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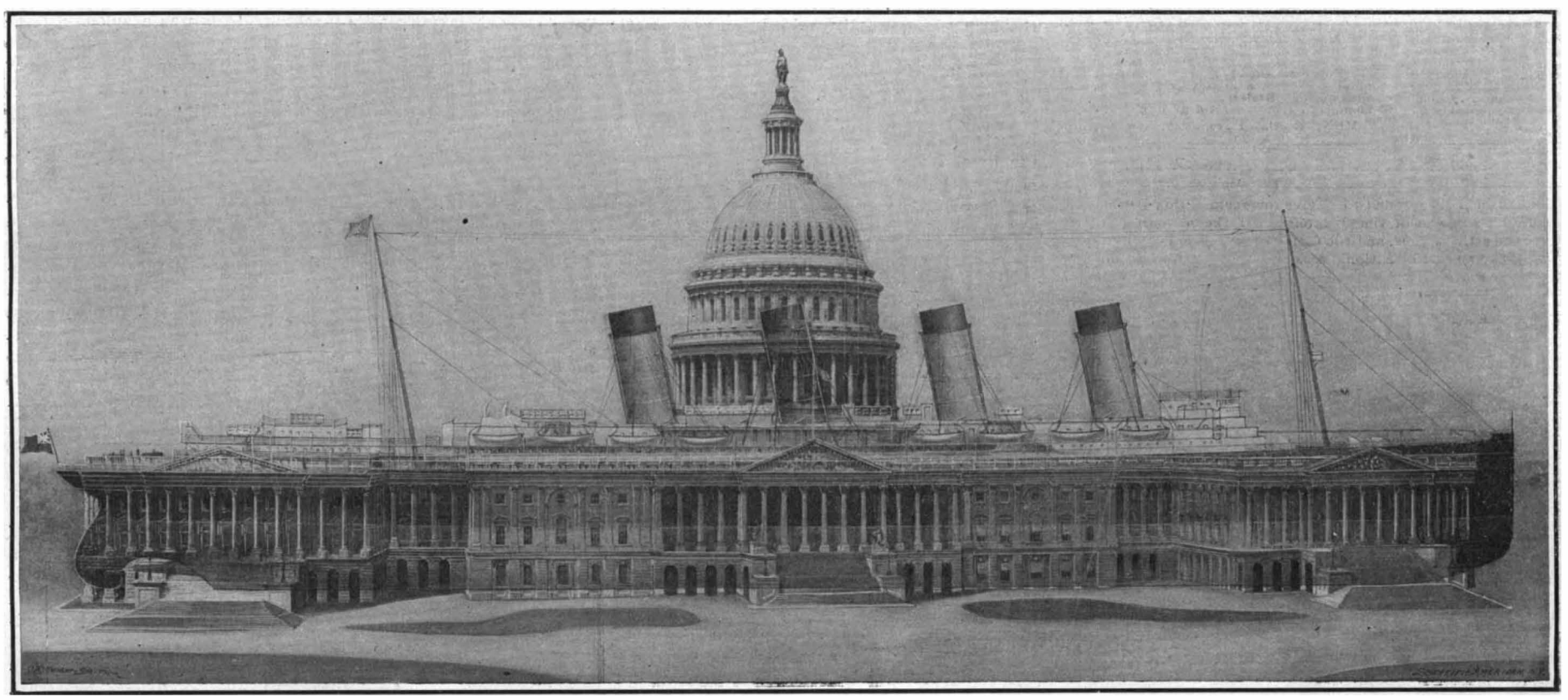

