stage floor, and are suspended by steel tape with channel-iron framing. The lifting and lowering of the cycloramas is controlled from the central control station on the right-hand side of the stage.

To light this huge structure—certain scenes in opera require light more intense than daylight—ample provision has been made for bank-lights in the wings on either side of the stage, for border-lights directly above the stage, and for spots, bunch-lights, footlights, and flood lights.

There are 16 bank-light frames, eight on each side of the stage, between the cyclorama frames and the counter-weight pipes. There are nine rows of border-light pipes, each 16 feet long. All sections of every row operate independently of one another, and all travel from stage floor to gridiron. There are also three light-bridges for spot lights and arcs. Two are located three feet from the proscenium wall, one above the other, traveling in fixed angle guides, while the third swings free directly over the seventh row of border lights, and is used for lighting the cycloramas. Lifting and lowering of the light bridges is controlled from the main rigging control station and also from controls located on the bridges themselves.

There are twelve "spot lines," six on each side of the stage. They cover practically every square inch of the stage, and all are mounted on cars which travel up and down stage and can be locked in the desired position.



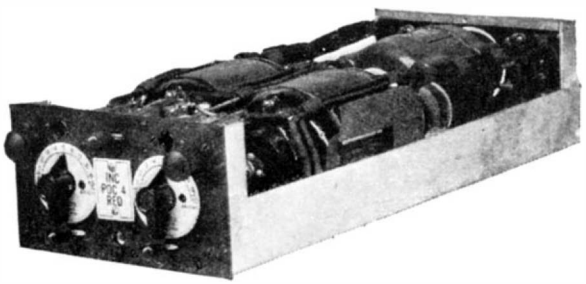
RECTIFYING TUBES

The new control scheme involves the self-synchronous motor and vacuum tubes

More than a hundred hoisting machines are required for this quantity of equipment, of which 61 are controlled from the main control board and a portable control board, worn by the chief electrician when directing the placing of his lights. Remote control is used throughout the stage, not only for raising and lowering the lighting equipment and some of the scenery, but also for dimming and brightening the lights, cutting out sections, changing lighting, et cetera.

Aladdin, with his wonderful lamp, has been outdone in this electrical installation, conceived and designed especially for the Chicago Civic Opera Company's needs by the General Electric Company. The system, which involves new and unique principles and which minimizes time, labor, and valuable space, enables the lighting director to leave his position back stage for the first time in theatrical history and take up a position in front of the curtain along with the prompter.

In front of the curtain, the lighting operator controls the stage and house lighting as easily as the orchestra conductor directs the orchestra. In front and on each side of him are arranged dials, knobs, tumbler switches, indicating lights, and so on. By the



VOLTAGE REGULATOR UNIT

The "Selsyn" receiver is the same type of control as is used in the Panama Canal locks for controlling the gates

mere manipulation of a single knob all the complexities of stage lighting are controlled, lights of various colors fading and brightening at various points and at the proper moments. Scenes requiring complex lighting effects such as sunsets, sudden thunderstorms, ballet lighting, et cetera, require no more effort for their control than is needed to flick a lighting switch in the home or to turn a door knob.

The advantages of the new method are manifold. Heretofore, the control of theater lights has been centralized in a switchboard back stage which, in the larger theaters, might be as much as 40 feet long by 8 feet high. The operation of the dimmers required much physical effort and agility, and many elaborate and ingenious mechanical schemes were often resorted to in order to simplify the work. Their manipulation made it necessary for the electrician to be at a point "off-stage" where he could not see, except indirectly, the effects he was producing and where he had to rely on cues of words or sounds to inform him when it was necessary to change the lighting effects.

PORTABLE CONTROL STATION

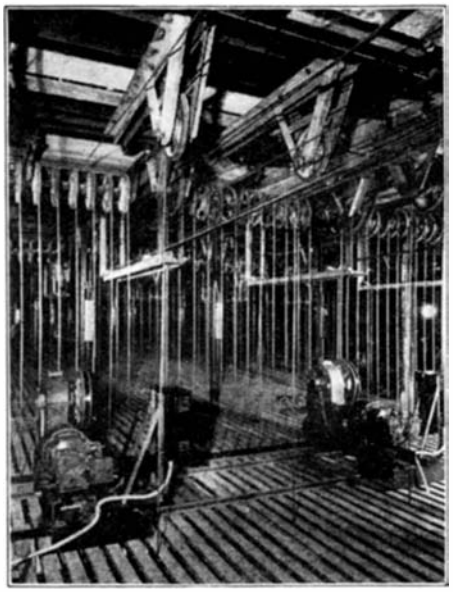
These stations control as much as 500 horsepower used for hoisting everything

For lighting the stage there are 141 individual circuits, each including lights of but one of the four colors used on a theater stage—amber, white, blue and red. The lighting operator could control the lights by manipulating knobs on every individual circuit, but to do so would involve the operation of as many as 141 knobs. A method has been devised, therefore, to govern all the lighting circuits through one knob, or to split the control into major and minor divisions, depending on color, location and function, each group in turn controllable through the agency of a knob.

THE individual circuits are grouped under the control of master knobs governing, for example, all the blue lights in the borders and footlights, all the amber in the pocket lights, all the white in the light bridges, and so on. In addition, all the lights of each color, no matter where located, are controlled by a color master knob. Finally, all the color masters may be operated simultaneously by a grand master knob.

The energy required for the control of any of the individual lighting circuits is approximately one tenth that consumed by a pocket flash light. The energy controlled, however, may run as high as 30,000 watts in a given circuit. The total energy used in maximum lighting effects may be as much as 1250 kilowatts or nearly 1700 horsepower of electrical energy.

Tucked away in the north wing of the building is the Civic Theater which seems a midget in comparison with the Opera House. The auditorium measures 80 by 57 feet, and the height is 47 feet. The stage is 70 by 32 feet, and the height to the gridiron is 71½ feet. Its equipment is very much like that of the Opera House, on a correspondingly smaller scale, but just as complete in every detail.

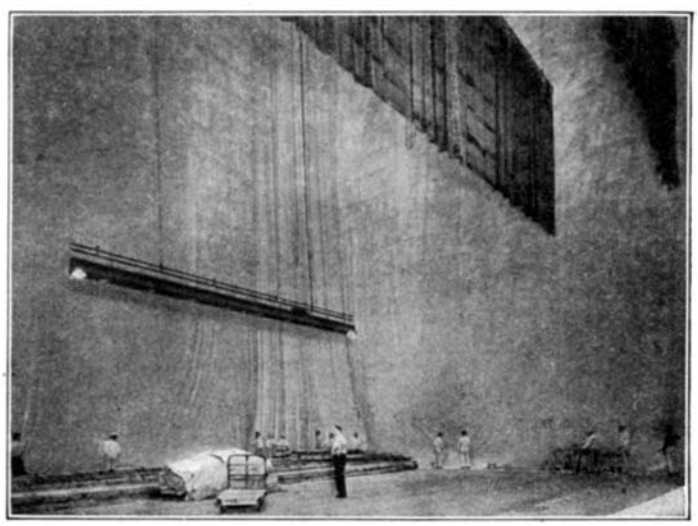


THE GRIDIRON FLOOR

The gridiron floor is 145 feet above the floor of the stage. The vast lifting equipment is the last word in stage economy

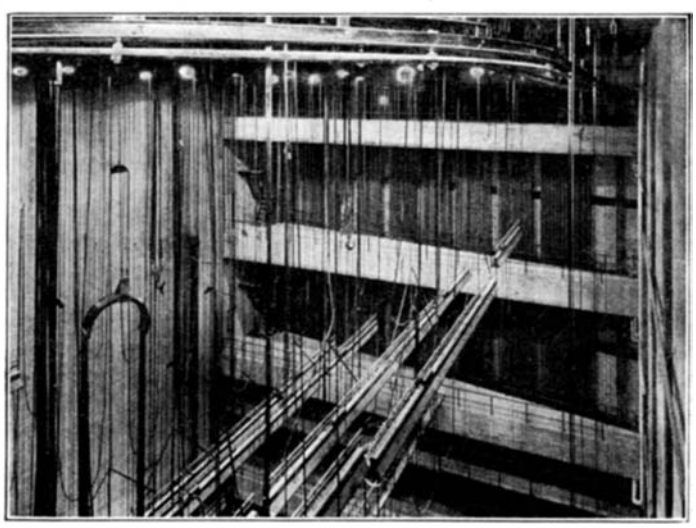
The total load on the foundations of the large edifice is about 202,000 tons, including live loads. At 28 feet below the water level (Chicago River) there is a connection with the system of the Chicago Tunnel Company, by which coal is delivered to the boiler-room and ashes are removed without being taken above ground.

The fire protection is most complete and a large automatic fire-door in the roof over the stage is arranged to open automatically in case of fire and thus keep flames and gases from spreading into the auditorium. The architects were Graham, Anderson, Probst, and White of Chicago, who are also the architects of the Shedd Aquarium and the Merchandise Mart, interesting examples of the art of the construction engineer.



PAINTING THE GREAT CYCLORAMA

Forty men covered 3000 square yards in two and three quarter hours. The huge surrounding cycloramas are 240 feet in length



A MAZE OF RIGGING

View from the upper machinery floor showing the cyclorama frames, the border lights, and the fly floors in the background

The Business Executive Takes to the Air

Survey Shows Many Firms Operate Company-Owned Planes

By DOUGLAS W. CLEPHANE

DICTATING AMONG THE CLOUDS

Mr. J. H. McDuffee, a well-known executive, using the equipment provided in a modern "flying office"

RECENTLY the general manager of a large banking corporation with branches in 500 cities was confronted with a problem. Within one week he had to hold conferences in ten cities, including New York, Cleveland, Kansas City, Denver, and San Francisco.

To accomplish this, traveling by train would have required three times the time at his disposal. The board of directors called in the sales manager of a well-known airplane manufacturing company and asked him to prove to the satisfaction of the board that this trip, as well as other business trips, could be made in a company-owned airplane, with assurance that the conference dates could be kept and that the executives would not be subjected to an undue risk.

To the officials of the company, the purchase of a company-owned airplane was a radical departure from their previous methods of doing business. To their amazement, the sales manager showed them that 170 business corporations now own one or more airplanes, that some 30 companies are operating more than one ship, and that at least 10 firms have fleets of six or more planes.

Still not satisfied, the directors wanted to be shown that air travel was safe. As their president expressed it, "It is highly important that these conferences be held on scheduled time. We can save thousands of dollars a year if we can reduce the time our executives spend in automobile and railroad travel. However, if one of these men should be injured or killed, we would suffer a tremendous loss."

The sales manager, who had met this problem many times before, produced figures compiled by the United States Department of Commerce, showing that there have been fewer casualties on air transport lines considering the number of miles flown and the number of passengers carried, than on the railroads having the highest standards of safety.

He proved to the satisfaction of the skeptical board that modern planes operated by competent pilots have achieved such a remarkable record for safe flying, that travel by other means should not be undertaken without serious consideration of the dangers involved.

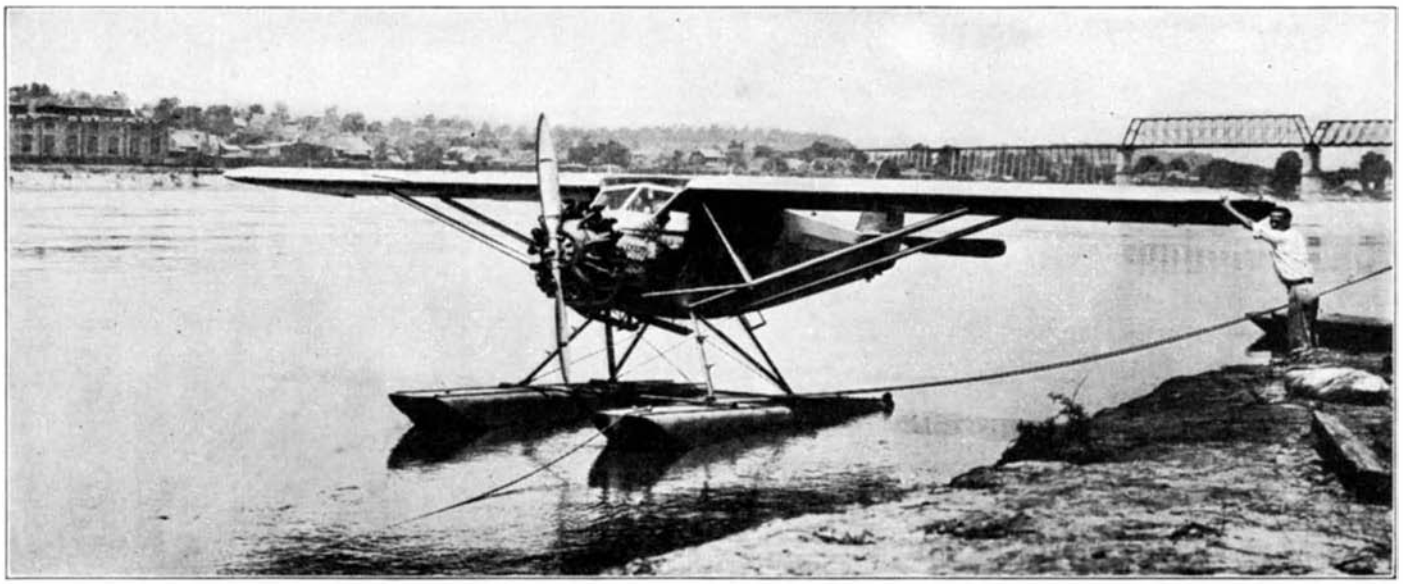
Willing to concede that a company-owned airplane would save their executives' time without unnecessary risk, the directors wanted to know if the operation of their plane would involve unwarranted expense. Figures were presented, compiled from complete cost records kept by a dozen corporations which had operated their planes a total of nearly 500,000 miles, showing that the cost of operation of a modern six-place cabin plane would run approximately 23 cents a mile, based on 500 hours operation a year.

THESE figures included the salary of a full-time pilot, complete insurance coverage, depreciation, interest on investment, cost of overhauls, hangar rent, gasoline and oil, and all other direct and indirect expenses. When a full load was being carried, the cost per passenger would run only a trifle over railroad fare.

Most of the members of the board were convinced, but the chairman, remembering a flight taken in a rebuilt war-time plane five years ago, objected to the discomforts involved in flying. "When I start out for a business trip," he declared, "I don't want to have to clamber up the side of a dirty cockpit. When I arrive for a conference I don't want to be covered with overalls, goggles, a parachute,

POLITICAL CAMPAIGNING WITH A CABIN MONOPLANE

Governor Walter Kohler of Wisconsin recently conducted his campaign for re-election with the aid of this airplane. By flying from town to town, a politician can deliver three times as many speeches as usual and has adequate facilities for preparing his talks *en route*



ANOTHER TYPE OF AIR TAXI POPULAR WITH BUSINESS MEN

Seaplanes and amphibians are rapidly becoming popular with business men for commuting and general business usage, because of the fact that they do not need prepared landing fields. An amphibian is at home on land or water. This picture shows a new Ryan seaplane

and other flying paraphernalia as if I were a circus performer. Flying is undignified, uncomfortable and does not yet offer the traveling comforts to which I am accustomed."

In answer, the sales manager persuaded him to go to the airport and witness a demonstration of a new cabin plane which typifies the trend toward limousine comfort in privately-owned airplanes. He inspected a plane which still follows closely the sleek lines of the famous "Spirit of St. Louis," made by the Ryan Aircraft Corporation. The banker had been closely identified with Colonel Lindbergh's flight, but had not followed the great strides in airplane design made during the past two years.

HE was surprised to find that the seats in the plane, which accommodates five passengers in addition to the pilot, were as comfortable as those in the most luxurious limousine. He found the enclosed cabin as carefully upholstered as the cabin of a fine yacht, equipped even to flower vases and cigarette cases. He was delighted to learn that he could see as well through the curtained windows of the airplane as he could from his own motor car.

The chairman was told that parachutes are no longer necessary as safety devices, and are not used except by student pilots and instructors, stunt flyers, and by pilots who must fly in all kinds of weather. He was amazed when told that the plane could be equipped with a self starter, and that non-shatterable glass was used.

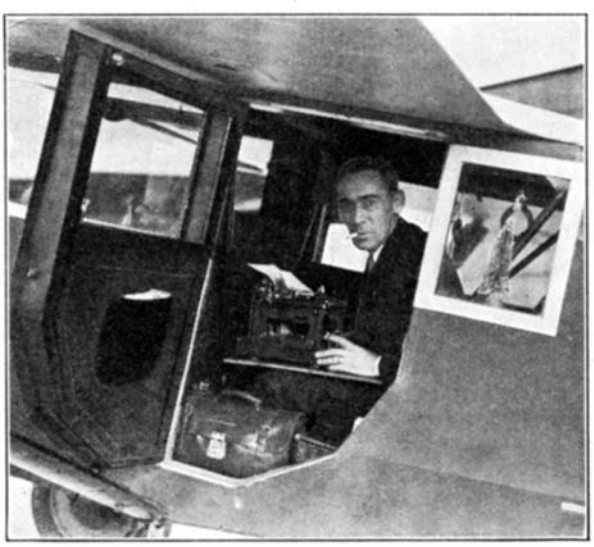
He was even more surprised when shown a "flying office" model, equipped with office desk, dictaphone, filing equipment, book case, thermos bottle set, electric cigar lighter, and other conveniences found in an executive's home office.

After accepting an invitation to take a flight, the banker gasped with amazement when the pilot removed both hands and feet from the controls, allowing the ship to maintain a compass course for five minutes without any attention whatsoever. Finally he took the stick himself, for the first time in his life, and found that holding a modern plane on a course, in smooth air, is no trick at all.

The board was convinced, the purchase followed, and in the first month of plane ownership, 11,100 miles were flown over 32 states, 440 passengers were carried, and an average speed of 112 miles an hour was maintained, which is 30 miles an hour less than the maximum speed of the ship.

So successful has been its operation, that the company has calculated that the plane has shown a profit of 8000 dollars in its first six months of operation by conserving the time of highly paid executives. This does not count the indirect saving from closer supervision of all activities of the company, the advertising and publicity value, transactions closed where it would have been impossible to get a man on the ground in time by any other means of travel, increased prestige, and other intangible advantages.

This case has been followed through somewhat in detail because it is typical of the problems that confront many other companies today.



MORE ORDERS PER SALESMAN

George Fridell, a salesman with a western fuel company, considers a plane "indispensable" in his work

ONE of the leading manufacturers of airplanes recently made a comprehensive survey of the business use of airplanes, finding that 170 firms in 45 types of business are now operating one or more airplanes. Inquiries from large corporations are being received at the rate of from 10 to 20 a week, and a recent mailing to hundreds of executives brought the information that 60 percent of the companies represented were considering the purchase of an airplane in the near future.

A few years ago an airplane was an object of curiosity and attracted a crowd wherever it landed, drawing attention to the name of the firm and its products. Many companies carried this further and installed flying displays of products, dropped samples and advertising literature and carried on other promotion stunts from the sky. So great was the advertising and publicity value that executives were inclined to overlook the airplane as a daily means of transportation.

LAWYER-PILOT

Charles L. Morgan, prominent attorney, owns and pilots his own cabin plane

Today the use of airplanes still draws some attention to the owner, and the arrival and departure of a plane in the smaller towns still receives news items in the local papers. It furnishes a valuable means of creating good-will among clients and others with whom the firm does business, but undoubtedly its greatest value is as a means of fast transportation. Airplanes are applicable to any line of business where dealings are conducted over a large territory requiring much travel by highly paid salesmen and executives.

CHARLES L. MORGAN, a well-known attorney for oil and gas companies in the southwest, was one of the first men in the legal profession to see the need of fast transportation. His statement of the use he is making of his cabin plane is an illustration of the modern tendency to apply air transportation to business.

"My plane reduces the state to about the size of a county, if I were using an automobile. Moreover, air transportation is much more comfortable, easier, and cleaner. Personally, if I drive an automobile three or four hundred miles, I am tired, while with the plane, I can do a 1000 miles, accomplish a day's work, and not be any more tired than if I had been sitting behind my desk all day.

"Practically, it works out this way: previously if a client sent me to some remote point in western Texas, I spent two days going, worked one day, and spent two days returning. The client has to pay while I am traveling because he is taking my time. Assuming that my charges are 100 dollars a day and expenses, one day's work cost him 500 dollars plus expenses. With my airplane, I am off right after daybreak. By nine or nine thirty, I am at my destination at work, and at night I am home as usual. I can charge him 250 dollars. My client has saved more than half and obtained quicker action, and I collect 250 dollars per day instead of 100 dollars."

Many salesmen are becoming sales engineers with specialized technical knowledge in addition to their ability to make sales and hold the good will of customers. Such men are rare and often receive more than 10,000 dollars a year. It is an economic waste to allow such a man to spend half of his time in travel, when the investment of a few thousand dollars in an airplane will allow him to treble the time he spends in constructive work.

Edward S. Evans, president of the Detroit Aircraft Corporation, which controls 11 well-known aviation companies, and who is associated with many other business enterprises, recently said, "I believe that in a few years the companies that do not furnish their best salesmen with airplanes will be as out of date as the firms that had their salesmen traveling in buggies when their competitors were using motor cars."

Another use to which airplanes are readily adaptable is the delivery of equipment and parts required in a hurry. At least 20 oil companies are using airplanes for this purpose. Other industries also are finding the airplane invaluable in this type of service. When a machine breaks down, tying up a whole plant or department, expense is a minor factor compared with the time lost in getting replacements. Several of the more progressive machinery manufacturing companies maintain their own planes for quick delivery service.

THE RYAN FLYING OFFICE

This cabin model, designed for business executives, is equipped with all appurtenances for transacting a day's work

TOO much emphasis has been placed on the romantic and unique uses to which an airplane can be put, so that many business men have overlooked the practical value of air transportation in daily work. The writer believes that five years from now, instead of 170 business firms owning airplanes, there will be thousands. The practicality of the "flying office" has been proved and about 20 such planes are now in use by presidents and executives of large corporations. Piloting the newer planes is much more simple than formerly.

Just 100 years ago school trustees in an Ohio town refused the use of a school for a debate on the subject, "Is the Steam Engine Practical." The school trustees wrote, "If God had intended that His beings should go at the unholy rate of fifteen miles an hour, He would have so declared in Holy Writ." A few executives of business corporations still assume somewhat the same attitude toward the adaptation of air transportation to their businesses.

EXECUTIVES AND PILOT READY TO TAKE OFF

Left to right: Pilot Dewey Noyes with Mr. A. M. Maxwell and Howard G. Jones, officials of the Standard Oil Company of Ohio, about to leave Cleveland Airport on a short journey

A Big Practical Problem for Science*

What Will Be the Power Source of the Future, When the Coal Supply of the World Is Exhausted? Photochemistry Offers One Possibility

By PROF. F. M. JAEGER
The University of Groningen, the Netherlands
Non-resident Lecturer in Chemistry at Cornell University

IT is a well-known fact, that, both for the biological processes in plants and animals as well as for the maintenance of human civilization, a continuous import of energy from outer space to our planet is necessary. The only source of energy that practically needs to be taken into account in this respect, and which daily furnishes enormous quantities of energy, is our sun. In whatever form we meet with energy on the earth, whether it be stored in coal or oil, or be immediately available to us, as in the flowing or falling water, or in the winds, it can in all cases easily be understood that this energy has always its real origin in that of the radiation which the sun continuously emits in all directions into space and some of which strikes the earth.