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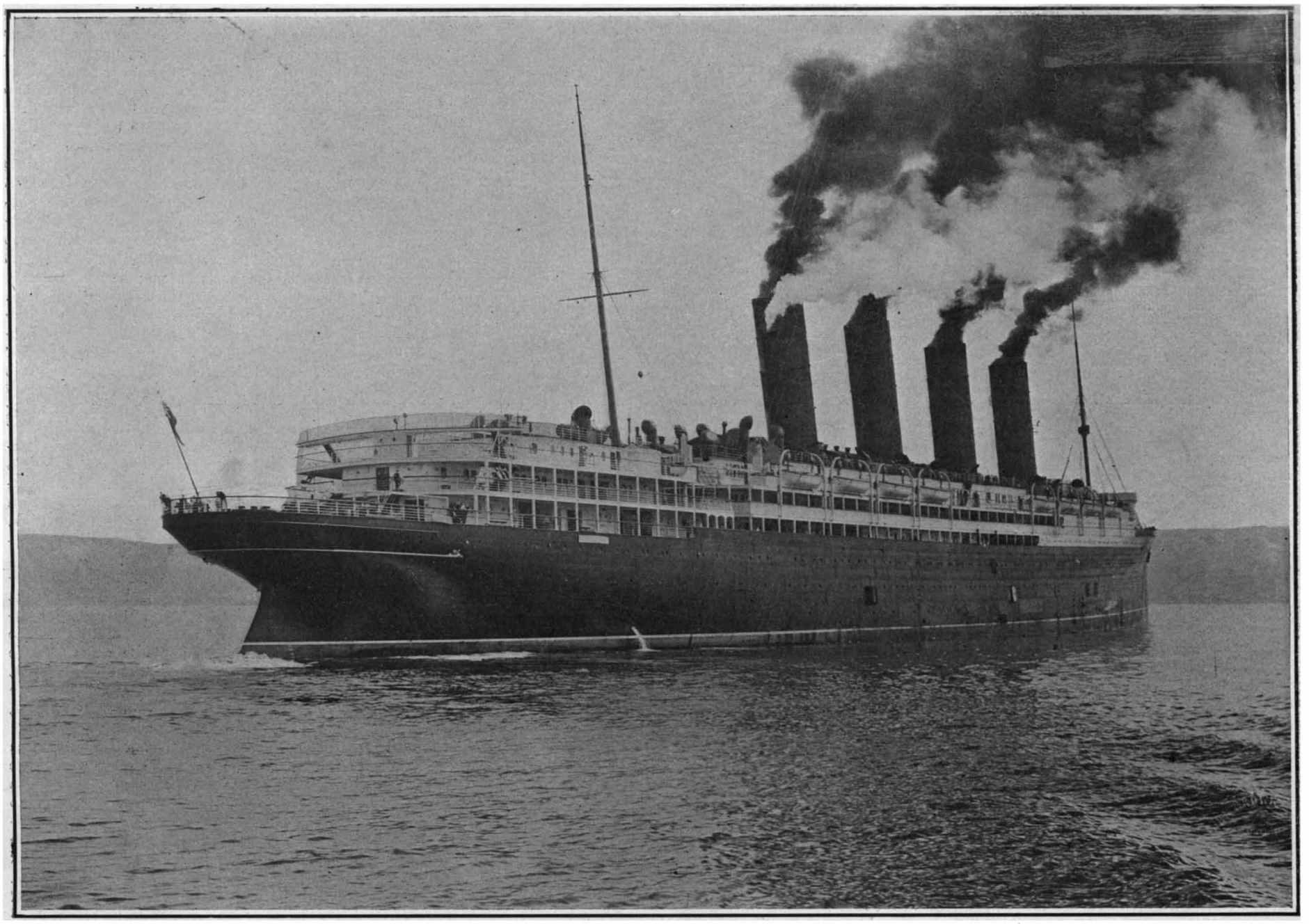

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THE NEW 25½-KNOT CUNARD TURBINE LINER "LUSITANIA."—[See page 188.]

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NEW YORK, SATURDAY, SEPTEMBER 14, 1907.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

A PORTENTOUS BRIDGE DISASTER.

Quite apart from the lamentable loss of life which it involved, the fall of the great Quebec cantilever bridge is the most disastrous calamity that could possibly have overtaken the profession of bridge engineering in this country. If we were to select out of the many fields of activity which are covered by modern civil engineering, some particular one in which the American engineer has displayed most signally his originality and freedom from tradition, we would choose that of bridge engineering; and if we had been called upon to name some one particular structure which stood as the highest exemplification of his skill in this particular branch of his profession, we would have selected the great cantilever bridge across the St. Lawrence River at Quebec. Not only did it contain the largest and most massive single span of any bridge in the world, but it was constructed upon a system of which the earliest types, on any large scale, were built in this country. Moreover, not only was the bridge American in type, but in the details of its construction also it was essentially American, the tension members consisting of eye-bars and the compression members of rectangular latticed sections, built up of plates and angle bars, the whole bridge being pin-connected. The skeleton design shows also the distinctive American features of wide panels, great depth of truss, and a resulting apparent lightness of the individual members. Furthermore, the consulting engineer of the bridge is perhaps the most distinguished bridge engineer in this country, his "Specifications for Railroad Bridges" having been for many years the standard authority on that subject. The actual design of the steelwork, moreover, represented some three years of careful labor on the part of another of our leading bridge engineers; and his computations had been checked, and rechecked, and every care taken to obviate any possible errors in the design. Let it also be borne in mind that the steelwork was built and the erection done by one of the biggest and most experienced bridge firms in the country. In view of the fact that this was the most monumental and daring structure of the kind ever erected, it was natural that special care should be taken, as it unquestionably was, both by the engineers and the contractors, to insure that everything connected with the bridge, from the inspection of the steel to the details of the erection, should be done with the utmost care and fidelity.

Nevertheless, on a comparatively calm summer's afternoon, the giant structure collapsed in one of its most important members—crumpled in upon itself—and sank into the shapeless mass of ruin so graphically depicted elsewhere in the columns of this paper.

The tremendous significance of this disaster lies in the suspicion, which to-day is staring every engineer coldly in the face, that there is something wrong with our theories of bridge design, at least as applied to a structure of the size of the Quebec bridge.

It would be a mighty consolation if only there were some evidence that faulty material or poor construction had entered into a vital part of the bridge; but thus far everything points to the contrary. There would be comfort also in the fact, if it could be proved, that the sudden fall of some massive member which was being lifted into place, or a sudden displacement of one of the erecting gantries weighing several hundred tons, had produced a dynamic shock throughout the huge framework, which had caused the stresses to rise beyond the maximum calculated stresses, and so had brought the bridge down. But alas! there is no evidence to show that sudden dynamic stress or anything approaching it occurred.

Are we to conclude, then, that those theories, those formulæ, upon which we have been building our bridges so successfully during the past quarter of a century, are inapplicable when the structure exceeds a certain magnitude? Can it be that for some unsuspected reason a stress per square inch which is perfectly safe in the end-post of a 500-foot railroad truss becomes perilous when used in the bottom chord of an 1,800-foot cantilever? As far as our engineering knowledge goes, there is no reason whatever why this disparity should exist. But if not, why is the Quebec bridge now lying at the bottom of the St. Lawrence River?

When we first heard of the fall of the bridge, we were satisfied that the failure was not due to the breaking of any of the tension members. Eye-bars, if the heads be carefully welded (and great attention is always paid to this point) are the most reliable portions of a framed structure. They are never known to give way. It was our expectation that the cause of failure would be found in the compression members; and, as we have shown elsewhere in this issue, the breakdown seems to have begun in one of these, namely, the bottom chord of the anchor arm of the cantilever. Two or three days before the accident it had been observed that this particular member was showing incipient signs of yielding, by springing from an inch and a half to two inches out of line, the deflection being toward the inside of the truss. We confess to profound astonishment that upon this discovery work was not instantly suspended. Instead of this, an engineer was dispatched to New York to see the consulting engineer, and another was sent to Phœnixville to the works of the bridge company. At about the very hour that instructions were being forwarded to suspend work, the bridge fell.

The methods of calculation of the strength of posts, struts, and chords, that is, of all members subject to compression, are based upon combined theory and experiment. Many years ago large posts which had been built upon the accepted formula were placed in a testing machine, and subjected to compression until failure occurred. These tests thoroughly verified the correctness of the accepted formula, and the latter has since been used universally in determining the dimensions of compression members necessary to carry any given load. This formula was used in designing the chords of the Quebec bridge. They were designed to carry, under the most severe conditions of full live load and maximum wind strain, a stress of 24,000 pounds on each square inch of metal. This is two-thirds of the elastic limit, or the limit at which the metal would begin to stretch. At the time of failure, this member was carrying only about 16,000 pounds per square inch, or less than one-half the elastic limit. Evidently, when compression members are built up according to the present methods, in sizes such as those in the Quebec bridge, there is a failure of the separate pieces to act together as a whole, and present that resistance to buckling which members built up in the same way have invariably presented when constructed in smaller sizes for bridges of less dimension.

Obviously, if confidence in future bridges of great span such as this is to be restored, the first step to be taken is to determine with absolute certainty why the failure occurred; and the best way to do this would be to build a compression member which is an exact duplicate of this one, and subject it to gradually increasing loads, until both the elastic limit and the ultimate point of failure have been passed. To do this would, of course, involve the construction of an exceedingly costly testing plant; but in view of the doubt which has been cast upon American principles as applied to the design of bridges of great span, not even this expense should be spared in an effort to get at the true conditions.