If this radiation is absorbed, it will for the greater part be transformed into heat, which causes the water on the earth to evaporate, and thus gives rise to the mighty formation of clouds. Inversely, the condensation of this water vapor is the cause of rain and snow fall, which in their turn feed the rivers, seas, and waterfalls. The differences in temperature and pressure in the earth's atmosphere that are brought about under the influence of the solar radiation are the causes of air-currents which give rise to the energy of the wind. The radiant energy of the sun given out several hundreds of millions of years ago is now stored up in the form of chemical energy in coal, after having been transformed and accumulated in the living vegetable cells of those far-off eras. Through the process of combustion, this stored-up chemical energy is used by us in our steam engines and gas motors of to-day. This stock of coal, and also of mineral oil, nowadays represents the principal source of energy that man utilizes for the production of mechanical power.

There is no other source of energy on the earth the output of which can even distantly be compared with that derived from the two sources just mentioned. We can safely say that practically our whole need of energy is supplied by that fossil stock of solar energy which is at present stored in our deposits of coal and oil. The necessary consequence of this is that we draw upon our energy capital to so great an extent that it must finally become exhausted, unless some way be found to replenish it by again accumulating this mighty solar radiation against the day when our stores of coal and oil will have been exhausted.

The total quantity of coal on the earth seems not to exceed about 2000 billion tons, of which at the present time about one and one half billion tons are used annually. This yearly consumption, however, is increasing so rapidly that our coal deposits will hardly be sufficient for another thousand years, a period that is very short in comparison with the length of the future existence of mankind on the earth.

Courtesy of Dr. Charles G. Abbot

ABBOT'S EXPERIMENTAL SOLAR COOKER

Dr. Abbot, Secretary of the Smithsonian Institution, devised this cooker, installed it at Mount Wilson Observatory and cooked with it. The parabolic aluminum reflecting surface focuses the sun's heat on a pipe which conducts hot oil to a reservoir. Cooking and baking temperatures up to 447 degrees, Fahrenheit, are obtained. The heat can be stored all night

BUT the exploitation of the coal deposits that still remain will become impossible long before that time, both for technical and for economic reasons. Within a period much shorter than these thousand years, the ominous consequences of the present reckless demolition of our coal fields will make themselves seriously felt, for the simple reason that the coal must be extracted from ever deeper and deeper levels with consequent rapid increase of the cost of mining.

The question as to whether it then will be possible to obtain the indispensable energy from other sources on earth must, so far as can now be judged, be answered in the negative. Again at the instigation of Sir William Ramsay, the possibility of such an eventual development of other energy sources was in 1910 seriously investigated in England by a number of competent men. On that occasion the possibilities were taken into account of making use of the ocean tides, of the internal heat of the earth, of the energy of the winds and waterfalls, of the kinetic energy of the earth's rotation and of its yearly motion in space, of the chemical energy of wood and peat supplies, and finally of the intra-atomic energy of the atoms of the elements.

This official inquiry showed that the application of the internal heat of the earth, of the kinetic energy of the

* From the George Fisher Baker Lecture, delivered at Cornell University, and reprinted by courtesy of *Science*.

earth's motions, of the energy of the winds, and the use of wood and peat supplies never would be of any significance for the solution of the problem in comparison to the enormous quantities of energy yearly furnished by our resources of coal and oil. The energy that could be obtained by the disruption of the atoms of our chemical elements would be enormous in amount, but we need not further consider it at this time because in the opinion of our ablest scientists the practical accomplishment of this objective will be achieved only in the far distant future, if ever.

The available water-power on the earth would, according to Engler, amount to about the energy of 70,000,000 tons of coal annually; that is, to about 4 percent of the energy necessary every year. Of course, the total water-power present on earth is much greater, but an appreciable part of it will probably never be available.

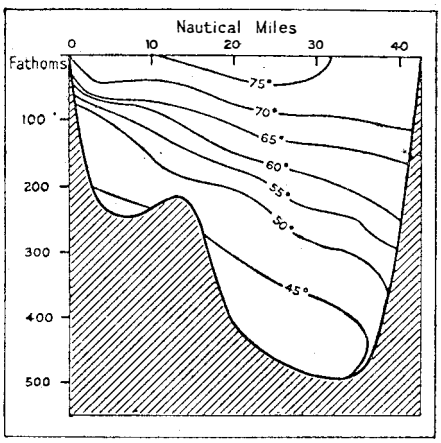
A CALCULATION made in 1922 by Steinmetz seemed to indicate that the energy of the flowing water, corresponding to the yearly amount of rain in this country, would be almost equivalent to that of your yearly coal consumption. Spoehr, however, has emphasized that these calculations are totally theoretical, as a great part of that energy is inaccessible and the distribution of the remaining energy over such an extensive territory would meet with almost insurmountable difficulties.

Therefore, in this respect, America is, for the time being, dependent in a large degree upon her own resources of coal and oil, of which the latter seems to be rapidly approaching final exhaustion, notwithstanding the apparently reassuring fact that new sources of limited extent are frequently being developed.

The possible use of the low and high tides of the sea has occupied the attention of various inventors since the 15th Century. Indeed, the periodically alternating low and high ocean tides would furnish gigantic quantities of energy if it were only possible to use them for mechanical purposes in a not too expensive and complicated way.

In recent times several solutions of this problem have been proposed, some of which have already found a practical application, although only on a relatively small scale, in France, in England, and in several places in Germany (Ditmarschen, Husum, Hüll). The systems with two large communicating water reservoirs, instead of those with a single one, seem to be preferable, as they allow an uninterrupted action both day and night, even during neap tide. Their theoretical efficiency, for a difference in sea-level of about ten feet is, however, less than that of a system with a single tank, and is not greater than about 12,400 kilowatts for each sea-tide and for each square mile of surface of the reservoirs, and in practice this efficiency is appreciably diminished by a number of uncontrollable factors, as, for example, the irregularities in the level-differences of the tides, to the square of which the energy output is proportional.

Such a plant would be extremely expensive and its maintenance would be very costly. Consequently it could economically be operated only under very favorable local conditions. It is therefore probable that no satisfactory solution of the problem of the production of energy in this manner is to be expected.



By Marmer, after Wust, courtesy of the *Geographical Review*

GULF STREAM TEMPERATURES

Cross-section of Gulf Stream through Straits of Florida, Cuban shore at right

Recently, however, there seems to be indicated another way of energy production from the sea, which, in my opinion, may become of high significance in the future. I refer to the experiments of G. Claude and P. Boucherot upon the utilization of the relatively small but very constant temperature-differences that exist throughout the year between the sun-heated surface of the tropical oceans and their deeper layers, the temperature of which is kept at from 37 to 39 degrees, Fahrenheit, by the cold polar-sea currents.

IN 1913 your countryman Campbell pointed to the possibility of obtaining mechanical or electrical energy by means of these very constant temperature-differences, and in 1923 Romagnoli, Dornig, and Boggia made analogous propositions. It was, however, only recently that the well-known French chemist Claude and his collaborator Boucherot succeeded in giving experimental proof of that possibility. They were able to demonstrate that a small Laval turbine designed to be driven by steam within pressure limits ranging from 300 to 3 pounds per square inch can advantageously be driven by water vapor with tensions between only 3/5 and 3/20 of a pound per square inch, corresponding to temperature-differences between 77 and 44 degrees, Fahrenheit, only.

According to their calculations and experiments, a net output of 383,000 foot pounds could be obtained from each cubic meter of water between 82 and 39 degrees, Fahrenheit, if there be subtracted the energy that is necessary for pumping the cold and air-free water from the depths of the ocean to its surface. An installation of this kind having a capacity that effects the displacement of 35,300 cubic feet of cold water every second, would be able to produce 400,290 kilowatts of electrical energy, this efficiency being about 30 or 35 times as great as that of a low and high tide plant of the same dimensions.

In their provisional installation at Ougree-Marihaye, Claude and Boucherot recently demonstrated before a meeting of engineers that a turbine could be run by utilizing the slight temperature-differences of the water of the Meuse, ranging only from 82 to 44 degrees, and that it could drive a dynamo with a capacity of 59 kilowatts. The calculations by Boucherot of the necessary costs of installation seem undeniably to indicate that the practical realization of this idea lies very probably within the limits of technical possibilities.

THE question as to whether it would be possible to use our present stocks of coal and oil in a more economical way than is now usually applied is of high importance and has often been the subject of discussion and investigation. In the present exploitation of our oil fields, about three fourths of the oil remains in the soil. This needs, in the future, to be recovered by some process suitable to the purpose.

Even the continuous improvement of the steam engine, or its substitution by turbine or gas motor, can not eliminate the ominous fact that the greater part of the heat of combustion of the coal and oil will, when thus used, always be wasted. At the present time it seems that the most effective way of limiting, as far as possible, this squandering of energy consists in the combustion of the coal at the mines themselves, and the immediate utilization of the heat of combustion for the production of high-tension electric currents.

It is possible that some way may be found for transforming the potential energy of the coal directly into electrical energy, but experiments along this line have not yet met with practical success. None of the so-called "fuel batteries" constructed for this purpose in the last decade can be considered as being adapted to practical development, because their current efficiency, even at higher temperatures, remains in each case much too small by reason of the unsatisfactory re-

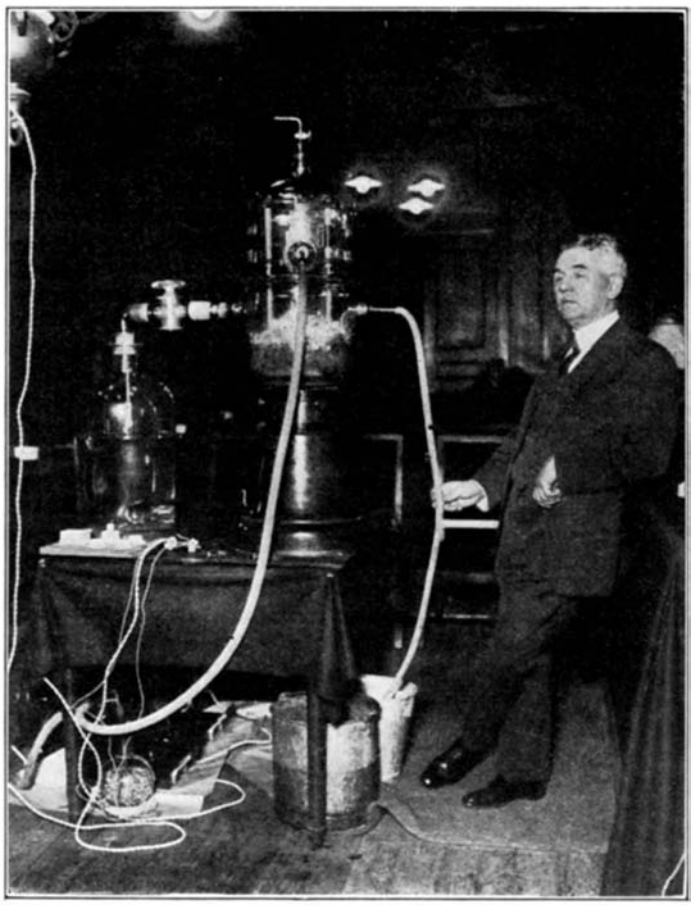
action-velocity of the electrochemical processes going on in them.

As the matter now stands, we can say that in answering the question as to how to make the future necessary energy production most completely independent of the fossil stocks of energy accumulated in former geological periods, we are chiefly confined to the mighty current of radiant energy that is flowing to us directly and continuously from the sun. This quantity of radiant energy appears to be stupendously great, but it is now almost completely lost by dissipation. Some data may give you a clearer understanding of this fact.

According to Langley's measurements of the solar constant, each square meter of the earth's surface receives, every hour, a quantity of radiant energy that is equivalent to 1800 calories. If we regard the sun as limiting itself to an eight-hour working day in tropical regions, it can be calculated that every square meter of the earth's surface receives from the sun's radiation a quantity of energy equivalent to the heat of combustion of 2.86 pounds of coal. For every square mile this is equivalent to 7400 tons of coal, which means that the total annual amount of energy produced throughout the world through the combustion of coal would be equaled by the radiant energy of the sun which, during a like period, falls upon a surface of only 1275 square miles. The desert of Sahara has a surface of about 2,300,000 square miles, and therefore annually receives a quantity of solar energy that is equivalent to more than 1800 times that derived from the world's total yearly consumption of coal.

AT present this enormous quantity of energy is almost completely lost; only three percent of it is absorbed and used by the living plants on the earth. Although this percentage is a very small one, the total quantity of radiant energy annually absorbed in this way over the whole solid surface of the earth still amounts to about 15 times the yearly world consumption of coal. But the question arises as to whether and in what way it would be possible to catch the enormous quantity of solar energy that now is dissipated every year, and to apply it to the production of mechanical and electrical energy.

In the consideration of this question two points should be emphasized at the outset; first, the necessity of concentrating and accumulating the solar energy supplied to large surfaces; and second, of absorbing this solar energy to the greatest possible extent. Absorption must precede the transformation of radiant energy into those other forms in which it can be used for our immediate purposes. After absorption, the solar energy may be immediately transformed into heat which may then be utilized in the usual manner for the production of mechanical work, or the radiant energy may be absorbed by special substances in which it sets up a "photochemical" reaction and thereby produces a certain amount of chemical energy. The chemical energy can afterwards be changed into another form of energy suitable for our use.



DR. CLAUDE AND HIS FAMOUS EXPERIMENT

He first demonstrated the principle involved, on a laboratory scale, before the French Academy of Sciences. Now he is installing a full-scale plant in Cuba, at Matanzas Bay

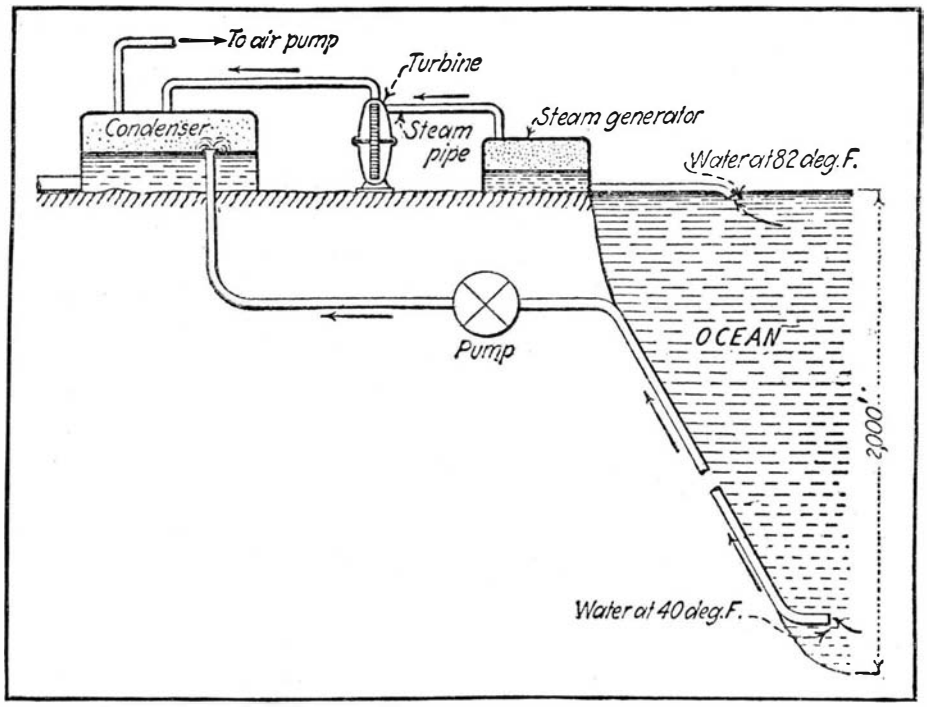
Nature has solved the latter problem of utilizing the solar energy through a most remarkable photochemical process in which that mysterious laboratory which we call the "living vegetable cell" is involved. The plant utilizes the radiant energy of the sun to synthesize a large number of complicated chemical substances in its protoplasm. These compounds accumulate in the plant organism, and their stored chemical energy can later be employed for the production of mechanical work. We also know of other photochemical reactions in which a fraction of the absorbed radiant energy is immediately transformed into electrical energy. I will discuss these more fully later on.

Let us first consider the other and simpler case of utilizing the solar energy by first concentrating and absorbing it, and then transforming it into heat.

Concentration of the radiant energy may be effected either by means of large lenses or by a system of mirrors; the absorbent heat-reservoir is placed at the focus. In actual practice, only systems of mirrors have been used. These are mounted on a light frame which permits them to be easily rotated, which is, of course, necessary because they must follow the apparent motion of the sun in the sky. The radiant energy concentrated by these mirrors falls upon a metallic reservoir which is blackened on the outside and which contains some volatile liquid that shows a considerable vapor tension at relatively low temperatures. Ammonia, sulfur dioxide or certain organic liquids of low boiling point are employed.

AN example of this type of installation is that devised by Shulz, in which, using sulfur dioxide, an output of about one horsepower was obtained for each square yard of surface of the absorbent reservoir. At the ostrich farm in Pasadena they have used, and perhaps still are using, a conical aggregate of mirrors of 32 feet diameter, in the focal line of which a steam boiler was placed. This developed steam at a pressure of from 150 to 225 pounds per square inch after only one hour's exposure to the sun, and the device was used for pumping water at the rate of about 2000 gallons per minute, and for driving a dynamo.

It may be possible that in dry and tropical climates this method of utilizing solar energy may be successful on a small scale, the cost of the equipment being compensated by the fact that the expense of operation is very low. But under less favorable conditions this device can never be expected to yield a satisfactory solution of the problem because it concentrates the radiant energy that falls on only relatively small surfaces. The proposal of Claude and Boucherot offers much greater promise in this respect because it utilizes the



SCHEMATIC LAYOUT OF CLAUDE-BOUCHEROT PROJECT

Water becomes steam at air temperatures if air pressure is greatly reduced. Claude and Boucherot do this by condensing the exhaust from the turbine with cold bottom water

energy that is accumulated over the immense surface of the ocean during long intervals of time.

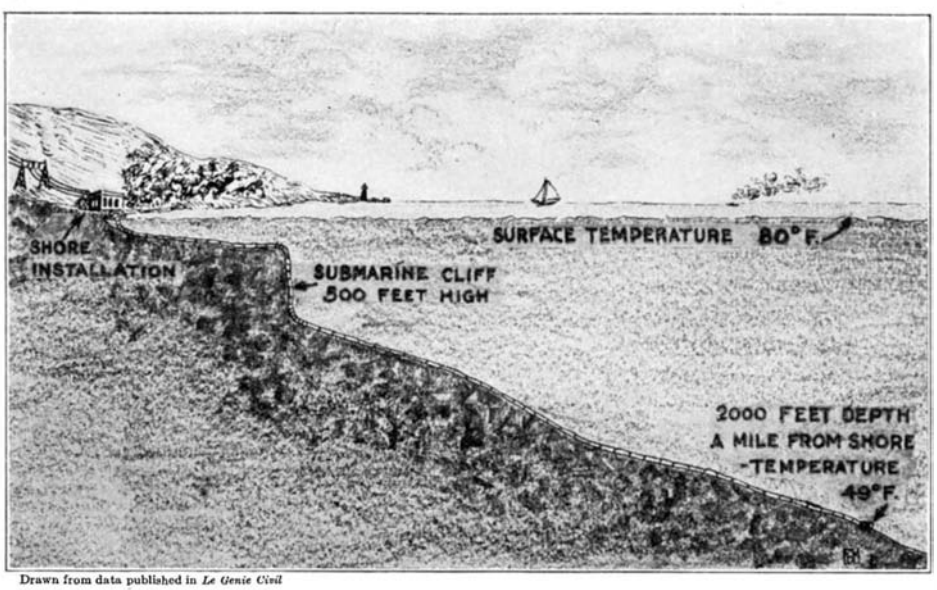
These considerations lead us to the conviction that the final solution of the problem must be sought rather in the utilization of specific photochemical reactions of the radiant energy. I intentionally use the word specific here because experience has shown us that the action of radiation upon chemical substances is highly exclusive in character. The assimilation of carbon dioxide by plants is a well-known example. The radiation is here absolutely necessary for bringing about this reaction which goes on at ordinary temperatures, the living cell being able under the influence of sunlight and with the aid of its chlorophyll to synthesize a number of complicated substances which we in the laboratory, in spite of the high development of synthetic chemistry at the present time, are able to produce either not at all or only with great difficulty, even when high temperatures and powerful agents are employed.

WE are still dependent, for the production of most of our foods and drugs, upon photochemical processes that proceed under the influence of solar radiation in the plant cells. Although it seems possible, according to the experiments of Ciamician and Ravenna, to influence these processes within certain limits by special external stimuli, we really as yet have little understanding of the true mechanism of these reactions. But the researches of Baly, which have shown that moist carbon dioxide may, in the presence of certain substances such as compounds of cobalt or nickel, be transformed through the influence of ultra-violet light into substances like sugar, have demonstrated that it is possible to produce, in the laboratory, compounds that are formed in the natural processes of the living plant.

No one as yet has succeeded in carrying on this photochemical synthesis on a large scale. It offers, however, an alluring prospect because, according to Brown's investigations, if it is assumed that a quantity of solar energy equivalent to five calories will transform one liter of carbon dioxide into sugar, and if only 4 percent of solar energy during an eight hour day is assumed to be photochemically active, it would be possible in this manner to produce 374 pounds of sugar every day by the use of a tank having a surface of only one hundred feet square. This amount of sugar, besides its value as a nutriment, would, if used as a fuel, be equivalent to about 154 pounds of coal. It is extremely doubtful, however, whether this method of utilizing solar energy will ever be brought to practical success.

The remaining possible solution of the problem of utilizing the radiant energy of the sun for the production of mechanical work is the application of reversible photochemical reactions which proceed in such a manner that the absorbed radiant energy may be converted into a usable form such as electrical energy. If the reversibility of such photochemical reactions is nearly quantitative in character, the photosensitive system of substances will then, in respect to solar radiation, play a rôle analogous to that of the lead accumulator in respect to electric energy. We might term such instruments "radiation accumulators"; they would be exposed during the day to the solar radiation which would cause a certain photochemical reaction, and then at night when left in the dark this reaction would reverse, the materials would return to their original condition, and the radiant energy absorbed during the day would be set free and stored up for mechanical uses.