It is too early to predict that, as the result of these investigations, we may be led to adopt the circular sections (by far the most effective form for long compression members) used by the late Sir Benjamin Baker for the Forth bridge, but we do believe that in future bridges of this size, the ratio of diameter to length of compression members will be greatly increased, and continuous cover plates will be used in place of the present open lattice-work reinforcement.

SUCCESSFUL FLIGHT OF AN AEROPLANE CONSTRUCTED AFTER LANGLEY'S MODEL.

Spurred on by the success of the Wright brothers in this country, and by the fact that these gentlemen have made a trip to France with the purpose of selling their aeroplane, a number of the well-known French experimenters have been making every effort to fly with a heavier-than-air machine. In a competition of models held last June in France, several models on the following-plane type, such as was first built and used successfully by the late Prof. Langley, made the best performances. Since then, M. Louis Bleriot has constructed and experimented with a full-sized machine of this type with quite remarkable results. A complete description of Bleriot's work will be found in the current SUPPLEMENT. Suffice it to say that with a machine having only about 215 square feet of supporting surface and weighing, all told, 617 pounds, he succeeded in flying a distance of 870 feet in two successive jumps of 401 and 469 feet, separated by a space of 39 feet, throughout which he touched the ground. His machine developed a speed of over thirty miles an hour. Its movement in a vertical plane was controlled by a horizontal rudder at the front end, this rudder being operated by a movable seat mounted on rollers, which was moved forward or backward similarly to the seat of a racing scull. The most notable part of this intrepid aviator's performance was the making of a turn at the end of the field over which he was experimenting, and landing with the wind at a speed of over thirty miles an hour without damaging his machine. This was a splendid demonstration of the inherent stability of the Langley-type machine, and complete proof that had Prof. Langley ever been able to successfully launch his machine, it would have made a successful flight. One of the most remarkable points to be noted with regard to M. Bleriot's performance is the fact that he had a motor of only about 20 horse-power, and each square foot of supporting surface was required to carry 2.8 pounds. One and one-half to two pounds per square foot is generally considered to be a good load for a machine of this type. Coming as it does at the moment of completion of the aeronautic trophy offered by this journal in commemoration of Langley and his machine, M. Bleriot's performance should put at rest all question as to the value of the type of machine proposed and successfully experimented with on a small scale by the late Curator of the Smithsonian Institution.

THE EVOLUTION OF MATTER.

The discovery of radium rays and other radiations has resulted during the last few years in a revolution, not only in the field of experimental physics, but of natural philosophy generally. Such fundamental laws as the laws of the conservation of energy and matter have lost a great part of their old prestige, and are far from occupying their former position as pillars of natural philosophy.

While the atom until recent years was considered as indestructible, radiation phenomena have shown that not only "radio-active" substances, but all bodies generally give out continually a stream of minute particles. These particles, which are thrown off by the atom at an enormous speed, possess the properties of rendering the air conductive of electricity, penetrating any obstacles on their way, and undergoing a deflection under the influence of magnetic or electric fields.

That these phenomena are common to all bodies has been first recognized by Dr. Gustave le Bon, who in a treatise recently published* deals with the significance and consequences of these theories.

For the old axiom, "Nothing is created, nothing is lost," Dr. Le Bon substitutes the principle, "nothing is created, all is lost." He considers radio-active phenomena as evidence of a permanent vanishing of matter and a gradual decay and transformation of it into an immaterial state, while passing through a number of intermediary conditions; the immaterial state corresponding to what is called ether. Ether and matter appear to him to represent things of the same order, the different forms of energy, namely, electricity, heat, light, matter, etc., being manifestations of one identical thing, differentiated by the stability and nature of its equilibria.

The products of this decomposing of atoms, according to recent researches, form substances intermediary by their properties between ponderable bodies and imponderable ether, that is, between two worlds which science has so far kept strictly separated. While matter was once considered inert, it now appears as an enormous reservoir of energy (inter-atomic energy), which it is able to give out without deriving anything from outside.

This inter-atomic energy manifested during the decay and disintegration of matter would result in most of the forces of the universe. The only essential difference between force and matter would be that the latter is a stable form of inter-atomic energy, while the former is unstable. By the dissociation of atoms, the stable form of energy called matter would be transformed into its unstable forms—electricity, light, heat, etc.