IT has long been known that such reversible photochemical processes really exist. For example, if a solution of mercuric chloride and ferrous chloride in water is exposed to light radiation, a reaction takes place in which certain amounts of mercurous chloride and ferric chloride are formed, a chemical equilibrium between the four salts being finally reached. If now this solution is placed in the dark, the sub-



Drawn from data published in *Le Genie Civil*

CLAUDE-BOUCHEROT PROJECT NOW UNDER WAY IN CUBA

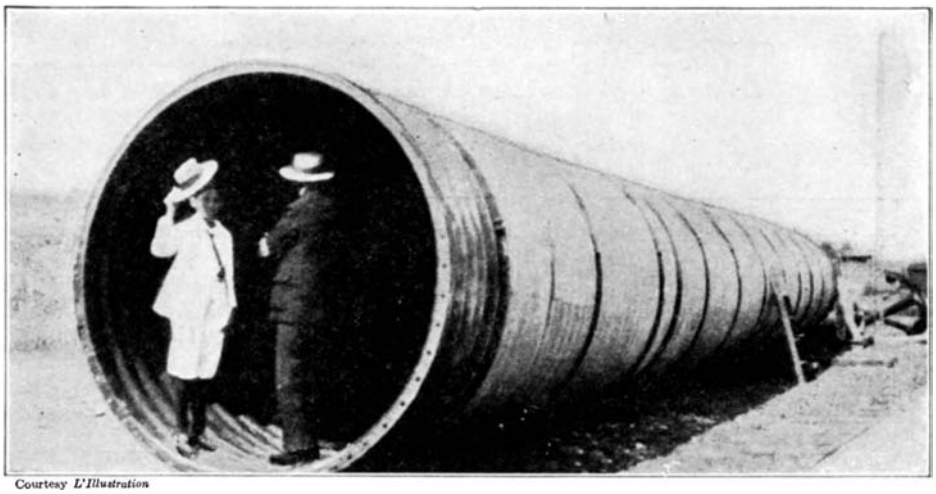
The tube, seven feet in diameter, is made of corrugated iron. An accident to it recently delayed the project. In the drawing both vertical and horizontal scales are the same

stances will revert to their original form, and during this inverse reaction the radiant energy absorbed will be completely set free in the form of electrical energy. It is possible to obtain a tension of 0.17 volt by means of such a photochemical cell; consequently a dozen such cells joined in series will yield the voltage furnished by an ordinary lead accumulator cell.

AGAIN, such a photochemical cell can be made by placing two platinum electrodes to an acidulated solution that contains potassium iodide and ferric chloride. When this cell stands in the dark, ferrous chloride and a certain amount of free iodine will be formed, the iodine remaining dissolved in the excess of potassium iodide. On exposing this cell to the action of light, the chemical equilibrium is displaced in the opposite direction, and potassium iodide and ferric chloride are regenerated. As with the previous cell the absorbed radiant energy is set free as electric energy.

Another remarkable example of a phenomenon of this nature is described by Rigollot. Two plates of red copper, each of them superficially covered with a thin layer of coprous oxide, are placed in a saturated solution of sodium chloride. If now one of these plates is exposed to light radiation and the other is kept in the dark, an electric current passes through the wire that connects the two electrodes. This current continues as long as the exposure lasts. The whole system returns to its original state in the dark. If the other electrode is illuminated, the electric current flows in the opposite direction.

These various experiments furnish definite proof that it is possible to convert radiant energy into electrical energy by means of reversible photochemical processes.



Courtesy *L'Illustration*

SECTION OF TUBING READY FOR INSTALLATION. CLAUDE PROJECT

The tubing is made of Number 7 gage sheet iron, is corrugated, very flexible, and light. The cold bottom water will be warmed only one degree in the pipe, it is estimated

There is, however, one great drawback to the practical application of such a method, and that is the very low intensity of the electrical current that is produced. The electrical work that can be done, which is a product of the voltage and current intensity, is, therefore, in all cases only extremely small. The explanation lies in the fact that the reversible transformations which take place in these cells are characterized by very small reaction velocities, and consequently the energy that is carried off can not be resupplied by the photochemical reactions with sufficient rapidity. The photochemical effect appears in general to be the strongest in those cases of reversible processes in which the oppositely directed reactions are slowest, and because of this fact, some investigators are inclined to doubt whether the utilization of such radiation accumulators can ever be of practical value. This opinion may, however, prove to be unduly pessimistic.

The construction of such cells is wholly a problem of reaction-kinetics. If it should prove possible to devise radiation accumulators or Volta-cells in which reversible and very rapid photochemical changes take place when radiation of such wavelengths as are contained within the solar spectrum is employed, the problem of using solar radiation as a source of energy might be regarded as definitely solved.

We are, however, still far distant from this goal. Photochemistry is still in its infancy and it has not yet outgrown the stage of mere empirism. It is quite possible, however, that when man's existence becomes seriously menaced because of a shortage of energy, photochemistry will rescue him from his distress.

The protection of mankind from this danger rests chiefly upon the physicist and the chemist, and they must ever be on the alert to find solutions for these intricate problems that involve the very existence of our race.

	Power Already Utilized			
	Horsepower	Percent of World Totals	Percent of Available Being Used	Total Horsepower Existing
Germany	1,100,000	3.6	55	2,000,000
Great Britain	250,000	0.8	29	850,000
France	2,100,000	6.9	26	8,000,000
Norway & Sweden	3,200,000	10.7	17	19,000,000
Switzerland	1,400,000	4.6	18	8,000,000
Spain	1,000,000	3.3	23	4,400,000
Italy	1,800,000	6.0	47	3,800,000
Russia in Europe	100,000	0.3	5	2,000,000
Rest of Europe	1,000,000	3.4	10	10,100,000
Europe	12,000,000	39.6	21	58,200,000
United States	10,000,000	33.0	29	35,000,000
Canada	3,200,000	10.6	12	26,000,000
Brazil	400,000	1.3	1.6	25,000,000
Mexico	500,000	1.7	8.0	6,000,000
Argentine	30,000	0.1	0.6	5,000,000
Rest of America	300,000	1.0	1.3	23,100,000
America	14,400,000	47.7	12.0	120,000,000
Siberia	90,000	0.3	0.2	51,000,000
China				20,000,000
Dutch Indies	80,000	0.3	0.5	15,000,000
Japan	3,000,000	10.0	21.0	14,000,000
New Guinea				10,000,000
British India	400,000	1.3	5.0	7,400,000
Rest of Asia				5,700,000
Asia	3,600,000	11.9	3.0	123,100,000
Africa	20,000	0.1	0.01	190,000,000
Australia	200,000	0.7	3.0	6,500,000
World Totals	30,000,000	100%	6%	497,900,000

From data in the *Stone and Webster Journal*

STATISTICS OF THE WORLD'S DEVELOPED AND UNDEVELOPED WATER POWER

The table shows that the world is using only 6 percent of its potential water power. Yet if every available hydraulic horsepower were to be used, the total would only equal half the present installed power from all sources in the United States alone. Water power is inadequate

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Exceptional Mastodon Bones Found

THE skeleton of a mastodon has just been unearthed in the village of Walnut, Indiana, and has been presented to Field Museum of Natural History, Chicago, by William and T. Bower, owners of the land upon which it was found. The

Courtesy Field Museum of Natural History

P. H. Yoder, a contractor of Argos, Indiana, with skull and other bones of mastodon he discovered

skeleton was discovered by P. H. Yoder, local contractor, and his crew, while excavating an open ditch on the Bower farm.

Prof. Elmer S. Riggs supervised the excavation of the bones, which are probably between 25,000 and 100,000 years old. Included in the remains obtained are the giant beast's skull, tusks, teeth, jaws, and what are believed to be more than half of its body and leg bones. The find is regarded by museum authorities as extremely important, as it is seldom that such nearly complete specimens of these great creatures of the dim past are found. The new bones will provide a more nearly complete skeleton of an individual than any previously obtained.

Skeletons of mastodons and mammoths are not rare; in fact it is commonly stated that every marsh or nearly every marsh conceals at least one such skeleton. Nevertheless finders of similar remains are always urged to notify qualified scientific institutions, giving them the opportunity to investigate, as any find may turn out to have unexpected importance.

Holes in Submarines Patched Under Water

A NEW device for quickly patching holes in disabled submarines under water has been tested by United States Navy officials and pronounced successful. The device looks something like a pneumatic hammer, but employs charges of high explosive to drive steel studs through the shell of the sunken vessel, fastening an emergency patch over the rent. It is the invention of Robert Temple, of Denver.

The advantages claimed for the new submarine patcher are great speed in emergency operations, and ease of handling under water. The method now in use requires a comparatively slow-working air drill, dragging many feet of cumbersome hose behind it. The new tool drives a steel stud, three and one half inches by one half inch, through a half-inch steel plate at a single blow. It makes no noise, and complete safety for the operator is claimed.

In a navy yard test, a torpedo flask with a hole ten inches in diameter in its side was lowered into the water. A diver went down with a submarine patcher and a steel plate big enough to cover the hole. He fastened the plate in place with eight studs in about 90 seconds.

Further possible emergency uses for the

To illustrate how cheaper amateur movies are made—enlarged film

new tool have been pointed out. It is possible to drive hollow studs as well as solid ones with it, and through such tubes water, liquid foods, and air could be supplied to men trapped within disabled submarines. The ends of threaded studs could be secured with nuts, thus making it possible to attach lifting cables at exactly the points desired by the commander of a salvage crew.—*Science Service.*

Cheaper Amateur Movies

A ROLL of 16-millimeter film, such as is used in standard amateur motion picture cameras, costs six dollars for a length of 100 feet which, when projected, gives a screen picture of only four minutes. A similar roll of film used in a new camera, the Homovie, which was recently announced by the Kodel Electric and Manufacturing Company, will give 16 minutes of pictures when projected in the Homovie projector. Besides this lower cost, the Homovie equipment has the advantage of eliminating frequent loading of the camera.

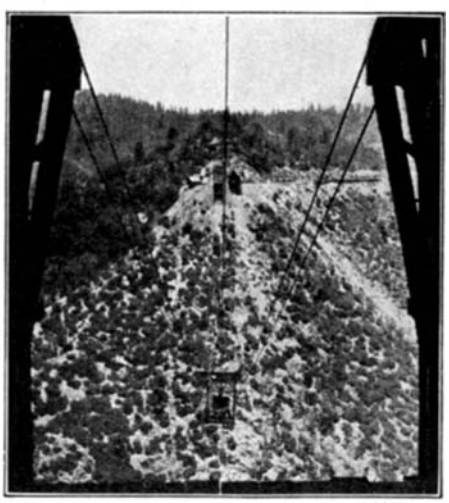
With the new camera, four picture images are made in each "frame" where only one picture is made with other cameras. These are taken in a sequence that will give a cross-wise projection as well as a length-wise projection. The sequence of the quarter "frames" are: forward, to the left, forward, to the right, and repeat. This is best shown by the accompanying illustration.

Since it is obvious that with a unit length of, say 100 feet, of standard 16-millimeter film, four times as many pictures may be made when using Homovie equipment as may be made with old style amateur movie cameras, it will be seen that the new equipment reduces the cost of amateur movies 75 percent.

Electric Cableway Spans Western Canyon

HIGH up in the western mountains, near the little town of Camino, California, the largest electric cableway in this country spans a canyon a half-mile wide. This cableway, recently completed for the Michigan California Lumber Company, carries lumber from a loading point on one side to the mill on the other. Because of the heavy weights, high speed, and long distance involved, the installation is one of the most outstanding of its type.

The cableway is operated by electricity, complete equipment for the purpose being supplied by the General Electric Company. A single loaded carrier, carrying a rail car loaded with a maximum of 24,000 pounds of sawed lumber—a maximum gross weight of 29 tons—passes to and fro between the two loading terminals on opposite sides of the canyon. The distance between terminals is approximately 2700 feet, the depth of the canyon is 1200 feet, and the maximum speed of operation is 1800 feet per minute, or a little over 20 miles per hour. The carrier makes a round trip in something over six minutes, including the three and one third minutes required for loading and unloading. The equipment is capable of handling this cycle continuously.



View from receiving and control building showing aerial tramway cable carrying a heavily laden car

Four steel cables, each two inches in diameter, support the carrier which runs on 32 wheels. The traction rope is endless and is one inch in diameter.

The electric equipment consists, principally of two 225-horsepower, wound-rotor, intermittent duty, hoist motors, operating mechanically and electrically in parallel, and controlled through suitable primary and secondary magnetic contactor panels. A single manually operated master controller governs both motors. The two motors are geared to two large sheaves, each eight feet in diameter, which engage the traction rope. Each motor is equipped with a motor-mounted brake. Momentarily the two motors are able to exert a combined output of 800 horsepower and, for short periods, most of this capacity is required.

Stopping the carrier at either terminal is normally accomplished automatically, in four graded steps, by means of a geared limit switch. After being so stopped at either end, the carrier is brought to the final position. This requires accurate spotting, in order to roll off the loaded rail car, and the final spotting is done by an operator located at each terminal, through the use of an "inching" push button.

Demonstrating the new cathode-ray television set with which large audiences may be entertained

The motors and power plant are located at one side only of the canyon, and the carrier is started and accelerated by the operator at the main master switch located on the motor or power side of the canyon. The necessity for inching the load to its final position on either side of the canyon by operators located on either side, 2700 feet apart, made it necessary to provide for the transfer of control back and forth across the canyon, with a red and green signal light system and proper interlocking of control circuits for safety reasons.

The entire equipment operates under both overhauling and motoring loads at different times during the cycle of operation. For example, as the 29-ton loaded carrier descends into the sag of the supporting cables—approximately 135 feet at the middle of the span—the motors act as generators for the purpose of limiting speed. At other times, when ascending into the terminals, maximum motoring power is required.

The cableway is also used, on occasion, as a man carrier, as it is often necessary to transport men across the canyon during operations.

Cathode-Ray Television Receiver Developed

TELEVISION which can be viewed by a room full of spectators rather than by only one or two, was announced recently by Dr. Valdimir Zworykin, research engineer of the Westinghouse Electric and Manufacturing Company. The use of a cathode-ray tube as a receiver gives this new type of television many advantages over the well-known scanning-disk method of visual broadcasting.

The cathode-ray television receiver has no moving parts, making it more easily usable by the rank and file of the radio audience. It is quiet in operation, and synchronization of transmitter and receiver is accomplished easily even when using a single radio channel.

Another advantage is that, using a fluorescent screen, the persistence of the eye's vision is aided and it is possible to reduce the number of pictures shown each second without noticeable flickering. This in turn allows a greater number of scanning lines and results in the picture being produced in greater detail without increasing the width of the radio channel.

Dr. Zworykin and his cathode-ray tube used in a television receiver

The apparatus described by Dr. Zworykin is now being used in experimental form in the research laboratories in East Pittsburgh. A number of similar receivers are being constructed in order to give the system a thorough field test through station KDKA, which already is operating a daily television broadcast schedule with the scanning-disk type of transmission.

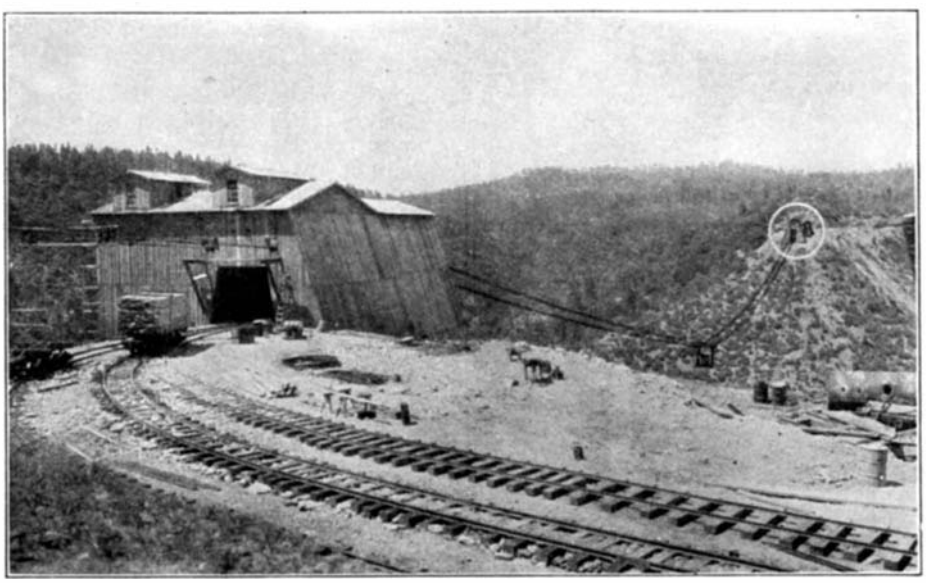
The pictures formed by the cathode-ray receiver are four by five inches in size. They can be made larger or brighter by increasing the voltage used in the receiver.

Dr. Zworykin developed an entirely new type of cathode-ray tube for his receiving apparatus which he calls a "kinescope." In this tube a pencil of electrons is bombarding a screen of fluorescent material. The pencil follows the movement of the scanning light beam in the transmitter while its intensity is regulated by the strength of the impulses received from the transmitter. The movement of the scanning beam—consequently of the cathode-ray pencil itself—are so rapid that the eye receives a perfect impression of a continuous miniature motion picture.

A reflecting mirror mounted on the receiver permits the picture to be observed by a number of spectators.

This condensed description of the methods used by Dr. Zworykin to effect television transmission can give only an idea of the possibilities of the new system. To the radio public it means, when perfected, a means of television which will be simple to operate because it has no scanning disk or other moving mechanical part. The receiver will operate in silence, offering no interference to sound broadcasts.

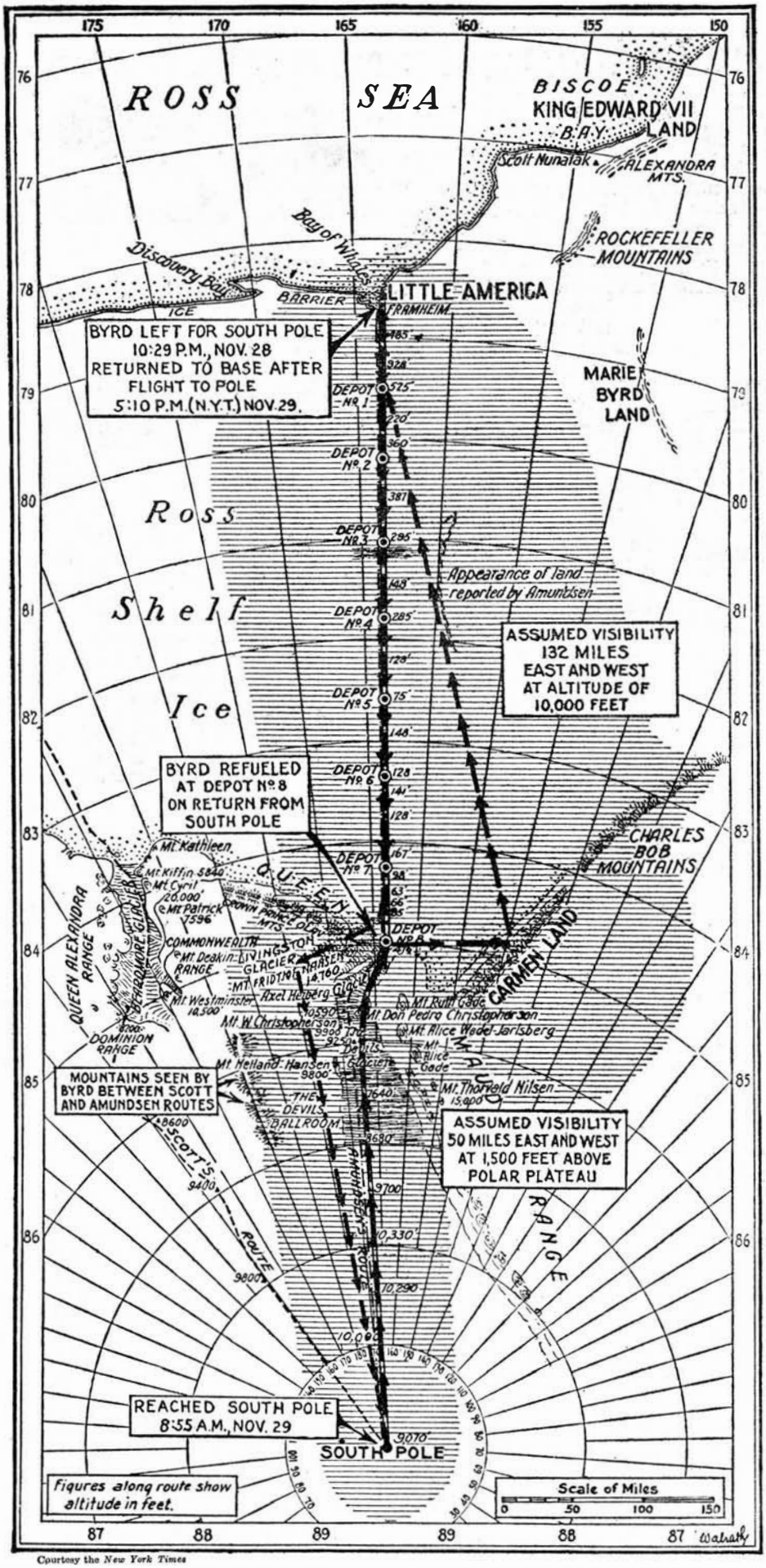
To the radio engineer the invention is important for the same reasons and because it will not be wasteful of radio wavebands. This is because the transmitter and receiver can be synchronized using but one channel.



Aerial cable tramway with a car, heavily loaded with lumber, part way across the valley. General view showing receiving terminal building and tramway

Mice Have Hereditary Twisted Noses

TWISTED noses "run in the family" of a strain of house mice discovered by Dr. Clyde E. Keeler of the Harvard Medical School and reported to the National Academy of Sciences, Washington. He found, upon dissecting some of the speci-



Courtesy the *New York Times*

After over a year of preparation, during which his expedition had been in constant touch with the world by radio, Commander Byrd, accompanied by Bernt Balchen, Harold June, and Captain Ashley McKinley, made a successful flight from Little America to the South Pole, November 28-29, 1929, over the route shown. He is continuing his explorations of the Antarctic

mens, that the peculiarity is due to the shortening of one of the nasal bones, while the other bone grows to normal length. He mated one of the apparently normal brothers of a twist-nosed mouse to a normal wild mouse, and among the offspring found one with a twisted nose; but it slewed to the right instead of to the left as in the original find. This "left-nosed" mouse, paired with an apparently normal litter mate, produced one male offspring with a straight but notably short nose. Upon examination it was found that both of its nasal bones were shortened.—*Science Service.*

Russia Makes Syrup Out of Watermelons

WATERMELONS instead of cane will be the raw material used in a new syrup factory recently established at Stalingrad, fromerly Tzaritzin, on the Volga. The product, known as "nardek" has long been made by a crude hand process, and is so popular that bee-keeping has practically disappeared from the region where it is used. The better grades of the syrup are used in cooking or confectionery, and the poorer grades in the manufacture of alcohol.—*Science Service.*

What Byrd's South Polar Flight Means

IN a special message to the *New York Times* relative to Commander Richard E. Byrd's notable flight to the South Pole from Little America, and return, on Thanksgiving Day, November 28, 1929, the National Geographic Society forecasts many valuable results.