The idea recently suggested that a transmutation of atoms, according to the dreams of alchemists, some day might become quite practicable, is obviously in agreement with these theories. In fact, according to Le Bon, the law of evolution, which according to Darwin is true of living beings, would be applicable also to the simple chemical bodies or elements, chemical species being as far from invariable as living species.

The practical interest attaching to the doctrine of the permanent decay of matter, due to its transformation into energy, will be fully appreciated only when a process for accelerating the disintegration of bodies has been found. When this has been achieved, a prac-

* L'Evolution de la Matière, Ernest Flammarion, pub., Paris.

tically infinite source of energy will be at the free disposal of man, the consequences of which can hardly be foreseen.

SEARCHING FOR PARASITES TO FIGHT FRUIT PESTS.

BY H. A CRAFTS.

A most unique calling is that of George Compere, chief field entomologist for the Department of Horticulture, State of California, and also for the Department of Agriculture of Western Australia. His work consists in searching the world for beneficial insects, or parasites, for the preservation of the fruit industry of the two states mentioned, from the ravages of insect fruit pests. The reason that he is able to serve both governments at once to their mutual satisfaction is that the fruit pests of California and Western Australia are identical with but few exceptions. Two of these exceptions are comprised in the codling moth and the fruit fly; the first is prevalent in California, but not in Western Australia, and the reverse is true of the second.

The prime object of three out of the seven world tours made by Compere was the finding of the parasite, or natural insect enemy, of the fruit fly; yet Compere did not forget the interests of his own State while making these tours; among the beneficial insects calculated to combat the fruit pests of California obtained by him during these travels was the parasite for the codling moth, which he found on the western coast of Spain, and one for the purple scale, discovered in the interior of China.

Compere's methods are peculiar to himself. When starting upon one of these insect expeditions, he severs all social ties, and remains in communication only with the horticultural officials of the two countries employing him. He goes alone and unattended, and engages no helpers until he arrives in a field of immediate search; then he may hire a guide, and perhaps an interpreter.

During his long sea voyages he is immersed in his collection of books on entomology, and studies them carefully in their bearing upon his peculiar line of investigation. But no sooner is a landing made, although it may be only for a few hours' stop at some lonely island in the middle of the Pacific Ocean, than Compere seizes his paraphernalia and hastens ashore to hunt insects until the steamer shall proceed.

His outfit on one of these expeditions is simplicity itself. It consists of a large sheet of white cotton cloth, a stick, an insect-case, and a microscope. As soon as he espies a tree or shrub that he thinks may be inhabited by some important member of the insect family, he proceeds to spread his sheet underneath its boughs, and when that is done he begins to beat the branches with his stick. When he has dislodged a great number of insects, he falls upon his knees, with the microscope to his eye, and makes a careful scrutiny of the sheet. Should he discover any interesting individual he proceeds to capture it, and consign it to his insect case.

And thus Compere goes about the world, hunting every nook and corner; plunging into jungle, morass, or tropical forest in his tireless search for more insects, regardless of personal danger. Once while traveling in India he found himself in a plague-infected district, and lost five guides in succession from the disease before he had completed his search. Then he was detained in quarantine on the frontier, and when he was about to leave, the local officials took it upon themselves to fumigate his baggage. Among his baggage was his case of insects, and every one of the creatures was killed by the noxious fumes. Then all the labor Compere had been to, all the dangers he had braved upon this expedition, came to naught. But the next season saw him on the ground again, and this time he was more successful.

One may ask why it becomes necessary to search in foreign lands for these beneficial insects, and why they may not be found within the borders of the State of California in conjunction with the injurious insects. This is quite readily explained: California is a new State, and her fruit industry is of comparatively recent origin and of very rapid development. Neither the injurious nor the beneficial insect was in the State originally. The first came in through negligence and lack of foresight; the second can be brought in only by great labor and research. The early fruit growers were more influenced by enthusiasm for the introduction of new and rare fruits than by wise caution in not importing at the same time about all the fruit trees in the known world. The pests came in through infested trees, shrubs, green and dried fruits, etc., because in the early days no one thought of horticultural inspection and quarantine such as California has since established; but the parasites did not come with them; so the pests gained a foothold, multiplied by the million, and have been productive of infinite evil.

Again, it may be asked why it is so difficult to obtain these parasites even in foreign lands, which are apparently their natural home. This question is also easily answered: In lands where pest and parasite exist in conjunction, there is eternal war between the two species; one is on the offensive, the other on the defensive, with the parasite always in the ascendency.