"Data gathered by the Byrd expedition will doubtless fill in many blank spots in regard to the Antarctic continent," said the message. "This will be most evident, perhaps, cartographically. From the mosaic maps made photographically from the plane during the dash to the pole, it will be possible to prepare maps in considerable detail definitely tieing the previously known areas of the southern hemisphere to the South Pole.

"To aeronautics, the expedition has already added much needed data in regard to the operation of airplanes and the behavior of metals and lubricants under conditions of extreme natural cold. Additional data in this connection was doubtless obtained on the final dash to and from the pole.

"Careful meteorological observations have been carried on by the expedition during its long stay at Little America, its sled trips and supplemental flights, and on the polar flight itself. Antarctica has been looked upon as a weather breeder for South America, South Africa, New Zealand, and Australia, and in a sense for the entire southern hemisphere. The detailed meteorological data to be brought back by the expedition may make possible more accurate weather forecasting for the whole world.

"In the radio field Commander Byrd has made history. He is the only man to have sent radio messages from both the North Pole and the South Pole. Throughout the stay of the party at Little America, radio conditions have been closely studied, and it is probable that the data collected may lead to the solution of stubborn scientific problems."

Since the above was written, Byrd has been made a Rear Admiral, retired.

This Bank Directors' room *is paneled in* PRESDWOOD

Typical of the beautiful finish which can be given to the perfect smooth surface of Presdwood. Directors' room in the Security Savings and Loan Company Building, Cleveland. Finish applied by Cuyahoga Lumber Company of that city.

The beautiful grain effects of matched veneers are reproduced so perfectly on Masonite Presdwood that even experts often think it is the natural wood. More conventional finishes can also be applied to this grainless board—quickly and at low cost—with brush or spray gun.

Presdwood is used in hundreds of products. Its smooth surface takes any finish. Its minutely fibrous character effects a perfect bond with either paint or lacquer. Its hardness and strength make the completed article almost immune from hair-line finish cracks.

Does not crack or splinter

Hundreds of industries have adopted Presdwood for its freedom from cracking, splitting and splintering, its great resistance to moisture, and because it never warps when properly handled. Where quality articles must be built at low cost, thousands of identical Presdwood parts are turned out by band saw, milling machine or punch press, for this grainless wood board is easily handled on any woodworking machine.

Presdwood is used in everything from tiny toys to motor truck bodies. It panels ice boxes and builds incubators. It makes strong specialty shipping containers for fragile articles, smooth packing cases for delicate silks. It fashions decks of fast hydroplanes; makes weather-resisting road signs, strong partitions and light shelving.

Lines concrete forms

Presdwood is used to line concrete forms, for contractors find that this grainless wood saves them thousands of dollars in labor costs, facilitates making, erecting and wrecking forms, speeds up the work where time means money, and produces a perfect, smooth surface unmarred by grain and knot marks.

Eighty of the many interesting uses for Presdwood are listed in the Presdwood booklet which is sent, Free, to any manufacturer, builder, or home mechanic. Your copy will be mailed on receipt of the coupon.

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111 West Washington Street, Chicago, Illinois

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Please send me, Free, a sample of Masonite Presdwood and the Presdwood booklet.

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

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Learning to Use Our Wings

Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN

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

Junkers "G-38"

QUITE recently the Junkers *G-38* made a successful trial flight at Dessau, Germany, flying for half an hour at an altitude of 1500 feet. The *G-38* is undoubtedly one of the largest land planes ever built, and it shows two distinct tendencies which are apparently in the minds of airplane constructors all the world over—increase in size and the gradual evolution of the airplane to the simplicity of a flying wing.

Exact performance data are not available as yet. It is quite clear, however, that the *G-38* is intended to carry 40 passengers (and *not* 100 as reported in some papers) with a fairly long range, is powered with four engines of 600 horsepower each, and has a wing spread of 137 feet.

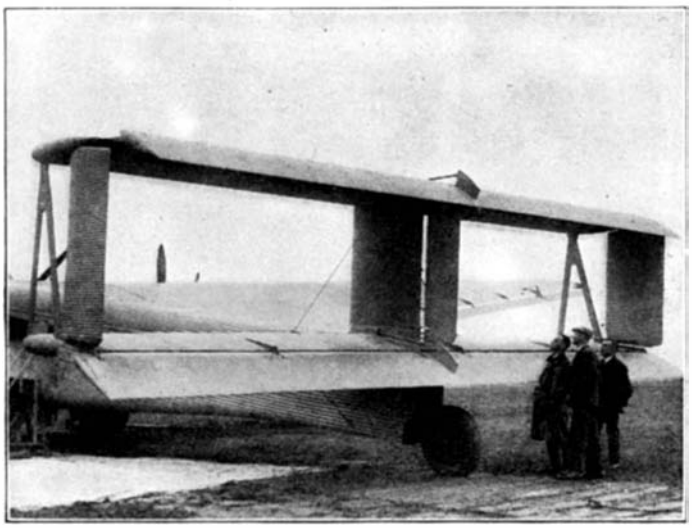
The wing construction is of the usual Junkers type; that is, braced entirely inside the wing, and tapering from root to chord, so that the wing is deepest and strongest at the root where the main stresses are to be found. With an increase in size of the wing, it is naturally possible to approach the ideal of the "flying wing." The depth of the wing at the root is between three and four feet. This allows the 12-cylinder engine, with two banks of six cylinders in V-form, to be entirely enclosed, with the only projection in the form of a streamline boss which covers the extended shaft to the propellers. Also, with the increase in size of the wing, the depth of the wing becomes an important fraction of the fuselage depth. Eventually, the fuselage will merge into the wing, or the wing merge into the fuselage, whichever way you wish to look at it.

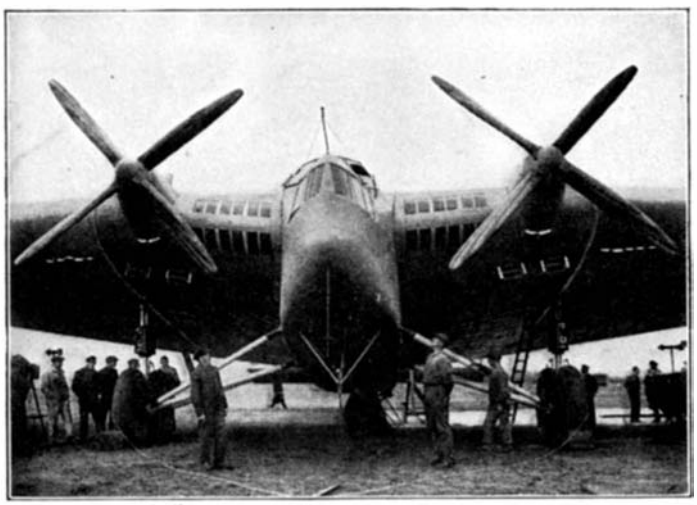
American experience has shown that when a propeller is mounted ahead of the leading edge of a thick wing, it is blanketed and loses much of its efficiency. This undoubtedly explains why the propeller shaft has been extended so far forward in the Junkers' planes.

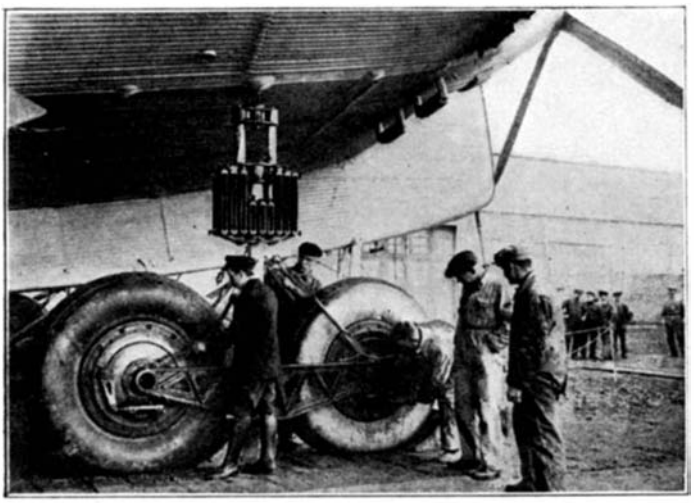
Looking at the photograph of the *G-38* in flight, we note that the two inboard propellers are four-bladed, and the two outboard propellers are two-bladed. Since four-bladed propellers are less efficient than two-bladed propellers, it may be asked why this combination has been adopted. The reason probably is that a four-bladed "prop" needs less diameter for a given horsepower and this allows the propellers to be brought a trifle closer to the center line of the airplane.

The front view of the *G-38* shows that there are two radiators for each engine, mounted under the wing and capable of being drawn into the wing when less cooling is required. There is one great advantage to the use of water-cooled engines for large planes as compared with air-cooled engines. On very large machines, the water-cooled engine can be housed so as to leave the airfoil undisturbed. This would obviously be impossible with air-cooled engines.

As planes increase in size, the question arises as to whether the pilot will have enough strength to operate the controls. Naturally the airplane constructor wants to stave off as long as possible the day when he must use servo motors, either hydraulic or electric, to operate the controls, since this means increase in cost and complexity.

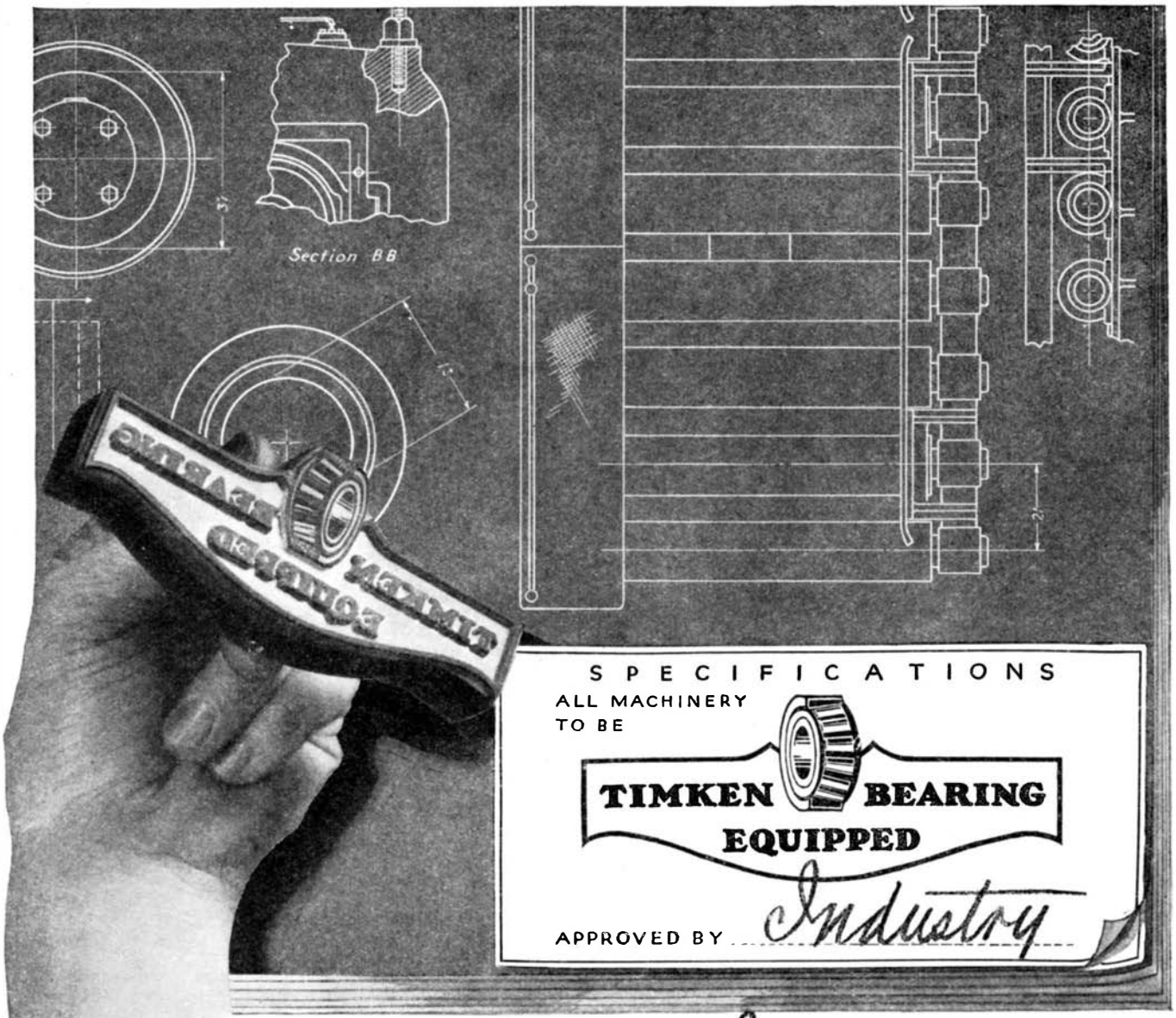






Upper left; The Junkers *G-38* in flight. *Upper right:* The tail surfaces are as large as the wings of a small plane

Lower left: Front view, showing the radiators. *Lower right:* Wheel-connecting truss is hinged in the middle



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America is sweeping aside obsolete methods and machines.

Machine buyers and builders have found a modern symbol of protection for production, freedom from friction, extended machine life, preserved alignment, reduced maintenance costs . . . they have found it in "Timken Bearing Equipped."

To all industry it means that all loads, whether all radial, all thrust or a combination of both, are capably carried by Timken,—*the one bearing that does all things well.*

Years of proof have brought recognition to this exclusive combination: Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken-made Steel. So "Timken Bearing Equipped" sweeps on as the universal *stamp of approval* in a national program of modernization.

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TIMKEN *Tapered Roller* **BEARINGS**

The way to avoid this undesirable contingency is to pay more and more attention to the balancing of the control surfaces. The ailerons of the Junkers *G-38* are hinged on points well behind the leading edge of the ailerons, the hinge points being supported by a series of arms mounted at the rear of the wing structure proper, and above the aileron. There is also a pronounced slot between the wing and the ailerons, which helps to reduce the turning moment of the ailerons and to improve their effectiveness at slow plane speeds. Both the elevators and the central rudder seem to be balanced in the same way as the ailerons.

Nothing illustrates the size of the *G-38* so well as the view of the tail surfaces. When compared to the size of the three men in our photograph, it can be seen that the tail surfaces are as large as the wings of many an airplane.

A "wrinkle" in design is the careful way in which the control horns are enclosed in a fairing.

There is one great advantage in multi-engined planes—the greater reliability of the power plant as a whole. In the *G-38* this reliability is further increased by the fact that the mechanics can get at the engines in flight, since these engines are enclosed in the wing. There is a small hand-operated trolley in the wing. The mechanic can climb into the wing from the fuselage and rapidly propel himself to any engine which may need attention.

The landing gear is particularly interesting. As planes get larger and larger, the question of the wheels becomes serious. Instead of having four wheels strung along the span of the machine, the designers have used two wheels in tandem on each side of the fuselage. The head-on resistance of the wheels is somewhat reduced by such an arrangement. It will be further seen from the photograph of the landing gear that the wheels are mounted at the end of a bridge-like truss, which is connected at its center to the shock-absorbing system. The truss is hinged at its center, so that the wheels can pivot about their common center, with shock-absorber cord keeping their pivoting motion within reasonable limits. This feature should be particularly useful when landing or taxying on rough ground.

European countries seem to be very slow in adopting the use of wheel brakes. In the *G-38* brakes are used, and with success. It is remarkable that the German designers still employ rubber as their sole means of shock absorption. The oleo landing gear has proved so successful in the United States, that it seems curious that the practice should not be followed in Germany.

MILEAGE AND TRAFFIC STATISTICS FOR PRIVATELY OPERATED AIRMAIL ROUTES WITHIN THE U. S. A., FOR YEAR ENDING JUNE 30, 1929

Month (all routes)	Length of routes, miles	Miles of service actually flown	Total weight of mails dispatched, pounds	Amount paid to contractors
July, 1928	12,021	653,883	214,572	$445,238.41
August, 1928	11,977	731,714	419,357	821,005.01
September, 1928	11,977	749,156	423,838	843,691.44
October, 1928	12,169	784,663	465,688	915,998.56
November, 1928	12,504	731,027	425,405	851,390.06
December, 1928	13,791	891,811	541,632	1,094,782.54
January, 1929	14,060	795,293	488,709	955,114.33
February, 1929	14,060	778,329	434,260	865,042.52
March, 1929	14,264	912,760	524,537	1,047,657.78
April, 1929	14,400	885,737	508,672	1,003,718.32
May, 1929	14,334	1,135,953	588,428	1,160,089.23
June, 1929	14,345	1,148,403	598,494	1,161,461.00
Totals	159,902	10,198,729	5,633,592	$11,165,189.20

Progress of the Year

THE American Society of Mechanical Engineers comprises some 12,000 or more members and is sponsor for a number of divisions which cover the widespread and varied field of mechanical engineering. Its aeronautic division presented at the December annual meeting of the society an authoritative report on the year's progress in aeronautics.

In the engine field there were three interesting tendencies. First: The use of ethylene glycol (Prestone) as the cooling medium instead of water. The boiling point of this chemical being so much higher than that of water, it is possible to use much higher jacket and radiator temperatures and thus reduce the size of the radiators. Second: The use of the Venturi cowl, which, placed around the air-cooled engine, reduces the air resistance of the engine considerably. Third: The increasing use of geared-down engines. The piston speed of the engine has been steadily increasing by the use of higher revolutions per minute, and this has been perhaps the main reason for the light weight per horsepower now obtainable. Unfortunately, very high revolutions per minute of the propeller do not co-ordinate well with the moderate speeds of commercial planes. Hence gearing down becomes imperative for the sake of greater propulsive efficiency.

In aerodynamics, the direction of progress has been largely in the elimination of head resistance, by the use of the Venturi cowling, retractible landing gear, fairing-in of wheels with so-called "trousers," and so on.

Another modern tendency in airplane design is to use wings of constant center of pressure. The ordinary wing has an unstable center of pressure motion. When the airplane pitches down by the nose, the center of pressure moves back and the nosing-down tendency is aggravated. When the airplane noses up, the center of pressure moves forward and the nosing-up tendency is increased. The horizontal tail surfaces are used to provide stability and to counteract the instability of the wing itself.

With the trailing edge of the main wing slightly turned up, it is possible, without much sacrifice in lift or efficiency, to secure a stable center of travel. It is then possible to reduce appreciably the area of the tail surfaces, and also to reduce the weight of the wing. If there is pronounced travel of the center of pressure, then the front spar carries most of the load at one time, and the rear spar at another time. With the constant center of pressure it is possible to make the front spar do most of the work, and to lighten the rear spar accordingly.

Another device which is receiving favorable attention is the floating-tip aileron. Here the aileron is placed beyond the tip of the wing itself, and is free to adjust itself so as to lie always in the wind. The control of the ailerons is, as usual, by lateral movement of the stick, but because the ailerons lie normally in the wind their effectiveness is not reduced at high angles of incidence of the main wing.

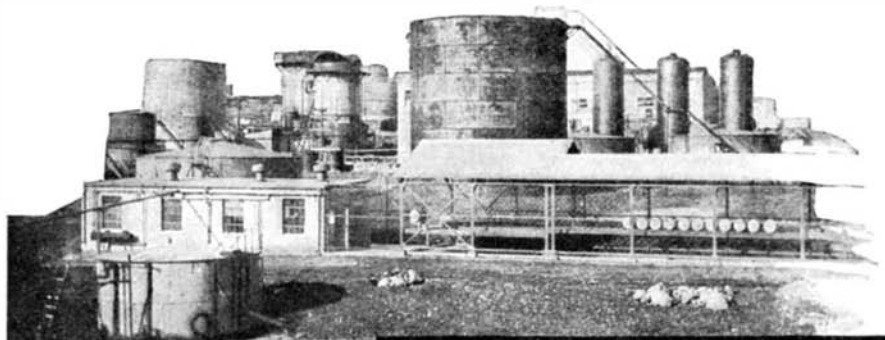
We reproduce two tables taken from the same progress report. One gives mileage and traffic statistics for privately operated mail routes. This shows a rapid and steadily growing increase in the number of miles flown and the amount of mail carried.

The other table shows that the United States now leads the world in scheduled

(*Please turn to page* 166)

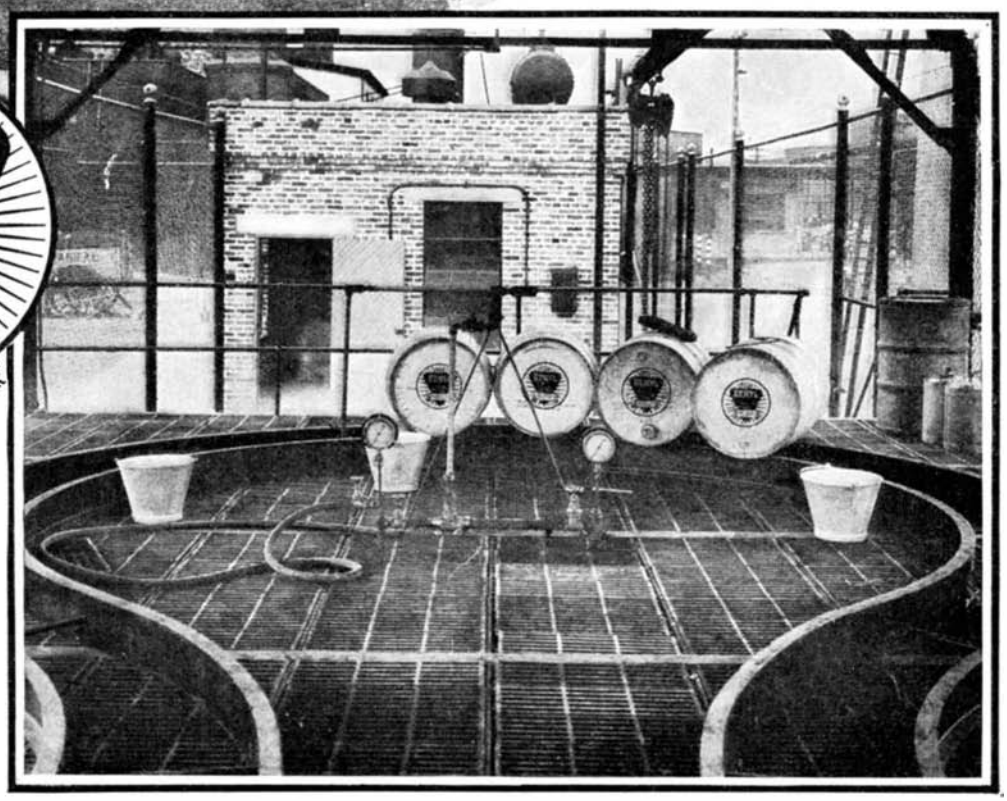
AIR-TRANSPORT MILEAGE OF THE WORLD—OPERATIONS OF SCHEDULED SERVICES IN AIRPLANE-MILES

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Australia	....	....	....	....	235,582	262,895	352,847	417,970	453,580	641,831
Austria	....	....	....	....	....	....	....	....	245,043	383,002
Belgium	....	....	....	....	....	160,000	144,500	....	....	....
Canada	....	....	....	....	....	294,778	446,648	631,715	....	....
Columbia	....	2,687	53,650	125,678	134,375	169,500	183,206	....	....	....
Czechoslovakia	....	....	....	....	....	126,400	48,300	170,895	257,888	605,314
Denmark	....	....	....	....	56,000	....	114,500	126,730	116,798	122,215
France	....	505,500	1,460,000	2,015,000	2,115,000	2,249,000	2,946,000	3,243,900	3,755,369	3,753,133
Germany	....	....	....	842,986	885,881	1,860,000	3,070,000	3,816,144	5,921,593	7,030,565
Great Britain	168,000	644,000	225,000	717,000	943,000	936,000	862,000	840,000	769,000	....
Italy	....	....	....	....	....	....	....	....	824,474	1,236,913
Mexico	....	....	....	....	....	....	....	96,800	146,400	....
Netherlands	....	50,850	217,000	246,200	336,000	482,800	679,753	597,500	813,510	1,007,920
Poland	....	....	....	66,293	142,057	233,923	465,847	....	654,873	630,175
Soviet Russia	....	....	....	....	....	288,600	292,595	311,000	....	....
Sweden	....	....	....	....	....	69,280	248,610	222,000	206,766	208,729
Switzerland	....	....	....	....	....	268,400	87,427	210,340	459,720	330,496
United States	393,066	880,028	1,828,354	2,329,296	1,743,030	2,220,761	2,910,611	4,407,263	6,009,226	9,888,307



Left—Typical refinery scene with Ethyl mixing plant in foreground.

Below—Close-up of Ethyl mixing plant. Drums on runway contain Ethyl fluid about to be mixed with gasoline to form Ethyl Gasoline.



WITH ETHYL BRAND OF ANTI-KNOCK COMPOUND ETHYL GASOLINE CORPORATION NEW YORK, U.S.A.

Knocks out that "knock"

Wherever you drive—whatever the oil company's name or brand associated with it—*any* pump bearing the Ethyl emblem represents quality gasoline of anti-knock rating sufficiently high to "knock out that 'knock'" in cars of average compression and bring out the additional power of the new high-compression cars.

How Ethyl Fluid is mixed with gasoline

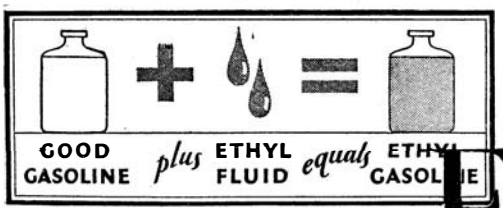
ANYONE interested in practical chemistry would enjoy a visit to one of the plants in which the oil companies mix Ethyl fluid, containing tetraethyl lead, with their gasoline to form Ethyl Gasoline.

What would probably be most impressive would be the *precision* with which it is done. Engineers from the oil company or from the Ethyl Gasoline Corporation supervise every step of the process.

First, the base gasoline with which Ethyl fluid is to be mixed is tested at an Ethyl laboratory. From this test, the exact amount of Ethyl fluid necessary to bring the gasoline up to a rigid standard of anti-knock quality is determined. An accurate measuring device is used at each refinery to insure that this quantity of Ethyl fluid goes into every gallon of gasoline.

Look for the Ethyl emblem.

Ethyl Gasoline Corporation, New York City.



The active ingredient now used in Ethyl fluid is tetraethyl lead.

ETHYL GASOLINE

Current Bulletin Briefs

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

Aeronautics

AVIATION (FACTS THAT EVERY AVIATION AND FINANCIAL OFFICIAL WILL WANT TO KNOW) tells about the efforts of the Better Business Bureau of New York City to apprehend and prevent fraudulent aviation promotion schemes. *Better Business Bureau, 280 Broadway, New York City—Gratis.*

AIRPLANE FUSELAGE WELDING AND HOW TO WELD DURALUMIN are two papers presented in one leaflet. The first is an outline course for welders engaged in aircraft construction; the second describes correct practices for making ox-welded joints in aluminum alloys. *Linde Air Products Company, 30 East 42 Street, New York City—Gratis.*

SINISTER BEACONS, a booklet dealing with fire hazards of airports and landing fields, lists recommended fire fighting materials and apparatus. *American-La France and Foamite Corporation, Elmira, New York—Gratis.*

Electricity

PROTECTION OF ELECTRICAL CIRCUITS AND EQUIPMENT AGAINST LIGHTNING (Bureau of Standards Miscellaneous Publication No. 95) tells how and where lightning arresters should be installed in those cases where it has been decided that their use is justified. *Superintendent of Documents, Government Printing Office, Washington, D. C.—25 cents.*

SHORT-WAVE TRANSATLANTIC RADIO-TELEPHONY, reprinted from the *Bell Laboratories Record*, is an interesting booklet presenting 12 papers which tell the various stages of the development of the two-way transatlantic telephone service over short-wave paths initiated by the American Telephone and Telegraph Company in 1928. *Bell Telephone Laboratories, Inc., 463 West Street, New York City—Gratis.*

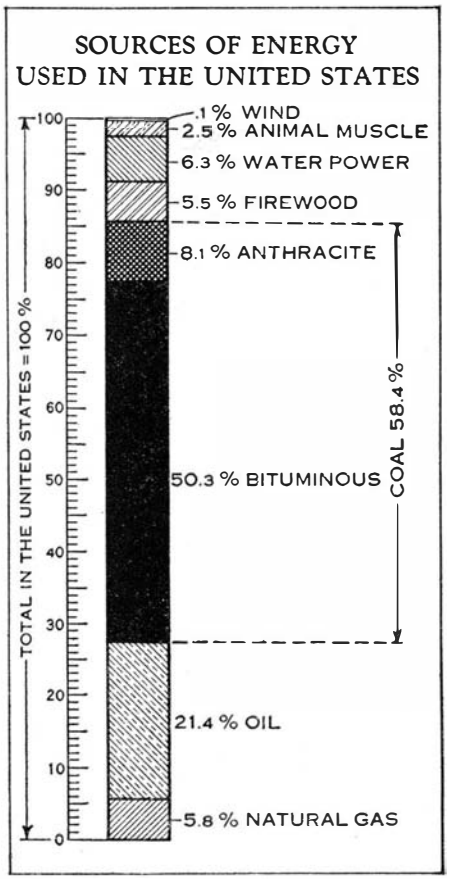
SOME UNIVERSAL PRINCIPLES OF COMMUNICATION, by John Mills, is an outline of the fundamentals of communication, and the relationship of telephony, telegraphy, sound pictures, and television. *Bell Telephone Laboratories, Inc., 463 West Street. New York City—Gratis.*

LIGHTING DATA, a series of booklets published by the Edison Lamp Works, includes the following new titles:
LOOKING AHEAD IN AVIATION; FLOODLIGHTING; ELECTRIC LIGHT ON THE FARM AND IN RURAL DISTRICTS; and LUMINOUS HARMONY IN THE HOME. All of these booklets are well illustrated and written in non-technical language, presenting valuable information and practical suggestions. *Edison Lamp Works, General Electric Company, Harrison, New Jersey—Gratis.*

ANALYSIS AND MEASUREMENT OF THE NOISE EMITTED BY MACHINERY, by B. A. G. Churcher and A. J. King, is an engineering study of noise, based on an extended investigation now being conducted by the Metropolitan-Vickers Electrical Company, Ltd., *Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W. C. 2, England—Inquire cost.*

Miscellaneous

SHIFT OF CIVILIZATION CHART AND MANUAL, by Samuel S. Wyer, is a striking presentation of the most significant steps in the development of science, religion, and law from man's beginning to the present day. *Fuel-Power-Transportation Educational Foundation, 1116 Beggs Building, Columbus, Ohio—Gratis.*



Self-explanatory diagram from the "Shift of Civilization Chart and Manual" mentioned in the text

GENERAL CATALOG illustrates and lists natural history materials collected and made available to educational institutions by the Frank A. Ward Foundation of the University of Rochester. The materials listed cover the fields of human anatomy, comparative anatomy, zoology, entomology, paleontology, geology, and minerology. *Ward's Natural Science Establishment, Inc., P. O. Box 24, Beechwood Station, Rochester, New York—75 cents.*

VITAMINS IN FOOD MATERIALS, by Sybil L. Smith, (Circular No. 84, Department of Agriculture) is a complete review of the authenticated data available concerning the various vitamins and their occurrence in food materials. More than half of the circular is devoted to bibliographies, showing references dealing with vitamin occurrence in each food. The references also cover the techinique for the quantitative determination of vitamins. *Superintendent of Documents, Washington, D. C.— 15 cents.*

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION (1928) is distinguished by its 600-page General Appendix, containing 27 outstanding papers written by leading scientists on a wide variety of topics. *Superintendent of Documents, Government Printing Office, Washington, D. C.—Two dollars (cloth binding).*

DAM OR BRIDGE: WHICH? Under this title, Mr. Cyrus C. Walker presents a well-prepared plan for converting the interior part of San Francisco bay into an enormous fresh-water lake, by constructing an earthen causeway from a point near Van Ness Avenue on the San Francisco shore to Tiburon on the Marin County shore, including Alcatraz and Angel Islands. The plan is suggested as an alternative for the proposed bridge across the Golden Gate. *C. C. Walker, 230 Upper Terrace, San Francisco, California.—50 cents.*

THE DUKE ENDOWMENT YEAR BOOK is an interesting description of the charities promoted by the bequests of the late James B. Duke. The millions of dollars accumulated by the tobacco and power interests of the Duke family are being returned gradually by means of well-directed philanthropies to universities, hospitals, orphanages, and rural churches. *The Duke Endowment, Power Building, Charlotte, N. C.—Gratis.*

SILVER SOLDERS is a new booklet describing the specifications and uses of various silver-alloy solders, with suggestions and instructions for correct soldering practice. *Handy and Harmon, 57 William Street, Bridgeport, Conn.—Gratis.*

SPONTANEOUS COMBUSTION OF HAY, by Dr. Charles A. Browne of the Bureau of Chemistry and Soils, presents the various theories of spontaneous combustion, summarizing the present knowledge of the subject. Dr. Browne adds a theory of his own, while pointing out the need for more study of the problem. *United States Government Printing Office, Washington, D. C.—10 cents.*

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Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

New Baking Powder Leaves No Traces in Bread

A NEW baking powder that leaves no undesirable traces in the bread is proposed by Edwin O. Wig in a recent issue of *Industrial and Engineering Chemistry*. Mr. Wig has investigated the properties of acetonedicarboxylic acid and finds it possesses many qualities which recommend it as a leavening agent.

Authorities disagree as to the physiological action of the products left by baking powders in baked goods. Inasmuch as all common baking powders leave saline cathartics, such as sodium tartrate, Rochelle salt, disodium acid phosphate, or sodium sulfate, and since there is some question as to the physiological effect of aluminum hydroxide, a leavening agent that would leave no residue would preclude the possibility of any controversy and would constitute an ideal baking powder.

Acetonedicarboxylic acid was prepared by adding fuming sulfuric acid to citric acid. The resulting acetonedicarboxylic acid was crystallized from ethyl acetate several times and then dried over calcium chloride. Cornstarch or other starch was dried by heating under reduced pressure in a flask on a steam bath. Starch and acetonedicarboxylic acid were then weighed and mixed so as to give a baking powder which would yield from 13 to 15 percent carbon dioxide, the usual strength of a commercial baking powder.

Cakes, and in one case, bread, were baked, some with a commercial baking powder and some with acetonedicarboxylic acid baking powder. The same recipes were used and the same oven conditions, the two products generally being baked side by side. In every case the acetonedicarboxylic acid powder raised the product as well as the commercial powder.

The investigator is convinced that an acetonedicarboxylic acid baking powder might be manufactured to compete with the more expensive baking powders on the market, especially if cheaper citric acid were made available. Such a powder would have the advantage of leaving nothing in the baked product.

Removing Calcium Sulfate Deposits from Pipes

IN hot water containing sulfates, the presence of even a small amount of lime will cause the precipitation of insoluble calcium sulfate. When pipe lines or integral parts become sufficiently coated to retard circulation, the removal of the deposit becomes an important problem. Calcium sulfate is not soluble in the usual solvents. Chemists of the United States Bureau of Mines have determined that a hot solution of bicarbonate of soda will react with calcium sulfate to form a loose mixture which permits the removal of the bulk of the scales by the current flow of the solution. The remaining scale is sufficiently changed so that a weak solution of hydrochloric acid will completely remove it from the line.

Catalysis Reduces Cost of Acid

ONE of the first things learned by the student in chemistry is that an acid is neutralized by an alkali—in other words, sulfuric acid and ammonia, for example, are at opposite ends of a scale and when they are brought together they destroy each other's identity as completely as Eugene Fields' Gingham Dog and Calico Cat:

"But the truth about that cat and pup—
Is this—they ate each other up!"

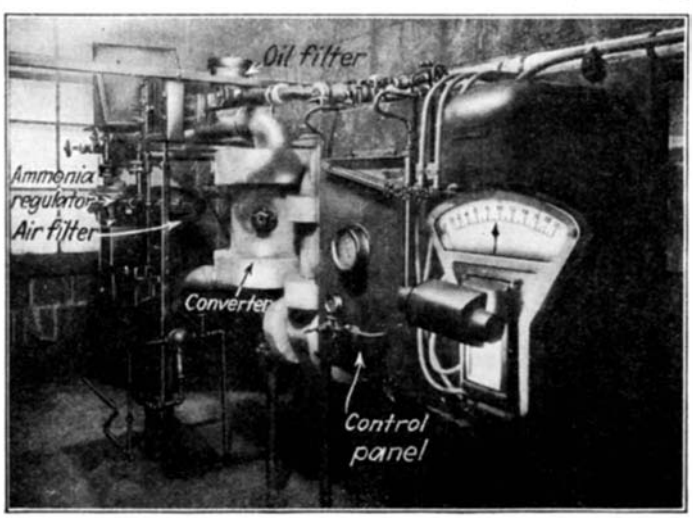
With this basic knowledge of the behavior of acids and alkalies, one would hardly expect an acid to be made by the use of an alkali. Yet this very procedure is finding extensive application in the manufacture of sulfuric acid, where modern chemistry has developed a process of transforming ammonia into the nitric oxides required for the formation of H_2SO_4 in lead chamber plants. Where formerly about three and one half percent of all the nitrate imported from Chile was used to supply nitric oxides in sulfuric acid plants, American manufacturers are now freed from this dependence on a foreign source and enabled to produce cheaper acid by the substitution of ammonia—a by-product of coke manufacture.

This process of oxidizing ammonia has been developed by the Du Pont Company and is similar to the Du Pont process for the production of nitric acid from ammonia. It is fully described by T. R. Olive in a recent issue of *Chemical and Metallurgical Engineering*. The most interesting feature of the installation, from the technical point of view, is its compact form and its automatic operation. The automatic gas analyzer, known as Ranarex, shows exactly what percentage of ammonia is being supplied to the system and another ingenious "robot," the Smoot regulator, adjusts the valve to keep the gas flow just right.

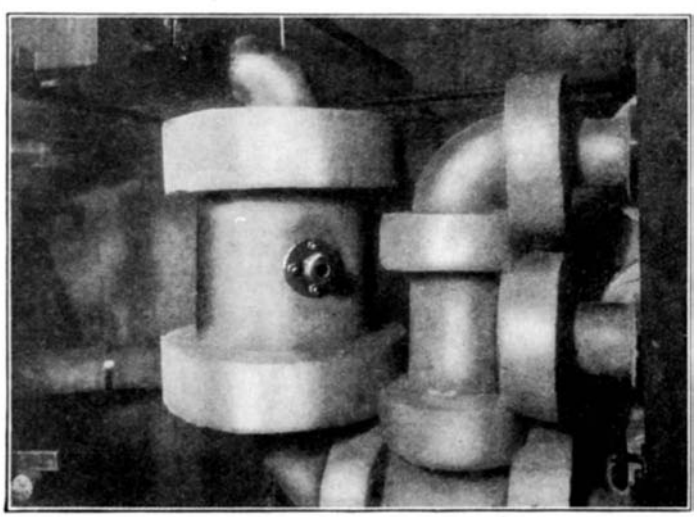
Ammonia gas, mixed with air, is filtered, heated to about 250 degrees, Centigrade, and passed through a converter, which contains a platinum-rhodium alloy gauze. Passing through this gauze, the ammonia is converted by catalysis into oxides of nitrogen. The reaction gives off heat which keeps the wire gauze at a cherry red heat. The surplus heat is also used to pre-heat the ammonia mixture entering the converter, by means of a heat-exchanger. Some of the remaining heat in the converted gas is utilized to vaporize the anhydrous ammonia which is used as raw material. The cooled gas is then delivered directly into the sulfuric acid plant, where the oxides of nitrogen play their vital part in the formation of that universally important chemical.

Different Dynamites for Specific Uses

WHEN Alfred Nobel began making dynamite on a commercial scale in 1865, the product was used for quarrying, submarine blasting, mining, and construction work. Since then, successive chemists have so improved this useful explosive that it is now almost fool-proof



One of the oxidation units of the sulfuric acid plant of the Davison Chemical Company, showing pressure gage, flow meter, and automatic ammonia gas tester



Close up, showing the converter and heat exchanger manifold. Through the sight glass in the converter, one may see the red hot platinum gauze catalyst

and there are dozens of different varieties made especially for specific uses. There is even one type, 90 percent gelatin, which is suitable or economical for any other work.

The high grades of straight dynamite, says Arthur LaMotte in a recent issue of *Chemical and Metallurgical Engineering*, have been found admirably adapted for blowing ditches in swamp land by what is known as the propagation method. They also are suitable for mudcapping boulders and rocks in quarry work, but these explosives are not suitable for use in the main boreholes in quarry blasting or in underground work. Medium-grade gelatins, 40, 50, and 60 percent, are admirably adapted for underground work in metal mining and hard-rock tunneling, but are not suitable for mudcapping or ditching by the propagation method, or for coal mining. Ammonia dynamites are used extensively in mining rock salt, gypsum, clay, and some of the more friable metallic ores, but cannot, of course, be used in submarine work or for ditching by the propagation method.

Waltzing Mice Detect Poison Gas

JAPANESE waltzing mice have been found to be more responsive to concentrations of the deadly carbon monoxide than canaries, long used by the United States Bureau of Mines for this purpose in connection with mine rescue operations. On the other hand, guinea pigs have been found to be unsuited for detecting dangerous amounts of carbon monoxide.

Due to their almost incessant activity, Japanese waltzing mice are more susceptible to carbon monoxide than either canaries, common house mice, or white mice. The Japanese waltzing mouse is thought to be a mutation of the house mouse and is commonly found in Japan and China. They appear to be unable to orient themselves in a horizontal plane, which results in an erratic running in circles—sometimes wide, sometimes narrow, and sometimes in pairs forming a figure eight and repeated many times in rapid succession.

In comparative tests with canaries made at the Pittsburgh Experiment Station of the Bureau of Mines, it was found that the Japanese waltzing mice showed signs of response to carbon monoxide in advance of signs in the canaries heretofore used.

Will Reveals Novel Conception of Immortality

CHEMICAL AGE reprints the following extract from the will of the late Henry A. Wadworth, a prominent and wealthy Englishman, which reveals the writer's unique conception of immortality, via chemistry:

"I believe (and some of the leading scientific men of the day assure me that I believe rightly) that at my death the organic constituents of my body will be quickly converted into carbonic acid and ammonia, and that those gases will, by the law of diffusion, be at once distributed over the whole world and will help to build other plants and in their turn animals, so that in the future every plant and animal in the world will contain an infinitesimal portion of my body.

"The inorganic parts of my body, the phosphates of lime, et cetera, will also be

(*Please turn to page* 163)

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

Carbon-Arc or Quartz Mercury-vapor Lights

SINCE the use of the carbon-arc and the quartz mercury lamps has become general there has been much argument as to which is more efficient, which type more suitable for the public, and which type less potential of danger. The carbon-arc lamp provides ultra-violet rays, exactly as does the quartz mercury-vapor lamp. The amount of ultra-violet rays supplied and the amount of infra-red or heat rays supplied depends, of course, on the size of the equipment, the intensity of electrical power consumed, and similar factors.

The carbon-arc lamp yields more heat rays than does the quartz mercury-vapor and should not, of course, be chosen when the heat rays are not desired. By the use of special carbons cored with materials which emit strongly in the longer visible rays and in the shorter infra-red rays, the carbon-arc lamp becomes an excellent source of heat rays. By the use of suitable screens of window glass, in fact, it is possible to screen out the ultra-violet rays entirely and thus to use the carbon-arc lamp purely as a heat lamp.

The American Diet

ONE of the most significant facts of the past 25 years has been the gradual change in the American diet. The amount of food taken is approximately 1000 calories less per day than used to be taken. The old die consisted primarily of meat, potatoes, coffee, and sugar, whereas it is generally recognized that Americans are eating more fruit and vegetables and that they do pay some attention to the question of vitamins.

Dr. Lovell Langstroth of San Francisco tabulated the diets of 501 persons having degenerative diseases, with particular reference to the amount of protective food substances which they ate, and with a view to finding out whether or not changes in the diet could be related to the degenerative diseases. He found that non-protective foods formed 54 percent of the average diet, and that if all accessory foods were included, the non-protective foods formed 88 percent of the average diet. Bread, butter, meat, potatoes, and sweet desserts formed the great bulk of the diet of most of the people studied. With the exception of butter and cream, which contain considerable amounts of the fat-soluble vitamin A, these diets are vitamin poor.

When the patients were put on a well balanced diet calculated to provide proper amounts of protective substances, the percentage incidence of degenerative diseases decreased. Thus a diet containing 70 percent of protective foods was prescribed in 44 cases of chronic circulatory diseases, 75 cases of chronic arthritis, 55 cases of chronic gastro-intestinal diseases, and 10 cases of migraine. Doctor Langstroth reports that 73 percent of these 174 people were improved by the change in diet. There were changes in their body weight, in the appearance and feel of the skin and subcutaneous tissue, and in the quality and reactions of the mucous membranes.

In discussing Doctor Langstroth's point of view, Dr. George B. Eusterman of the Mayo Clinic pointed out that the known criteria of an efficient diet are simple. They include adequate calories to supply energy, sufficient protein of the right type, a carbohydrate-fat ratio which must fall within certain limits, adequate amounts of fluid, and sufficient fresh fruit and vegetables to safeguard the vitamin and inorganic salt intakes. Overeating of sugar or carbohydrates results usually in obesity. A persistent relative vitamin deficiency is likely to provoke bodily discomfort, impaired tone of the body, and a lowered resistance to disease.

Symptoms of Tuberculosis

INVESTIGATORS for the National Tuberculosis Association have studied the order in which the important symptoms of tuberculosis appear in various people. This is, of course, of the greatest importance, since early diagnosis and treatment are essential to recovery. Cough is the most common symptom reported; frequent colds and expectoration of a good deal of material are also quite common.