The pest gradually disappears under the constant attacks of the parasites, and as it disappears the parasite is deprived of its natural food; for under no conditions will it subsist upon a vegetable diet; and then the parasite disappears by reason of a food famine. So Compere does not look for a parasite in any locality where the pest is prevalent, for the very presence of the pest is proof positive that the parasite is not existent in that neighborhood, but must be looked for in some place where the pest is very scarce; and the pest or natural food of the parasite being scarce, of course that insect is found in diminished numbers; consequently the search for it is made much harder.

After the search has been made and the insect found, comes the delicate and difficult task of transporting a colony to one or both of the two countries in whose interest the search has been made. This requires patience, perseverance, and a considerable amount of ingenuity and inventive genius. You cannot pick up any kind of an insect and put it in your pocket and carry it home some 25,000 miles, nor can you send it by mail or express and stand any chance of its arriving at its point of destination alive and in good condition. There is a difference in insects and the ways of handling them.

Take Compere's experience with the parasite for the fruit fly! The discovery and final landing of this insect in West Australia required three consecutive tours of the world, as I have already stated.

There was one long and unsuccessful hunt in the Orient; then Compere heard of the insect having been in Washington, D. C. To that city he went, and learned that the creature had been sent to the Smithsonian Institution in that city for identification by Dr. H. Von Ibering, director of the museum at Sao Paulo, Brazil, but had been returned after identification. That was a good enough clew for Compere, so he hurried down to Bahia, and in that neighborhood found the object of his search, in the shape of a large beetle.

There are two general classes of parasites that are sought after to prey upon the fruit pests—the internal and the predaceous. The first is one that lays its eggs in the grub of the injurious insect, and as the young hatch and levelop they feed upon the surrounding tissue, and the pest is killed in embryo. The predaceous parasite is one that in its mature form pounces upon the pest insect in whatever form the latter may be found and devours it.

The Brazilian beetle discovered by Compere belongs to this last described class and the naturalist decided to herd a lot of them together, confine them and then personally conduct them all the way to Perth, West Australia, *via* London and Marseilles. He had constructed a tin case containing compartments and he divided his colony of beetles into sections, and put a section into each compartment. Then he secured passage on the first steamer out that was going his way; secured on board a corner in which to keep his insects, and then provided for feeding them on grubs on the voyage. He secured an ice box, charged with ice, and filled it with fresh meat; then he caught a lot of blow flies and shut them up in a tin case by themselves. Next he provided an open case in which to place a piece of meat for exposure to the blow flies, and still another case in which to place his maggots as fast as they developed upon the meat.

The maggots were used as food for the beetles. But the latter proved to be hungry fellows, and they devoured between one hundred and two hundred maggots per day, and Compere was compelled to exert himself to secure a sufficient amount of food, and he was constantly filled with anxiety as he observed that the bugs were regular cannibals, and just so soon as grubs became short, turned upon one another.

He kept them alive, owever, until he reached London, and in that city, hiring a cab, he scoured the precincts in search of suitable food for his hungry beetles. Happily he ran across a firm in Gray's Inn which made a business of supplying fishermen with bait, and of them he bought two gallons of maggots.

These lasted until he reached Port Said, and in that vicinity he discovered that the very fruit fly which was the natural food of the beetles was prevalent in that region. Here he secured sufficient food for his beetles for the balance of the journey to West Australia, where the insects were landed alive and in good condition, the journey from Bahia to Fremantle having occupied a period of forty-six days.

But in West Australia a new and unlooked-for difficulty was encountered. It was in the dormant period of the fruit fly that the beetles arrived, and therefore there was no food for them. They were placed in cold storage, in the hope of keeping them alive until the fruit fly season opened, but in this the entomologists were disappointed, and the next year Compere found it necessary to make another trip to Brazil after more beetles. This expedition was properly timed, another colony of beetles was secured and successfully transported to West Australia, where the insect has since been bred by the million and turned loose upon the fruit fly.

The securing of the purple scale parasite in China and its transfer to California were accompanied with almost equal difficulties. This parasite, unlike the fruit fly parasite, is a minute wasp, so small as to be almost invisible to the naked eye, and is one of the internal species.

It was transferred in this fashion: The California horticultural officers at San Francisco secured from Southern California a number of small lemon trees heavily infested with purple scale, and these were potted, boxed up, and dispatched to Compere in China, as soon as he had found his parasite.