One of the leading symptoms is the fact that the person becomes tired too easily and suffers with fatigue early in the morning. Loss of weight and appetite are common in this disease. About one half of the persons examined suffered with pain in the chest. This pain is usually due to the fact that the tuberculous infection produces inflammation inside the chest and adhesions between the lungs and the chest wall. Hemorrhage from the lungs is not so common as an early symptom. The five most common symptoms of tuberculosis in the early stages are cough, being too easily tired, loss of weight, loss of appetite, and pain in the chest.

Inflammation of the Spine

THE human backbone is a most inefficient tissue. The erect carriage of the human being is an acquirement of comparatively modern times, as one considers the age of the earth, and thousands of years are required for the adaptation of tissues to a new function, rather than a single generation. The development of the X ray enabled specialists in orthopedic surgery to study the condition of the spine in a fairly simple manner. Recently Dr. L. W. Allard conducted an investigation concerning spinal inflammation among orthopedic specialists throughout the country and among industrial commissions. When the X-ray plates were examined, it was found that a considerable majority of people over 50 years of age have had at one time or another inflammations of the spinal joints, and that these show in the X-ray pictures even though they may not give any important symptoms.

The most frequent occurrence seems to be in male laborers, which Doctor Allard believes is due to the fact that they are constantly subject through their active life to infection, disturbances of digestion, strains in posture, and repeated accidents. Often a relatively minor accident, such as a sudden twist or fall, which would not affect a normal spine, will produce disability in one which has previously been subjected to infection.

Industrial commissions constantly assert that injuries of the back with disability cause them more trouble than any other type of injury which comes to their attention. Certainly a man with an old inflammation of the spine should not select an occupation which is likely to put new stresses and troubles on any tissue. The United States is not the only country which is confronted with this problem. It has been found among industrial workers abroad that there are seven times as many disabled by inflammations of the joints of rheumatic character as are disabled by tuberculosis.

The primary method of relief for such inflammations is, of course, rest of the affected tissue, with the application of heat, and other common methods of alleviation. Rest may be not only the type that is secured by being in bed, but also rest through the prevention of motion. An inflamed or painful tissue should not be moved or manipulated. The specialist in orthopedic surgery produces rest for inflamed backs by the use of braces and corsets which hold the spine immovable.

The Changing Characters of Infection

AGAIN and again it is necessary to point out that germs are living organisms and that they change their characters exactly as do human beings in response to changes in their heredity and in their environment. The matter has been brought significantly to the public attention in recent months because of reported failures of the ordinary commercial anti-meningitic serum in the case of epidemics of meningitis which have occurred in various parts of the world. Apparently the meningitis germ will change its character from time to time during the intervals between epidemics and the serum which was useful in a previous period may not act against the newer germs. This does not mean that the serum treatment is in any sense of the word to be discredited. When a serum is prepared by the injection of the germs which may be isolated from the current epidemic, it is just as effective and efficient as in previous instances.

In a recent small epidemic in a western city, involving 60 cases of the epidemic

type, cerebro-spinal meningitis in ten cases was fatal. Because of the great fatality in these early cases, a different serum was obtained and this was found to give much better results. Of the 21 patients given this serum, 14 lived and seven died. Among patients who did not receive this serum, the mortality was 21 percent higher than among those receiving the special serum.

The study of the epidemic caused Dr. J. Mercer Anderson to conclude that there was a marked variation in the virulence of the meningitis germ and that the serums used varied in potency, so that it is important to determine that the specific serum is active against the specific organism. Fortunately it is possible by immunologic reactions to make such determinations promptly in any instance.

Ajinomoto

THE Japanese eat much rice and little meat. Such a diet has little energy in it. Hence the Japanese add to their food a substance which has a meat flavor but which is not meat. The use of meat in the diet, as is pointed out in a recent editorial in the *Journal of the American Medical Association* is condemned by Buddists, and instead, shavings of dried fish are added to Japanese dishes to improve the flavor.

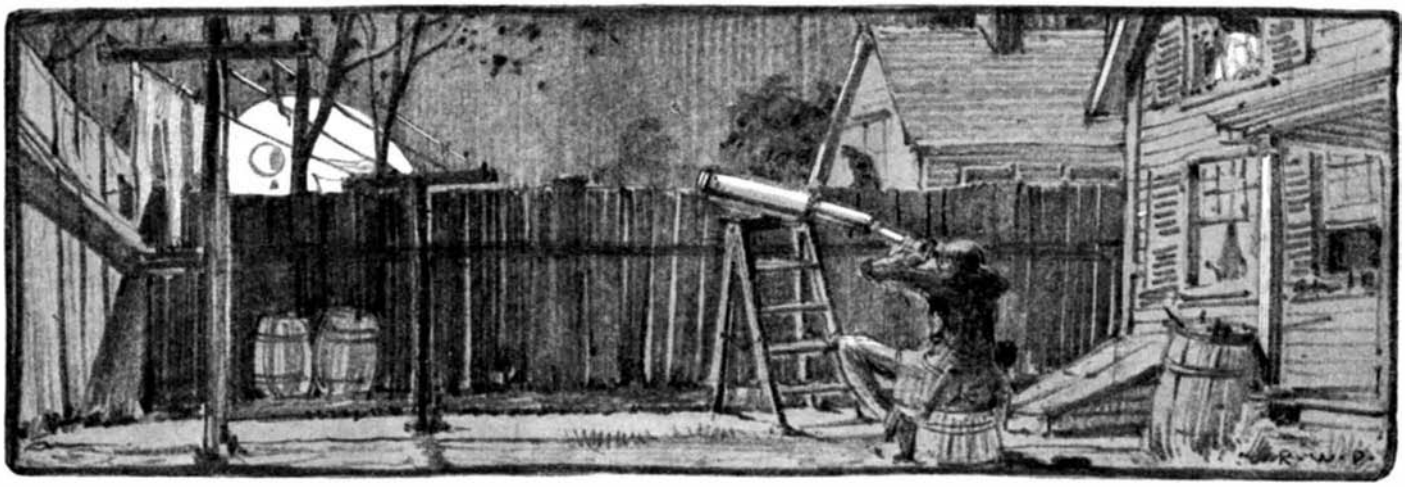
The important substance is monosodium glutamate. It is now available in commerce and is said to be as common in Japanese cookery as is salt in American cookery. This substance is called in Japan "Ajinomoto" or the element of taste. It is reported that it is manufactured by hydrolyzing gluten or soy bean with hydrochloric or sulfuric acid. In this country it costs two to three dollars a pound.

Sugar and Convulsions

WHEN changes occur in the blood, the body reacts in various manners, according to the chemical substances that may be present. If the amount of sugar in the blood is extremely low, the patient becomes confused and may develop convulsions. This has happened in some cases when an overdose of insulin has been taken. Whenever this occurs, it is customary to feed quantities of sugar and orange juice to supply the deficiency, and the convulsions are promptly relieved after taking the food.

Some years ago it was suggested that convulsions in infants following a period of fasting with fever might be due to the fact that there was an insufficient amount of sugar in the blood. Fasting prevents the intake of sugar, and fever burns up sugar in the body. Dr. J. P. Crozer Griffith of Philadelphia determined to test the matter thoroughly on a group of infants and children who had been subject to convulsions. His work caused him to believe that the night fast which the child takes because it is asleep is not of importance in producing convulsions in the morning, but he is inclined to the belief that the amount of sugar in the blood does have something to do with the time of appearance of the convulsions.

There seem to be relationships here which have not been definitely established, since a low blood sugar may exist without convulsions. On the other hand, in some instances the feeding of sugar caused prompt discontinuance of the convulsions, and this factor seems to be of much greater importance in some cases than in others.



The Amateur Astronomer

THE entire inventory of materials which C. A. Olson, Oakland Avenue, Westwood, New Jersey, used in making his mirror may be seen in the photograph reproduced below. With the exception of the pitch lap, a few chemicals used in silvering the glass, and other inexpensive gadgets,

Simple equipment for telescope making

the whole array is of the kind that can be picked up around the average household and is typical of the kind used in telescope making. Note absence of tools; none are used.

THE small observatory shown at the right was made by Albert F. Schroeder, 1175 Forest Cliff Drive, Lakewood, Cleveland, Ohio, and will be described in detail in a later number.

THE upper telescope on the opposite page is a four inch, made by Arthur D. Flagg, from easily obtained materials, the mirror disk being a piece of broken windshield from a motor car. Mr. Flagg used part of an old Ford water pump for his polar axis support. He also used the brass shells of discarded light sockets for making three eyepieces. A magnification of 40 or more diameters may be had from such a telescope.

P. M. JONES, 3421 Second Street, Des Moines, Iowa, whose second telescope is illustrated opposite, used the H C F lap and "found it all that was claimed for it, both in its rapid cutting and the ease of changing the tool to alter the figure." The framework of his mounting is of steel angles. This is very rigid. The yoke is made of three-inch channels welded at the joints. The telescope has a friction drive on both axes, consisting of a 10-inch disk edged to fit a small V-shaped roller held against it by a spring. Setting circles were made of lacquered protractors costing 20 cents each.

WE now continue and conclude below Professor Douglass' informative discussion of "Atmosphere, Telescope and Observer," begun in the last number:

"It is easily a matter of observation that making allowance for the variation in brilliancy of the apparent field when the eye is in the focus, the atmospheric currents are precisely the same in telescopes of different apertures at the same time and place. This is of course what should be expected. But different apertures do change the character of the seeing and this also is what we expect. Conceiving the waves to consist of crests and valleys as the waves on water, we see that the refraction takes place on the slopes between these and that two adjacent slopes refract in opposite directions. If we take the distance from crest to crest as d and the mean amount of refraction in each slope as r seconds of arc we shall find that in a telescope with an aperture of $\frac{1}{2}\ d$ or less the image in the focus will oscillate through a distance of 2 r. If the aperture of the telescope is d we would see in succession, if the waves were all of perfect form, first a haziness of the planet, then a displacement of r seconds in one direction, then a haziness followed by a displacement of r seconds on the other side of its original position, then a haziness as at first, and so on; the haziness in each case being due to the presence of two slopes at once before the lens. If the aperture were $1\frac{1}{2}\ d$ there would be alternations of haziness with these displacements of r seconds, the displacements themselves being not entirely free from haziness. With further increase of the size of the objective, displacements would for a time exist but become more and more hazy until at last they would cease, leaving the planet perfectly steady but blurred.

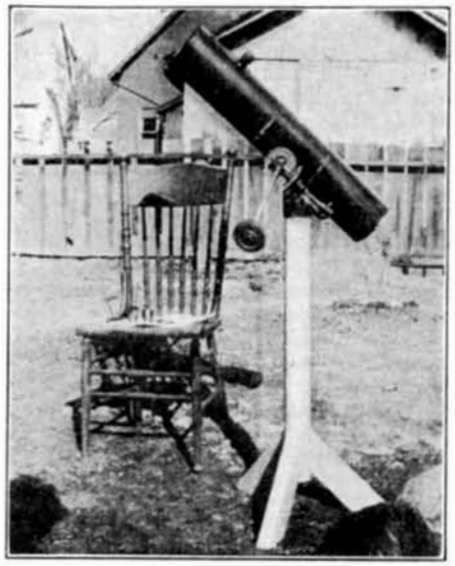
"Such is the effect of using different apertures. As a matter of fact we rarely have such simple conditions in actual experience. We have a given telescope and usually three series of air waves which may all be of different sizes. By a big diaphragm we can get rid of the blurring effect of the largest set. By medium and small diaphragms we can improve successively the bad effect of the other series but in doing so the light is enormously decreased. We may summarize this matter of aperture by saying that the smaller the aperture the more bodily motion and less confusion of detail; the larger the aperture, the less bodily motion and the more confusion of detail.

"Good seeing then, apart from transparency of the air, consists of two factors, steadiness and definition. In a given atmosphere these factors vary with the aperture, one being improved at the expense of the other; either one may come from a superior atmosphere.

"Aperture has another effect on the seeing which is of different kind, namely, physiological. It principally concerns observers of planetary detail. All the effects of this kind observed, vary with the size and brilliancy of the pencil of light entering the eye. The first imperfections noticed are motes which float about and persist in coming upon the planet which is under examination. They can also be seen against a clear blue sky.

"Perhaps the most harmful imperfection in the eye is the lack of homogeneity within the more dense transmitting media, either the lens or the membranes; probably the

An easily made observatory



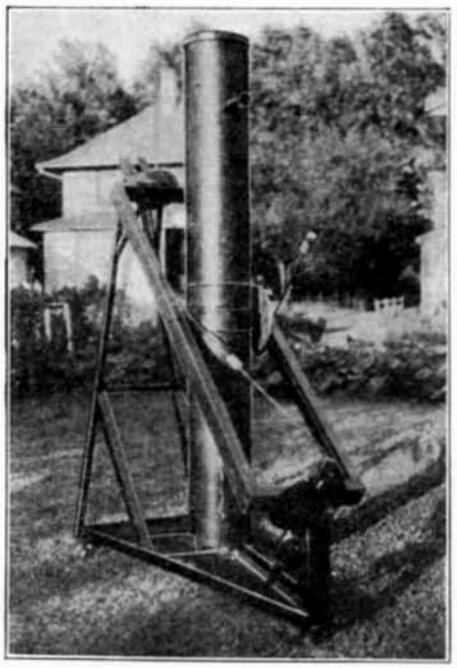
Arthur B. Flagg's trim reflector

former. Under proper conditions the lens (presumably) displays irregular circles and radial lines, the whole resembling a spider-web structure. Under actual tests this structure is so very prominent that we wonder why the eye is able to give such good definition as it does. No optician could ever sell a lens so badly made, except for the coarsest usage; in proportion to its size it has the imperfection one finds in the lens of a bull's eye lantern."

Professor Douglass next describes methods of examining one's own eyes, but this is too long to quote here.

"High powers greatly reduce contrast," he continues. "When one changes from a low to a high power the light parts of the planet become correspondingly fainter but the dark parts seem to become lighter.

"The eye has considerable power of adapting itself to contrast occurring in different intensities of light in a manner entirely independent of the size of the pupil. This has often been exemplified in the experience of visitors looking at Mars, when the emergent pencil was much smaller than the pupil of the eye; at first they see nothing but a glare of light but after looking some-



O. M. Jones' double yoke mounting

times for 12 to 15 minutes the glare diminishes and markings begin to appear. This is a certain power of adaptation which I have never seen mentioned before. After much practice that first glare becomes less and less noticeable and the eye becomes more sensitive to the particular range of contrast sought. That, in fact, is the training required by the eye to discern planetary detail, and for different planetary bodies which present different degrees of contrast and different intensities of light the training has to a certain extent to be undergone afresh in each case."

FROM Professor Douglass' article the reader will have gathered some of the basic principles of good seeing and bad. It is quite natural that the beginner should assume that magnifying power, or rather actual *seeing* power, should be increased simply by increasing the aperture of the instrument used. The matter is not, however, so simple as that; it involves a number of variable factors, variable not only from night to night but from place to place. At best any telescope is a compromise—a compromise between a number of these factors. The most elementary point for the very beginner to grasp is that mere magnifying power does not necessarily guarantee good seeing. On many occasions one can crowd on higher magnification by means of higher powered eyepieces and actually see less than with a low power. Fully to understand the considerations Professor Douglass discusses naturally requires years of patient observation under a wide variety of circumstances.—*A.G.I., Tel. Ed.*

The Heavens in February

By PROF. HENRY NORRIS RUSSELL, Ph.D.

At 11 o'clock: Feb. 6.
At 10½ o'clock: Feb. 14.
At 10 o'clock: Feb. 21

At 9½ o'clock: March 1

At 9 o'clock: Mar. 7.
At 8½ o'clock: Mar. 15.
At 8 o'clock: Mar. 22.

NIGHT SKY: FEBRUARY AND MARCH

MERCURY is a morning star and is best seen about the 15th when he is 26° from the sun and rises at 5:40 A.M. He remains visible low in the dawn till the end of the month. Venus is in conjunction with the sun on the 6th but she will not come into sight in the evening sky until next month. Mars is still unfavorably placed, rising about 6 A.M. and is too low for telescopic observation of any profit. Jupiter is in quadrature on the 26th and comes to the meridian at 6 P.M. He is in Taurus, north of Aldebaran, which he greatly outshines. Saturn is a morning star, rising between 4 and 5 A.M. Uranus is an evening star and sets about 9 P.M. in the middle of the month. Neptune is in opposition on the 21st, at which time he is in Leo in 10° 18′ R.A. and 11° 18′ north declination, 3¼ degrees east and one degree south of the bright star Regulus. He is invisible to the naked eye, and the observer with a small telescope can detect him only by his motion, comparing sketches of the sky made on successive nights.

The moon is in her first quarter at noon on the 6th; full at 4 A.M. on the 13th; in her last quarter at the same hour on the 20th; and new at 9 A.M. on the 28th. She is nearest the earth on the 12th and farthest off on the 24th. During the month she is in conjunction with Uranus on the 3rd, Jupiter on the 7th, Neptune on the 13th, Saturn on the 23rd, Mercury on the 26th, Mars a few hours later, and Venus on the 28th.

Chemistry in Industry

(*Continued from page 157*)

dissolved, and by the agency of rains, rivers, and ocean currents will also be distributed, but more slowly. The energy left in my body, after death degraded to heat, will quickly leave it and form part of the energy of the universe. This I believe to be the true resurrection of the dead, and the life everlasting. I believe in God, but like the God of St. Paul's Greeks, it is an unknown God, as in our present state of development we are incapable of understanding Him."

Ultra-violet Rays Said to Improve Flour

ACCORDING to the *American Miller*, at least one German flour mill has become convinced that treatment of flour by ultra-violet rays produces a superior product. In this mill, flour is exposed to ultra-violet rays to produce a low-cost food which abounds in the antirachitic vitamin D. Other changes occur simultaneously with this treatment and give better baking qualities and a more wholesome taste. Compared to milk, on the basis of food value, flour and flour products are said to have the advantage of greater constancy and much better keeping quality.

"All the Gold in the World" Is Not So Much

SINCE the discovery of America, world production of gold has only slightly exceeded a billion ounces, approximately 1,003,500,000 ounces being indicated by study of available records, says Scott Turner, Director, United States Bureau of Mines. More than half of the grand total of gold production for the past 435 years, or 516,273,000 ounces, was produced in the first 27 years of the present century. Of the cumulative world production of gold since 1492, 467,000,000 ounces are estimated to exist in the form of monetary stocks, while 536,563,329 ounces represent the balance of gold lost or absorbed in other than monetary uses.

The scarcity of gold may be illustrated by the fact that if the entire world production since the discovery of America were cast into a cube its edges would measure only 38.5 feet.

Rare Earths in Glass Produce Remarkable Effects

MOTORISTS may have noticed the glass tank atop the gasoline pumps in the service stations and observed that this glass if often tinted. Contrary to popular belief, this is not merely a decorative idea, but it represents a scientific effort to minimize the decomposing action of sunlight on the gasoline that stands in the glass tank. It has been found that certain elements, particularly the rare earths, impart a delicate tint to glass which filters out those rays of the sun which tend to "crack" the gasoline. Many other interesting discoveries have been made lately regarding the effect of these substances in glass; for example, a trace of neodymium in the glass of one's spectacles should partially correct color blindness.

Professor Weidert, of the Kaiser Wilhelm Institute for Silicate Research of Berlin, and director of the technical optics laboratory of the Berlin Technical High School, recently discussed the use of the rare earth elements as components of glass. He

pointed out that one gram of neodymium or praseodymium cost 20 marks before the war, but is now much cheaper. Didymium glass was used during the war for secret optical telegraphy. Glass containing cerium was used in spectacles to cut out ultra-violet light, and zirconium was used in the production of cloudy opal glass. Neodymium glass is especially suitable, by insertion before mercury vapor lamps, for the production of monochromatic light. Neodymium makes red or green appear sharper; it may, therefore, be used to correct incomplete color-blindness.

Recently, neodymium and praseodymium have been applied extensively in the manufacture of art glasses. In these, the color depends on the thickness of the glass, so that parts of varying thickness show a changing play of colors; and the glass is, therefore, used in the production of artificial gems. The color also depends on that of the incident light; for example, praseodymium glass is green in daylight and colorless in candlelight.

Impregnated Hemp More Durable

A RUSSIAN chemist named Pissarew, of the Institute for Textile Research, has obtained a patent on a method of impregnating hemp by means of which, it is claimed, the durability and mechanical properties are improved very substantially. The tensile strength is increased by 50 percent, and eight years at least are added to the useful life of the hemp fibers.

The method is particularly suited for cordage, fish nets, and water hose. The impregnating substance, which is called "Naphtiol" is quite cheap, the cost of production being estimated at only about 20 rubles per 100 kilograms when manufactured on a small scale. It is obtained from residual products from the refining of petroleum. The impregnating process can be carried out in the same way as ordinary impregnation with tar.

New Borate Mineral Is Finding Commercial Use

MINERS, prospectors, and mineralogists have so thoroughly searched every nook and cranny of the earth's upper crust that nowadays new minerals are seldom found, or where they are discovered, are apt to be rare, and to exist in small quantities of no particular commercial importance. Nevertheless, a new boron-containing mineral, discovered within the last five years, has been found in such quantities as to render its commercial exploitation possible, according to the Pacific Experiment Station of the United States Bureau of Mines.

The new mineral, which has been variously called Razorite or Kernite, is found in the Mojave desert of California, at depths some 600 to 800 feet below the present surface of the ground. The pure mineral is colorless, transparent, and occurs in lamellar or columnar form. It contains the oxide of boron and of sodium, together with some water, and in places is of high purity, but differs markedly in physical properties from the ordinary borax of commerce.

Its constitution has been of great interest to the chemist, who has hitherto known only the normal crystallized sodium borate, which contains ten molecular proportions of water to one of borate, and the octahedral sodium borate, with five molecular propor-

tions of water. Both of these forms are readily soluble in water, the former being the sort found in nature as the result of the the natural evaporation of alkaline lakes. The octahedral form is unstable with respect to water at ordinary temperatures, and is not found in nature, but can be prepared in the laboratory by crystallization above 142 degrees, Fahrenheit. Chemists have not succeeded in preparing the new mineral form in the laboratory, for although it contains from three and one half to four molecular proportions of water, it is dissolved in water only with considerable difficulty. It seems probable that the material is a product of volcanic activity.

One of the larger uses for the borate is in the manufacture of certain special glass, and for glazing sanitary ware.

"Tin" Cans Made of Aluminum in Norway

THE use of aluminum cans in place of the conventional "tin" variety has possibilities of revolutionizing Norway's canning industry, according to a report from Oslo to the United States Department of Commerce. At present the experiment is limited to canned fish, 50,000 aluminum cans having been ordered for this purpose, but there is reason to believe that it will be extended.

The Norsk Aluminum Company, Hoyanger, Norway, is backing the experimentation. This firm is making plans to install rolling equipment for the special gage sheets that are required. While it is admitted that the most serious objection is the price of the new container, it is pointed out that the expense of the printed label may be done away with, as the aluminum can may be attractively embossed. The light weight, and consequent lowering of shipping costs, is said to be another advantage. Then, too, the empty cans, being pure metal, have considerable reclamation value.

It would appear that the low cost of electric energy in Norway would make for cheaper aluminum, since the production of this metal is an electrolytic process in which the cost of power is a major factor.

New Freezing Mixture

EVERYONE who has made ice cream is familiar with the rock-salt-ice freezing mixture used. When a lower temperature is desired for use in the chemical laboratory, chemists have long used a mixture consisting of one part ammonium nitrate, one part sodium carbonate, and one part water. Although this mixture permits a temperature drop of 31 degrees, centigrade, it has the disadvantages that it is expensive and the ammonium nitrate is comparatively difficult to obtain. A mixture frequently used as a substitute, consisting of ammonium chloride, potassium nitrate, sodium sulfate, and water, gives a temperature drop of only 25 degrees, centigrade. Furthermore, the price of this mixture is relatively high.

German patent 463,792, granted to W. Kasch of Berlin-Wilmersdorf, describes a mixture of ammonium chloride, sodium carbonate, and water, which is obtainable at only one fourth the price of the first named mixture and gives a temperature drop of 31 degrees; furthermore the material is easily obtainable. The best proportions in which this new mixture may be used are 100 parts ammonium chloride, 150 parts sodium carbonate, and 300 parts water.

Learning to Use Our Wings

(*Continued from page* 152)

airplane miles. The United States is first with 9,888,307 miles per annum, Germany comes second with 7,030,565; and France third with 3,753,133 miles. We believe that this lead will be increased year by year.

"This Aviation Business"

ERNEST W. Dichman, formerly of the Army Air Corps and now chief engineer of the Fairchild Airplane Manufacturing Company, has produced one of the best books on aviation for the lay reader that we have ever seen; "This Aviation Business" (Brentano's, New York).

The chapter entitled "The Period of Evolution" gives the right historical background. "Notable Flights and their Significance," is a thoughtful review of the solid achievement which has accompanied the adventurous flights of the past. "Commercial Development" and "Popular Enthusiasm after May, 1927" bring the reader completely up-to-date in the history of American commercial aviation.

The author is not entirely satisfied with the safety of aviation, and points out that "there is an unfortunate tendency to jump at each of the newly announced inventions as the cure for all the ills of aviation." He says, further: "The actual facts are these: There have been many all-metal airplanes catch fire and burn. Several three-motored airplanes have had forced landings. Pilots have been lost using the radio beacon. The efficacy of the Handley Page slot still remains to be proved. The N.A.C.A. cowl is still in the experimental stage, and the autogyro needs ten years' work before it will be developed to any degree of satisfaction." It is good to hear a conservative note from time to time.

At the present time great numbers of young men are seeking to enter aviation in any capacity. While aviation will grow rapidly and steadily, it is impossible that it should absorb indefinite numbers of young men. In "Aviation as a Career," the author voices a sound warning to aviation aspirants and at the same time gives an authoritative guide to training and prospects in the industry.

The author's style is really surprisingly good, particularly for an engineer, and we cannot resist quoting the following striking passage "A young man came to see me the other day. His ostensible purpose was to discuss some aviation ideas. His real purpose may be summed up by his question 'How does one git into this aviation game anyhow? This is the coming thing and I want to git in on the ground floor.' This young man happened to be a farmer. His hands and face plainly showed the marks of honest toil. He was just itching to get away from the monotony of the farm and into the air. This sort of experience, with suitable variations, is repeated on an average of once a week. Druggists, bank clerks, draftsmen, mechanics, young men of almost every calling are anxious to give up their jobs and learn to fly. One garage owner with a comfortable business was ready to sell out and take up flying. The boy who delivers my laundry recently announced that he was quitting his job to begin a course in flying at a local field."

Lieutenant Dichman first of all discusses the question of age for the would-be pilot.

If a man is over 30 his chances of becoming a thoroughly competent commercial pilot are very small. A man in his early twenties is the most likely candidate. Under 20 he is apt to be foolhardy and reckless. Over 30 he will think too much, and this will make him over-cautious. He learns slowly, his manipulations of the controls are mechanical, and he seldom becomes a natural pilot.

For the young man of moderate means, the author advises application for admission to the Army Air Corps Flying School. If he has the necessary physical and mental qualifications he may be admitted as a flying cadet. He then receives $75 a month in addition to board, clothes, and shelter. "He will be made to do a number of things which he does not like, which will be good for him. However, he will certainly be taught to fly or gently but firmly told that he does not possess sufficient natural aptitude and be discharged."

The course of instruction lasts one year and is thorough. Time in the air amounts to about 300 hours. He may then remain in the Army or if he chooses to enter civil life, he will find many opportunities open to him. He may become a general utility pilot with some operating firm. He may do photographic work, cotton dusting, et cetera.

It is difficult to break-in with the transport companies and an apprenticeship stage as flying mechanic or assistant pilot is necessary, at 150 to 175 dollars a month. After this, he may become a regular transport pilot, and earn between 5000 and 6000 dollars a year. The author advises great caution in selecting a private school (for the man who does not get into the Army flying school) both as regards the amount of fees to be paid and the competency of the school selected.

The author covers with similar accuracy other careers in aviation—sales, drafting, engineering, operations, and so on. We advise every young man with aviation aspirations, or his parents, for that matter, to read, learn, and inwardly digest this chapter.

Aviation is passing through a period of financial depression, and the public which has financed aviation on such a generous scale is the sufferer. The following words of warning should have been written a year or so ago: "The entire nation has taken hold of the aviation idea. The tales of fortunes made in gold or oil are recalled. The automobile industry is drawn upon heavily to supply inspiration. If you had invested 100 dollars in the original Ford company you can figure out how many millions you would be worth to-day. Every investor in aviation securities considers himself a potential Rockefeller or Ford. There has been money made in aviation. There will be more money made in it. But there has been and will be a great deal of money lost in aeronautical ventures." Analysis of passenger transport is particularly pessimistic from the financial point of view.

Nevertheless, the author forecasts a great future for the industry. Central and South America will be brought close to the United States. San Francisco will be as close to New York as St. Louis is now by rail. "I confidently expect the presidential candidate of 1936 to use the airplane a great deal in his traveling."

The final note: "Aviation is becoming a real business."

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$5.00 postpaid

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By Benjamin Gruenberg, Ph.D., Biologist

THE yearly output of popular works on evolution is large but this is a work we have singled out from all the others to reread and save. Too many of the books on evolution have not been well rounded, but Professor Gruenberg has covered every phase of the many-sided subject of evolution—except, perhaps, the fossil record of extinct animals. This being the case, the book would serve as a companion piece to Dr. Thom's "Dust to Life," which especially emphasizes that phase. As the 466-page book is attractively dressed—fine paper, large print, showy covers—it would be a desirable library-table work. One feature noted is that the author handles the subject of human evolution with tact and diplomacy; you could lend this book to a Fundamentalist without fear of making an enemy. Yet it does not sidestep. $4.20 postpaid

Dust to Life

By Burton Peter Thom, M.D.

"DUST TO LIFE" is called a "scientific story of creation" and such, after a careful reading, we find it. Dealing first with non-living matter as atom and universe, its main theme is the origin and evolution of life. Many books have covered similar ground but not as this one does; it gives a most detailed account of the various forms that have lived in the past—the dinosaurs genus by genus, the giant mammals, and the precursors of man—than any book we have seen. The usual assortment of charts, tables, diagrams, and genealogical trees which to some make existing textbook treatments of the same subject more of a task than a delight, are omitted from this book, and the treatment is wholly popular. It is, however, accurate, authoritative, and scholarly. 121 illustrations, 387 text pages. $5.20 postpaid

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Commercial Property News

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

"Trademark Specialists" Repudiated

A BULLETIN regarding circulars recently issued by certain self-styled "trademark specialists," has been issued by the Committee on Trademarks and Unfair Competition of the Association of the Bar of the City of New York. This committee, under the chairmanship of Harry D. Nims, includes Henry T. Hornidge, Ellis W. Leavenworth, Alan N. Mann, Howard M. Morse, Orson D. Munn, A. Parker-Smith, James McKinley Rose, George W. Tucker, Wallace White, and William B. Whitney.

The bulletin follows, in full text:

The Association of the Bar of the City of New York has authorized the publication of this bulletin in order to inform the general public regarding certain fundamental principles of trademark law and to correct some erroneous conclusions or impressions which may have resulted from the recent activities of so-called Trademark Specialists who have been circularizing the business world.

1. The first person to use a trademark on merchandise acquires title thereto in the territory where his goods are marketed. Therefore the suggestion by these Trademark Specialists that the owner of a trademark is in danger of losing his mark by not having it registered according to their suggestions is entirely contrary to fact.

2. Registration in the United States Patent Office is not at all essential for the protection of vested trademark rights. It is desirable as being *prima facie* evidence of ownership (when secured under the 1905 Act), and for other practical and procedural reasons such as giving the registrant the right to use with his mark the phrase "Reg. U.S. Pat. Off." and the right to bring suit in the federal courts. The advertising Trademark Specialist in the cases investigated has exaggerated the importance of specific forms of registration and the language used is susceptible of a construction which might mislead the trademark owner as to the true situation.

3. As a rule no mistake fatal to common-law trademark rights can be made in obtaining a trademark registration, but it is usually advisable, because of the technical nature of the procedure and the probable need of overcoming Patent Office objections, that competent counsel should be entrusted with this work. The Specialist's warning that a single defect lurking in a registration may cause the loss of a mark and the good will of the business and similar expressions are obviously erroneous.

4. Vested trademark rights are recognized and protected by the courts in all the States irrespective of state or federal registration. Therefore the statement often found in some of these circulars and letters sent out by these self-styled Specialists that state registration is necessary in order adequately to protect trademark rights is not true. State registration is helpful only in exceptional cases and the trademark owner should not be burdened with the large expense involved in securing such registration except in unusual cases.

It is obvious, therefore, that the general public need not be disturbed or alarmed by the statements and veiled suggestions of disaster often found in circulars and letters which are constantly being received by trademark owners, circulated by persons and concerns thus soliciting use of their services in connection with such matters.

Rejection of Claims Due to Delayed Application

DELAY for nearly five years in making the application for reissue patent covering locomotive reversing-gear mechanism resulted in rejection of certain claims of the delayed application by the Commissioner of Patents *exparte* Henry Helmholtz *et al.* The decision was rendered on an appeal from the ruling of the examiners in chief, finally rejecting claims 10 to 16 of reissue patent Number 17483. The original patent Number 1208556 was granted December 12, 1916.

The applicants accounted for the delay by general statements that they were engaged in furtherance of the war aims of the Government and could not exploit and did not learn of the defects of the original patent until shortly before the filing of the application. This was held to be an insufficient special circumstance which would not excuse the delay in view of the fact that the patent was assigned three years after it was issued, and nearly two years before the reissue application to a corporation which furnished no excuse for its delay.

Invention Rights Barred by Disclosures of Prior Art

IT is the intention of the Patent Statute to reward invention, and not to reward diligence in unearthing prior patents which have not been turned into commercial success. A person is not entitled to the reward given inventive genius if his invention has already been disclosed to the public through the records of the Patent Office, even though the prior art device has not gone into extensive and successful commercial use, according to a decision of the Circuit Court of Appeals for the Tenth Circuit.

The case in question, W. H. Butcher Packing Company *versus* Cincinnati Butchers' Supply Company, was heard by Circuit Judges McDermott, Lewis and Phillips, on appeal from the District Court for the Western District of Oklahoma. The lower court had found infringement, awarded an injunction and directed an accounting, but the Court of Appeals reversed the decree, with instructions to dismiss the bill. The machines of both parties of the suit were found to lack novelty over the prior art, and therefore had no right to claim patent protection.

The plaintiff's patent for hog-dehairing machines, Number 1388898, issued in 1921 to Charles G. Schmidt and Oscar C. Schmidt, was held to be more like the prior art than the patent held by the defendant was like that of the plaintiff. Because of public use of the prior art machines, in which the invention had been disclosed, the later patentee has no grounds for demanding the rights of the inventor. Finding no infringement, and not passing upon the validity of the claims in suit, the court held it unnecessary to discuss presumptions, commercial success, or many other points ably briefed and argued. The decree was reversed and the bill dismissed.

Facsimile Signature Upheld

DESPITE its similarity to the opposer's trademark, the autograph-signature mark "E. W. Williams," has been upheld by the Assistant Commissioner of Patents on the grounds that a facsimile signature possesses such distinctiveness as not to be confused with marks otherwise portrayed. The ruling reversed the decision of the acting examiner of interferences, which had sustained the opposition to the registration of the signature. J. B. Williams Company, owner of the mark "Williams," had contested the registration of the facsimile mark, both marks being used for cream to be used after shaving.

In holding that there was no likelihood of confusion by the current use of the two trademarks on goods of the same descriptive properties, the Assistant Commissioner pointed out that in every branch of the law handwriting is considered distinctive. The distinctiveness, in such cases, is in the penmanship and the mark is not the mere name of an individual. According to the ruling, the mark "E. W. Williams," as written, bears no resemblence to the mark "Williams," despite the seeming evidence to the contrary.

Profits from Expired Patents

MORE and more holders of valuable patents and trademarks are realizing that the best insurance for profits during the post-patent period is in building recognition for the future by extensive advertising. When patents expire, the company which has established itself firmly in the field is at a distinct advantage over its competitors, even when the industry at large is free to make use of the invention. As many patent-holders have learned, this "head start" can be perpetuated and capitalized by the judicious use of display advertising.

A slightly different result, illustrating the same principle, was pointed out recently in *Engineering and Mining Journal:*

"Basic patents on a machine used extensively by a specific industry were owned by the ABC Corporation. The XYZ Company also made the machine, along with other products, paying the ABC people a royalty for every machine sold. The XYZ Company chose to stay in business without making a practical profit on this particular product. Why?

"Two years or so ago the patents expired. The expected happened. Dozens of manufacturers turned to making the machine. But instead of diminishing sales for the XYZ Company, there came increased sales, pyramiding profits, and leadership in the field. This leadership is being maintained today by the same formula that was used steadily for three years before industry-at-large was free to make the machine.

"During the three-year period from 1923 to 1926, when XYZ's profits were barely enough to pay royalties to the patent owners, XYZ advertised regularly in certain well-chosen periodicals, building recognition for the future, intrenching themselves in a strategic position for the post-patent period. After the patents expired, in 1926, pyramided effects of continuous advertising sent sales and profits constantly upward.

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Mark Suggestive of Use Held Not Descriptive

ALTHOUGH the notation, "Detective Special," the word "Special" having been disclaimed, is obviously a recommendation of revolvers to detectives and suggestive of their use, it has been held that the notation is not so clearly descriptive as to justify the Patent Office in refusing registration. The applicant, Colt's Patent Fire Arms Manufacturing Company, had appealed to the Commissioner of Patents from the decision of the examiner of trademarks. In refusing registration, the examiner asserted that the mark is descriptive of the goods, offering in substantiation of his stand a reference from the applicant's catalog describing the revolver in question as "a snub-nosed Colt shooting the powerful .38 special cartridge, yet small enough to ride handily in the side pocket of coat or overcoat."

The Commissioner concluded that the revolver has no structural characteristics which make the weapon particularly suitable for use by a detective any more than for any other person. It was conceded that the mark would be interpreted in the nature of a recommendation of the revolvers to detectives, and would function, not descriptively as to the characteristics of the articles but suggestively as to their use.

Among the references cited by the applicant in defense of the mark were, "Hotel Special," for coffee; "Cow Boy Special," for overalls; "Miner's Special," for gloves; "Planter's Special," for feed for horses; and "Banker's Special," for revolvers, showing that it is the practice of the Patent Office to register marks of such character. Concerning the trademark, "Banker's Special," for revolvers, the Commissioner said, "I fail to see any distinction as to registrability between the two marks, and feel that either both should have been registered or else both should have been refused registration. The instant mark is regarded as not so clearly descriptive of the applicant's goods as to justify the Office in refusing its registration. The decision of the examiner of trademarks is reversed."

Why Spark Plugs Do Not Crack

"THOSE who drove automobiles a few years ago will recall vividly, among other troubles, the grief caused by cracked spark plugs," we are reminded by J. T. Pardee of the United States Geological Survey, in a recent issue of the *United States Daily*. "Today we have forgotten about spark plugs. They have ceased to be a source of trouble—no one ever hears of a cracked porcelain any more."

Explaining "Why spark plugs do not crack," Mr. Pardee describes the way this improvement was brought about, an incident which clearly illustrates the value of purely scientific research carried on for its own sake and without any immediate economic object in view.

"In June, 1926, in the course of field work for the Geological Survey, in Inyo County, California, Adolph Knopf, a geologist, saw an outcrop of rock that had been taken by one prospector for silver ore and by another for phosphate. It evidently was neither, and so far as its appearance indicated was merely one of the host of rocks that compose the bulk of the earth's crust.

"However, the geologist, recognizing the mass to be of an unusual character, stole time enough from the otherwise economic work assigned to him to gather specimens and to ascertain the facts of its occurrence. Later, at Washington, an examination of his collection showed that the rock was largely composed of a mineral called andalusite. Now at that time andalusite was not known to have any economic value. But, because of its scientific interest, a description of the occurrence was published in a scientific paper.

"Before that time the silicate minerals had been one of the many subjects of investigation by the geophysical laboratory, which had, among other things, determined what to the layman might appear to be a bit of perfectly useless information; namely, the amount of swelling and shrinking shown by andalusite and other minerals when they were heated and cooled; or, in scientific terms, their coefficients of expansion.

"The geologic paper and the results worked out by the physicists fell into the hands of engineers looking for substances with which to make spark-plug procelains that would not crack, and presto!—andalusite was the answer. The geologist's research had found the deposit, and the physicist's research had shown its suitability for the purpose sought.

"Again in the course of field work, this time in the Rochester district of Nevada, the same geologist discovered another scientifically interesting occurrence, a mass of the mineral dumortierite, which, in the course of events he described and for which the physical properties had been made known as before, with the result that the spark-plug makers were directed to a deposit even more valuable for their purpose than the andalusite.

"Today, as an indirect result of purely scientific, uneconomic investigations, we drive our automobiles with never a fear of a 'missing' plug."

Electroplating Process Claims Declared Patentable

FINDING nothing in the claims that limited them to any particular apparatus, the Board of Appeals of the Patent Office has reversed the action of the examiner who had rejected as unpatentable certain claims of a process for electroplating the interior of tubes. The process claims had been rejected as not being patentable over the apparatus claims which were allowed by the examiner. The allowed claims are included in patent Number 1733404 issued to Frank A. Fahrenwald, covering both process and apparatus for electroplating tubes.

The Board of Appeals held that the apparatus disclosed, when operated in the manner described, carries out operations

Patents Recently Issued

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Pertaining to Aeronautics

BRAKING DEVICE FOR AIRCRAFT—By which the speed may be smoothly checked in flight, and the craft automatically maintained with safety in a fore and aft balance, so that when landing it may be brought to rest in a relatively restricted area. Patent 1731735. Marion H. Aten.

Pertaining to Apparel

GARMENT—An article of wear convertible from a plain rectangular form to be used as a steamer rug, or given the form of a wrap with sleeves and a collar by the engagement of a minimum number of fasteners. Patent 1736594. Bessie J. Hart.

BUCKLE—Including a tubular body which is adapted to telescopically receive the free end of a belt, or one of a pair of members to be connected thereby, and permit a limited relative movement between said members. Patent 1737492. William H. Carroll.

Designs

DESIGN FOR A STOCKING—Patent 79876. Ruby Lefi.

DESIGN FOR A DRESS—Patent 79730. Dorothy Long.

DESIGN FOR A TEXTILE FABRIC OR SIMILAR ARTICLE—The inventor has been granted nine patents for ornamental designs for textile

set forth in the process claims. This fact, however, is not sufficient reason for rejecting the claims as functional, the decision stated, when such process claims are not limited to any particular apparatus. In such cases it was held that process claims should be allowed, since the process form of claim may be more satisfactory than an apparatus claim.

The application disclosed a process by which a tube to be electroplated is mounted for rotation; the anode is shorter than the tube and is caused to be reciprocated to and fro lengthwise of the tube. The liquid is circulated through the tube. One of the claims stated: "The process of electroplating the interior of a tube which contains the step of electrolysing a solution of plating metal in contact with the entire tube interior as cathode, and simultaneously impressing upon the tube and anode two independent movements, one a gradual axial movement relative to each other and the other a gradual movement of rotation of the tube around the anode."

Garment Pressing Machine Patent Upheld by Court

INVENTION, and not mere double use, is involved in applying to a steam garment-pressing machine a suction drying device taken without substantial variation from another art, where the patentee was not only the first to make application of the old device to the new use and the first to show how it could be made, but he was also the first to perceive and show utility in making it. On these grounds, the Weinberger patent (Number 1193093) for a garment pressing machine has been sustained by the District Court of Delaware, which simultaneously declared invalid the Spencer patent (Number 1326982) covering a device substantially the same. These decisions terminated a suit brought for the alleged infringement of both patents, United States Hoffman Machinery Corporation *versus* Pantex Pressing Machine, Incorporated.

The Delaware court ruled also that although an examiner had rejected certain claims of a patent application which were subsequently allowed by examiners-in-chief on appeal, a court may hold the patent invalid on the same prior art considered by the Patent Office.

It was held that the placing of old elements in juxtaposition without a new function or effect is not combination, yet when elements are so united that by their joint action on their common object they perform additional functions and accomplish additional results, the union is a true combination, and whether they coact successively or simultaneously is of no importance. Also, according to this court, the substitution of one element or device for another which performs the same function in substantially the same way and accomplishes substantially the same result, even if the substituted part performs the function better, is within the capacity of one skilled in the art and is not a patentable invention.

Fur Company Denied Use of Name "Hudson"

UPHOLDING the rights of the historic firm known as the Hudson's Bay Company, chartered by King Charles II in 1670 under the title, "The Governor and Company of Adventurers of England Trading Into Hudson's Bay," the District Court of Minnesota has ruled that no other firm dealing in furs and blankets can do business under a firm name containing the words "Hudson," or "Hudson Bay." The above firm had opposed an application of the "Hudson Bay Fur Company," for permission to continue its established business under the revised name, "Hudson Furriers, Incorporated."

The Minnesota court ruled that the defendant, by improperly adopting the name "Hudson Bay Fur Company," had been in error, and despite the fact that large sums had been spent in advertising the improperly acquired name, it should discontinue the use of the word "Hudson."

The court said: "If defendant had never used the name 'Hudson Bay Fur Company,' the wrong and deception, if any, involved in now using the name proposed (Hudson Furriers, Incorporated) would be much less than it would be under conditions as they actually exist. The application of the defendant seems like an effort to see how far it will be permitted to go, without incurring the penalties of the law, along the lines on which it should never have entered at all.