As the little trees reached him he unboxed them and exposed them to the parasite until they became thoroughly infested with that insect. Then he reboxed the trees and dispatched them back to California.

The product of his first expedition died in cold storage on the way over from Hongkong, and this necessitated making a second trip. This latter was successful and the little wasps are being reared in their new home in immense quantities and sent into the scale-infested orchards of the southern part of the State.

SCIENCE NOTES.

Work on the Panama canal is progressing faster than has been calculated, and as a result it is estimated that the expenses for the current year will exceed appropriations by about $8,000,000. The office of the canal commission has issued the following statement: "With the present organization and the progress which now is made, the canal can be completed more rapidly than by restraining expenditure within the appropriations which were made at the last session of Congress to continue the work until 1908. Work on the locks and dams at each terminus has been opened and will be pushed vigorously during the year, while very little was done at those places during the fiscal year which terminated June 30, 1907. The time of completion of the canal appears to depend now upon work at Gatun, rather than on the work of excavation, which has hitherto been generally taken as the determining feature. The progress in this direction has been faster than anticipated, and the appropriation made at the last session of Congress would not be sufficient to supply the necessary plant to begin laying the concrete in the locks and dams during the next fiscal year, although progress already made indicates that such a beginning is advisable. In order to avoid reducing the force, to keep within the expenditures already authorized for this fiscal year, the chairman of the commission has recommended to the Secretary of War that the work be allowed to proceed, and that Congress be appealed to at its next session to make good any deficiency in the funds now available. If the funds requested are not provided it will, of course, be necessary to reduce the rate of expenditure to keep within the appropriations on hand. About $8,000,000 in excess of the appropriations already made could be used to advantage in pushing forward the work during the present year."

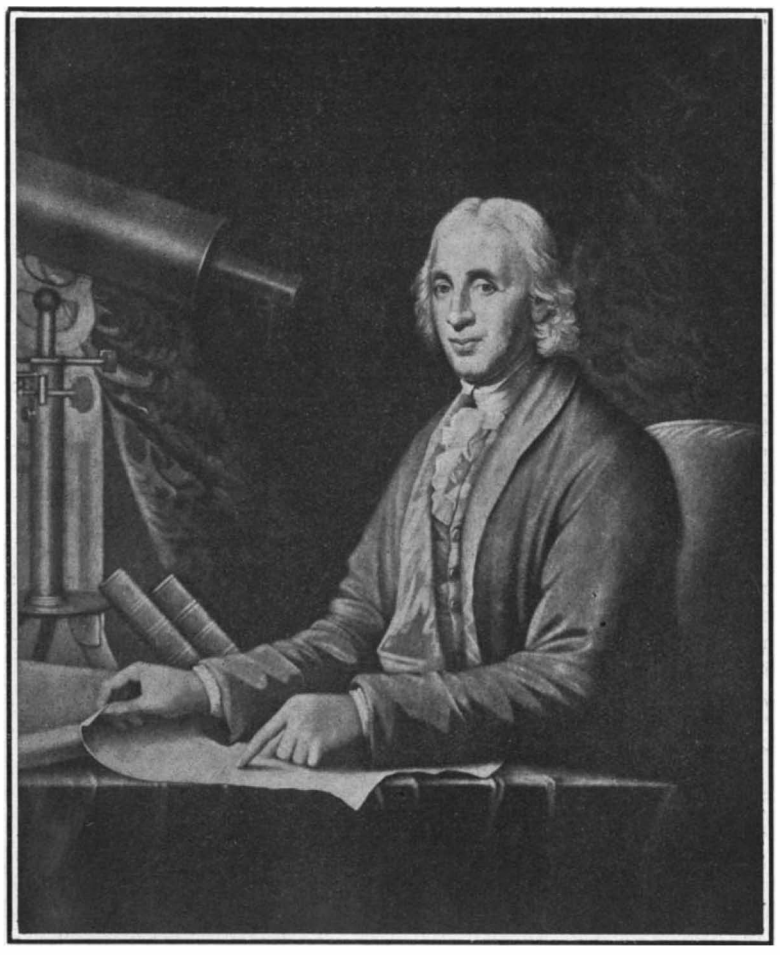
Extended experiments recently conducted in this country have shown clearly that fruit trees suffer very materially, and are often killed outright, when grass is allowed to grow under the tree and close up to the trunk. Various probable reasons for this effect, such as the removal of plant food and of water by the grass, also the supposed liberation of carbonic acid, which might prove injurious to the roots of the trees, were respectively demonstrated to be outside the primary cause of injury, and, finally, after seven years' work, it was concluded that the injurious effect could only be due to some poisonous substance formed in the soil by the roots of the grass. On the other hand, it is a well-known fact that in many instances considerable difficulty is experienced in obtaining a growth of grass under trees. Mr. C. A. Jensen has given an account of certain experiments bearing on this point in Science. There is distinct evidence that plants produce toxic conditions in the substance in which they grow, and as a rule the excretions given off by the roots of a certain plant are more toxic to the same or a nearly related plant than to plants not so closely related. The effect of tree seedlings on the growth of wheat was tested, and after eliminating as a cause of injury such factors as removal of plant food or water by the tree-roots, it seemed that the roots of the latter had some direct effect on the growth of the wheat, which suffered in all the experiments. The seedlings were placed in plant pots, hence the roots of the tree and those of the wheat plants were in close contact. Trees of various kinds were used in the experiments, and the retarding influence, although noted in every instance, differed in degree; cherry was least active in checking growth, pine most so. The conclusion arrived at was that the effect of trees on wheat appears to be due to the excretion by the trees of substances toxic to wheat.