"The world is wide, and available and good names for defendant's business are many. It has a great range of selection without trespassing upon the rights of plaintiff, and without, by a possibility, deceiving the public. Some such name should be chosen. In the face of the decree which has been entered in this case, the defendant has continued to use and advertise under the prescribed name for quite too long a time. The matter should now be promptly closed, and changed conditions, conforming thoroughly to the spirit of the decree, should be inaugurated without delay."

Examiner Upheld in Ordering Drawings Corrected or Withdrawn

WHEN drawings submitted with an application for patent are lacking in conventional symbols specified by the Rules of Practice for all applications involving electrical systems, the examiner is justified in ordering the drawings corrected or withdrawn. This decision was made by the Commissioner of Patents, acting on a petition from an order from a patent examiner.

Although the art generally may use different symbols in illustrations, uniformity is declared to be necessary in patent applications in order to facilitate clearness and accuracy on the part of the examiners. For many years a chart for the guidance of draftsmen as to the use of symbols in connection with wiring diagrams have appeared in the Rules of Practice. This chart has been modified from time to time as the practice adopted by engineers and others skilled in the arts has changed or advanced. The application's drawing (*ex parte* Rodman), the examiner's requirement, and the applicant's petition were submitted to each of the five principal examiners in charge of the respective divisions of electricity, for comment. At least four of them strongly supported the requirement of the examiner, in the interest of clearness and accuracy. This action of the examining staff and the Commissioner of Patents emphasizes the importance of having applications and drawings prepared by attorneys and draftsmen thoroughly familiar with the Rules of Practice as revised to date.

Electrical Devices

ALARM APPARATUS—An electric burglar and fire alarm which normally utilizes the house lighting current for actuating an alarm when the surreptitious opening of a door or window is effected or when a fire occurs in the building. Patent 1732276. John A. Morrison.

INDICATING APPARATUS—For indicating, annunciating or displaying indicia bearing elements, which are displayed and concealed successively in numerical order, as the result of actuation of a single controlling device, including a source of electrical energy. Patent 1733817. Joseph S. Moranor.

COIN-CONTROLLED CIRCUIT CLOSER—Which automatically controlls an electric device, such as a fan arranged within a public toilet having a hinged door, upon the insertion of a coin in a coin slot and the closing of the door. Patent 1734838. Arthur W. Tucker.

AUTOMATIC SWITCH—A safety switch for a motor driving a given piece of machinery, which stops the operation of the machinery in case of an accident, but does not stop the running of the motor. Patent 1735761. James E. Huey.

TELEVISION APPARATUS—A system employing a square scanning beam upon a photo-electric cell controlled by two rotating spherical surfaces, the axis of which are disposed at right angles to each other. Patent 1735553. Samuel T. Syphrit.

ELECTRIC ADVERTISING DEVICE—Wherein round or other shaped articles are provided with a magnetic member which co-acts with means forming a field whereby as the field is energized the article is moved about without apparent cause. Patent 1736613. Guy McGoshen.

Of General Interest

SUBMARINE SAFETY DEVICE—Including a marking buoy controlled from the interior of a submerged vessel, and a cable attached thereto which will draw upwardly a normally collapsed hose, through which the crew of the disabled vessel may be rescued. Patent 1734864. Willy Krause.

HOLDING MEANS FOR VANITY CASES—The holding structure for the removable plates being swingably connected to the casing and constructed to hold any kind of powder, rouge and like renewals which may be applied without the use of tools. Patent 1734860. William G. Kendall.

SKYLIGHT—Which is fireproof, and comprises a metalic frame structure made of separable members so that the skylight can be disassembled and shipped in knock-down condition, and secured without the use of solder, bolts or other fastening elements. Patent 1734840. Sidney Volk.

PHOTOGRAPH EXHIBITOR—Comprising a cabinet having a plurality of supports for the mounting of photographs on one or both sides, the supports being movable in the order of book pages thereby successively displaying the pictures to view, without injury by handling. Patent 1734790. Helmuth F. Bandt.

SHAVING BRUSH—Wherein the handle and brush element are separable, the brush consisting of a flexible bristle carrying strip helically wound and detachably held within the handle so that after use the bristles may be thoroughly sterelized. Patent 1734873. William M. Neissl.

COMBINED ARM REST AND PROP—Which may be readily adjusted for use as an arm rest or a prop, and will serve advantageously on a combination fabrics. Patents 79749, 79750, 79751, 79752, 79753, 79754, 79755, 79756, 79757. Frieda B. Paisner.

DESIGN FOR A DRESS — Patent 79887 Dorothy Long.

bination folding chair and cot in connection with one of the sections. Patent 1736569. Arthur F. Bailly.

METHOD OF WELDING COPPER-BOILER ENDS—Whereby an extra-thickened portion presenting an internal bead at a point where the head joins the shell is caused to fuse and extend inwardly, presenting a strong structure, which is water and steam tight. Patent 1733922. Albert H. Trageser and Louis Hassinger.

HOLDING RING FOR COMPACT PLATES—Comprising an annular tubular ring structure wherein one or more corrugations are provided, whereby different shaped compact plates may be properly engaged and held resiliently and removably in place. Patent 1734859. William G. Kendall.

TRAY—A serving tray consisting of two parts, a frame and an article holding plate, the plate resting in contact with the frame and handles which hold it from slipping, yet may be easily removed for interchange or cleaning. Patent 1733838. Malcolm Steiner.

BRUSH—A hair brush of the type which includes a handle and a detachably associated bristle carrying section which may be easily disassociated to permit of a thorough cleansing and sterilizing of the parts. Patent 1735802. Rocco Statuto.

BOTTLE CRATE—Particularly designed for transporting milk bottles, including non-metallic vertically arranged partitions of a size and spaced in such manner as to reduce chipping and breakage, and minimize noise in transportation. Patent 1735772. John F. Maurer, Jr.

VENTILATOR—Particularly adapted for location in the ceiling of a room, for transforming horizontal circular motion into vertical circular motion, giving a maximum air space from a minimum area occupied by the device. Patent 1735760. James R. Howard.

TRAPS—For rodents, including a box of tapered construction, a door mounted for up and down sliding movement within channels, and a bait holder and latch rod, the disengagement of the bait automatically closing the trap door. Patent 1735786. Sherman S. Pearl.

WHEELBARROW—In which an auxiliary rear wheel is provided for relieving the operator of a portion of the load, but is adjustable for support at various heights without the necessity of releasing the grip on the handles. Patent 1735527. John Cwik.

SHIELD FOR COOKING STOVES—Readily adjustable, and whereby the cook is protected against the fumes and heat rising from the stove and food, yet permitted a clear view of the food, and in no way interrupted with the manipulation thereof. Patent 1735806. James F. Struble.

SAFETY RAZOR—Wherein a hollow handle is provided which constitutes a container for the remaining parts so that when not in use they may be arranged into a small compact package. Patent 1735751. Thomas C. Green.

ADJUSTABLE CHAIR SEAT—Which can be satisfactorily used in connection with lunch counters or the like, and is characterized by means permitting of quick and convenient adjustment to afford maximum clearance between the seat and the counter. Patent 1735304. George B. Travis.

RECORD BINDER—Of the loose-leaf type, which will be of all metal construction, extremely durable and efficient in use, yet will permit of light-weight construction of the parts. Patent 1736711. Ernest W. Jackson.

CONTAINER COVER—Serving as a sealing for preventing leakage of the contents or excluding air therefrom and including a compartment for holding a direction-bearing pamphlet in such manner that it will be displayed when the cover is removed. Patent 1736286. Clen S. Humphrey.

VISIBLE-CARD FILE CABINET—In which each drawer is hinged at its inner end to a latch member adapted to normally prevent the drawer from being entirely withdrawn from the cabinet, and to support the drawer depending if desired. Patent 1736655. Lugi Lombardini.

LOOSE-LEAF BINDER—Comprising a binding member in the form of a strap which extends through slots in the aligned perforations of a plurality of sheets and is fastened to prevent accidental movement of the sheets. Patent 1735031. Royden E. Beebe, Jr.

BEDCOVER FOLDING DEVICE—Which functions on any conventional form of bed, to render available as bed covering the entire length of the blanket and other coverings, by eliminating the necessity of tucking covers beneath the mattress foot. Patent 1736212. Benjamin A. Moeller.

COUPLING DEVICE—For connecting necklace or locket chains, including a pair of rotatable notched elements connected for movement in opposite directions, the notched portions receiving and completely embracing an article to be coupled. Patent 1737481. Michael Rabb.

INSCRIPTION DEVICE—For sand blasting letters or other configurations upon tomb stones, whereby special designs may be set up and pressed into a prepared coating for cutting out, the letters being more accurate than when cut by hand. Patent 1737500. George B. Johnson.

UMBRELLA—A collapsible umbrella, including channel shaped members one of which is slidable within the other, and pivoted ribs, the parts being arranged so that it can be carried in a hand bag. Patent 1737464. Henry R. Lillich and Carter Smith.

PLAYING CARDS—Of what may be termed the standard type, with the suits so marked with distinguishing elements that one of the suits may be told from another, at a glance as they are fanned in the player's hand. Patent 1737478. Jesse E. Simmons.

DIRECTORY BOARD—Primarily adaptable to city maps, enabling a stranger to quickly locate a desired street or place, the function being electrically performed by pressing a button, the device may also serve as an advertising medium. Patent 1737520. Thomas P. Richardson, Jr.

VALVE FOR FUEL-STORAGE TANKS—For trapping and preventing water which has seeped into gasoline or kerosene storage tanks from being sucked into the pump, and also functioning to warn the pump operator should water have gotten into his tank. Patent 1737529. John H. Viele.

Hardware and Tools

PIPE-REAMING ATTACHMENT FOR PIPE THREADING TOOLS—By which reaming the pipe for removal of burrs is accomplished simultaneously with, and by operation of the threading tool, thus upon completion of threading the pipe is devoid of interior burrs and ready for installation. Patent 1731727. Max Richman and Harry H. Leon.

BENDING TOOL—Particularly adapted for use by workers on building construction jobs, for the purpose of carrying out clip bending operations in conjunction with structural elements to support the latter in readiness for application thereto of other structural material. Patent 1736585. Fred R. Fehlhaber.

GAUGE FOR APPLYING HINGES—By virtue of which inserted leaf hinges, where it is necessary to cut an angular groove, may be rapidly applied with accuracy, and without requiring the mechanic to resort to unnecessary measurements. Patent 1736709. Ernest Flagg.

SUPPORTING DEVICE FOR RAILS—Comprising a base or wheeled truck, having U-forms constructed of metal mounted thereon, for holding the side rails of a ladder or scaffold, and threaded studs for securing the rails in fixed position. Patent 1736501. John J. Macklem.

CARPENTER'S LEVEL—In which the number of bulbs usually employed is reduced by combining with the straight edge a circular bulb allowing a reading to be conveniently taken, whether disposed vertically or horizontally. Patent 1736502. Robert B. Maddox.

Heating and Lighting

MARINE SIGNAL LIGHT—A portable signal light adapted for marking the location of buoys, dories, channel stakes, fishing gear, etc. The portable nature of the device makes it useful generally where a signal light is needed. Patent 1735797. Louis T. Scott.

AUTOMATIC CONTROL APPARATUS FOR GAS BURNERS—Which can be set to any required opening by hand and is subsequently controlled by means of a thermostat for the purpose of keeping the temperature of an oven or its equivalent substantially constant. Patent 1736649. James Dolphin.

DAMPER CONTROL—A special operating element for the damper control of heating or ventilating pipes and means for locking the damper in any adjusted position, rattling due to draft through the pipe being prevented. Patent 1735034. Frank H. Bryant.

Machines and Mechanical Devices

BELT TIGHTENER—Automatically operated for maintaining the constant engagement of a belt with the drive pulley and a variable engagement with the driven pulley, so that as the tightner moves toward the driven pulley the frictional engagement is increased. Patent 1737467. Paul E. Mahaffey.

WASHING MACHINE—Including inner and outer casings of the reciprocating types, with cleaning solution inlets and outlets, wherein clothing is subjected to the washing process in an easy manner, and in less time than is usually required. Patent 1737480. Max Troy.

CONCRETE MIXER—And transporting tank, which operated in one direction will mix the sand and cement, and in another position will propel the mixture to a discharge point, adding the water immediately before the discharge of the concrete. Patent 1737522. Carlyle H. Scott.

COMBINED DISPLAY AND VENDING MACHINE—A coin operated machine which prominently and attractively displays the merchandise which it handles, is adapted to handle a wide variety, yet permit the selection of any particular article, which will be automatically dispensed. Patent 1737499. Robert C. Hardman.

FRUIT - PITTING MACHINE — Particularly adapted for removing the pits from dates by an intermittent motion, means being provided for holding the fruit, and positioning the pit within the path of a knife for longitudinally slitting the fruit and ejecting the pit. Patent 1734010. Anthony Gotelli.

PAINT ROLLER—For applying paint to collapsible tubes, at the same time preventing injury and correcting irregularities in the tube to a certain extent, while applying the paint in a properly coated form. Patent 1733893. Frank J. Lynch.

ATOMIZER—By which a thorough atomizing and intimate mixing of liquid fuels, such as crude oil or other hydrocarbons, and air will be effected, and ejected at a high velocity thereby obtaining a highly combustible mixture. Patent 1733413. Oscar Kay.

COMBINATION BAILER, DUMP AND PUMP—Characterized by features of construction and operation by which the device may be readily converted to adapt it for carrying out bailing, dumping and pumping operations in sinking well holes. Patent 1733837. Harry J. Steinberger and Harr A. Miller.

STOCK-FEEDING MEANS—For machines effecting dual operations upon stock, the stock being fed to one part of the machine, operated upon, and then returned to another part of the machine for a subsequent operation. Patent 1734868. David E. Milne.

PLUG PACKER—Having means by which it may be determinately positioned above the bottom of a well hole to shut off gas or water strata below the oil bearing strata. Patent 1734884. Edward E. Simpson.

VEGETABLE CUTTER—A machine of comparatively large capacity, whereby vegetables or fruits may be cut, chopped or minced in an expeditious manner. Patent 1735702. Harry M. Williamson.

MACHINE FOR PROCESSING FIBROUS FILLING MATERIALS—Including, cotton, cotton waste, down, feathers, hair, floss, kapok, jute and similar materials, such as are commonly used in filling mattresses, pillows, cushions, etc., consisting in beating, cleaning and mixing the materials. Patent 1735749. Max Goldberg.

SAFETY ATTACHMENT FOR EXTRACTORS—For laundry machinery, for positively preventing the opening of the cover until the machine has reached a dead stop, or starting the machine until the cover is completely closed, thus safeguarding operators against injury. Patent 1735745. Joseph Gariglio.

MEASURING DEVICE—For gasoline apparatus, which will positively determine the quantity of gasoline dispensed by a weighted element that controlls the operation of a reciprocating tank, by movement of the weight to a point indicating the quantity required. Patent 1735729. John K. Carter.

WOOD TRIMMING OR EDGING MACHINE—Wherein a plurality of superimposed barrel staves or other flat longitudinal members may be trimmed along their edges in a single operation, and after trimming will be caused to fall into a receptacle. Patent 1735792. John C. Ramsey.

SAW TABLE—Having a removable top with a plurality of slots through which gauge bars may be projected at predetermined distances from each other and from a circular saw, for cutting boards lengthwise at a predetermined width. Patent 1735773. William P. McIlvanie.

PLUNGER—For air pumps, having a cup formed of leather or suitable composition in which is mounted a resilient member adapted to counteract the deformation while retaining the cup walls in contact with the cylinder walls. Patent 1735757. Ernest W. F. Herrmann.

LUBRICATOR—An automatic mechanism which will feed lubricant from a reservoir by the action of centrifugal force to a bearing as the latter is heated, the lubricant being cut off from the bearing as the latter cools. Patent 1735266. Leslie C. Dutro.

SPINNING AND TWISTING FRAME—Having a special form of stop motion for arresting the machine when the bobbins are full, thereby ensuring that each doffing shall be of uniform weight and length; the machine may be very easily started. Patent 1736656. Lewis Lumby.

DIE FOR IMPRINTING PLASTIC MASSES—An imprinting machine for dough blanks or masses prior to the baking thereof, the parts which are made of aluminum or other non-rusting material, may be readily separated to permit of cleansing. Patent 1736579. Meyer Collis.

SPEED-CONTROL PULLEY—By means of which a belt connected with a machine may be driven at the same rate of speed as the pulley, or at varying degrees, or completely arrested, without removing the belt from engagement with the pulley. Patent 1736578. Joseph Chudner.

MACARONI MOLD—Having means for forcing the macaroni paste through a die plate and for forming curly or spiral macaroni of tubular formation having a longitudinal passage or opening extending throughout. Patent 1736611. Giuseppe Lubrano.

MEANS FOR IMPREGNATING FELT OR OTHER FABRICS—In a specially formed tank for holding the fabric, such as floor-covering or roofing, to be impregnated with a suitable oxidized, rubbery asphaltum or other saturant, that they may be elastic, strong, taut and water-proof. Patent 1736633. Karl H. Schutte.

TACKLE TO SUPPORT SCAFFOLDS OR SIMILAR DEVICES—Which will permit the workman who is standing on the scaffold to control, at will, the height of same with regard to the ground without the least danger of accident to himself or fellow workmen. Patent 1736723. Manue A. Serra y Perez.

FEED-GATE CONTROL—For cutting off the supply of grain or other material after a certain amount shall have passed into the buckets of an endless chain elevator, thereby preventing choking while running at full speed. Patent 1736691. Ole F. Aplin.

JOINER—Having means for automatically feeding warped or uneven boards into the machine and holding them in position while advancing against the planers, to insure a true and even surface when the board comes from the machine. Patent 1736641. William G. Zimmerman.

ELEVATOR—Particularly adapted for freight, one of the outstanding features being its automatic operation which is performed by the dumping of the object upon a certain lever forming part of the elevator. Patent 1736584. Federico G. Diago.

Medical and Surgical Devices

DIATHERMY KNIFE—For use where electricity is employed in tonsil-lectomy, comprising a cutting blade and insulating material against the edge, whereby a tonsil may be cut, the tissue destroyed, and the tonsil removed without bleeding. Patent 1735271. Sutten H. Groff.

METHOD OF MANUFACTURING DRY YEAST FOR MEDICAL AND PHARMACEUTICAL PURPOSES—Consisting in subjecting yeast to the action of alcohol at a temperature of 55 to 65° C., extracting the liquid, drying the resulting mass, and subjecting this mass to the action of heat at a temperature from 150 to 160° C. Patent 1736657. Cornelius Massatsch.

MEDICAMENT APPLICATOR — Particularly adapted for applying a medicament to the cervix uteri, having a cup-shaped member at the discharge end to fit over the mouth of the cervix, so that the treatment may be direct. Patent 1737454. Ernest L. Foley.

Musical Devices

HARMONICA HOLDER—Capable of being folded into a substantially flat or nested position, but when in use, will firmly hold the harmonica in position for operation against the mouth, or in an out of the way position. Patent 1734799. Leigh A. Elkington.

Plumbing and Fittings

CLOSET BEND—For connecting a water closet bowl with the soil pipe, having a non-siphon inlet whereby water coming from that end which connects with the closet will not cause siphoning in other fixtures connected with the inlet. Patent 1733823. Osgood M. Redlon.

Prime Movers and Their Accessories

PISTON—Having means by which the skirt can be shortened in length and yet overcome the tendency of the piston to rock in the cylinder, particularly adapted for use in internal combustion engines. Patent 1733422. Albert Mertz.

INTERNAL - COMBUSTION ENGINE—Having an auxiliary piston co-operating with the working piston to maintain compression within the cylinder while passing over dead center, no compression being lost, and ignition taking place when the crank arm is in most effective position. Patent 1734867. Douglas J. Martin.

NOISE ELIMINATOR FOR INTERNAL-COMBUSTION ENGINES—For use on crank case opening covers and pans for absorbing and liberating metalic vibrations, there is no metallic connection between the adjoining parts, and oil-tight joint being formed without constant attention. Patent 1737466. Harry J. Lynd.

Pertaining to Recreation

TOY WINDMILL—Comprising a figure with waving arms, acting in a very life like manner, a plurality of sets of oppositely revolving wind driven means, and electric lights to illuminate the device while in motion. Patent 1734858 John F. Keller.

AMUSEMENT RIDE—Wherein the carriages or cars may be moved up and down as they move in a circle, or may move upwardly and then in a circle giving to a limited extent the sensation of flying. Patent 1734856. Jacob Irsch.

GAME APPARATUS—For playing indoor golf under similar rules governing the game as played outdoors, the game board being laid out to simulate a course with tees, fair ways, putting greens, hazards and lines indicative of "hooks" and "slices." Patent 1735794. Herbert H. Bristow.

HAND FISHING NET—For landing fish after they have been caught and drowned, equipped with a readily adjustable loop for supporting the net at the fisherman's side at a height to obviate its entanglement with obstacles on the ground. Patent 1736624. Allan S. Richardson.

Pertaining to Vehicles

LIGHT PROJECTOR—A headlight mounted to conceal the source of light from the front of a vehicle and reflect the rays downwardly and forwardly toward the ground, without causing glare in the eyes of approaching drivers or pedestrians. Patent 1731125. William M. Cassetty, Jr., William C. Alford, and Frank L. Ross.

CONVERTIBLE SEAT FOR MOTOR VEHICLES—Whereby the conventional type of built-in seats of an automobile may be easily converted into a bed substantially the width of the vehicle body, or reversible so that the occupants may face the rear. Patent 1732151. Frank A. Clark.

SUMMER TOP FOR AUTOMOBILES—Adapted to extend over the roof of the automobile in slight spaced relation thereto whereby the auxiliary top will receive the direct sun rays, and thus protect the roof from blistering and damage. Patent 1733007. Sigurd M. Dahl.

COMBINED STARTER SWITCH AND CHOKE—Which will serve as the usual choke rod and as a circuit closer for controlling an electrical circuit to the usual starter, may be adjusted to any desired position while the motor is in operation. Patent 1733911. Gloyd L. Seifert.

SHOCK ABSORBER—Constructed so as to afford relatively large and small by-passes for fluid to compensate for weak or strong recoils, and to provide a large by pass for return of the fluid. Patent 1734857. Edwin S. Kant.

DIRECTION SIGNAL — Which utilizes the vacuum produced at the intake manifold of the vehicle's engine for actuating a semaphore arm by which the movements of the automobile may be conveyed to pedestrians and vehicular traffic. Patent 1734094. George MacKay.

WINDSHIELD WIPER—In the form of an attachment, in which a swinging motion is imparted to clean a sector shaped space, and electrically heated means and cutting means, for melting the snow or ice and scraping the same away. Patent 1735070. Joseph M. Young.

AUTOMOBILE CONTROL MECHANISM—By means of which the motor is automatically used as a service brake through the operation of the usual control levers in the usual manner, thus eliminating wear and tear and reserving the brake for emergency. Patent 1736089. Paul G. Peik.

SLACK ADJUSTER FOR BRAKES—Which may be readily adjusted to take up anv appreciable wear on the shoes, and will not readily get out of order, notwithstanding weather conditions. Patent 1735752. Jesse R. Grube and Louis F. Munsch.

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