A FORGOTTEN MASTERPIECE—THE RITTENHOUSE ORRERY—AND ITS MAKER.

For one hundred and thirty years the University of Pennsylvania has possessed an ingenious scientific toy which, though long forgotten, at the time it was made created a furor through several colonies, and attracted the admiration and envy of scientists in Europe. This is the orrery constructed by David Rittenhouse, and the instrument and its maker are alike worthy of being remembered. Rittenhouse, like Franklin, Fulton, and others, was a self-taught investigator, and earned his fame by making a distinctive mark at a time when the colonies were dependent on Europe—and particularly on England—for many things which they yearned to produce at home. His family name is known as that of the oldest paper-making firm in America. His father, however, left the mill for the land, and it was as a farmer's son that David Rittenhouse was born in Germantown in 1732. At the age of fourteen or earlier, he followed the plow, but the work suffered, for he would sit down at some flat stone, and with a piece of chalk cover it with intricate calculations. It was soon evident that he had neither liking nor the physique for farming, and he drifted into mechanics, choosing clockmaking for a livelihood. He was soon prosperous, and clocks bearing his name are still to be found in many old Pennsylvania families.

Rittenhouse was a sanely balanced American. Inclined to delicacy, and perhaps emphasizing his weakness by overstudy, he was a deep student and thinker, and a religious man. But business did not suffer at his hands. With a pride in his craft, and a determination to produce no unworthy work, he asked good prices, and did much of his business in elaborate clocks for "gentlemen of respectability and taste." These clocks of his not only showed the changes of the moon and movements of the planets, but often contained a music box, which played at intervals. A curious blending of the enthusiast and the business man peeped out when he commenced work on his orrery. So enmeshed was he in his calculations that he had to refuse urgent orders for clocks, but he "ventured to promise them after harvest, for ready money." At this time a planetarium, or apparatus for showing the relative sizes and positions of the various members of the solar system, was a common possession of people of wealth who aspired to be art patrons. These toys were known as orreries, after a British Earl of Orrery who had financed the making of one.

When Rittenhouse decided to make one he intended to make a reliable scientific instrument; or, as he sarcastically said, "one which will not differ several degrees from the truth in a few revolutions, as is common with orreries." His biographer ingeniously says that not even people of skill and intelligence can fully grasp the beauty and intricacy of this instrument from any diagrams or written description; and the only description extant seems to be that of Rittenhouse himself. He describes the machine as "intended to have three perpendicular faces, that in the front to be four feet square (Fig. 1), made of sheet brass curiously polished, silvered, and painted in proper places, and otherwise ornamented. From the center rises a gilded brass ball intended to represent the sun.



David Rittenhouse, A.M., President of the American Philosophical Society, and Maker of the Orrery.

Round this ball move others to represent the planets. They are to move in elliptical orbits having the central ball in one focus; and their motions to be sometimes swifter, and sometimes slower, as nearly according to the true law of an equable description of areas as is possible without too great a complication of wheel work. The orbit of each planet is likewise to be properly inclined to those of the others; and their aphelia and nodes justly placed; and their velocities so accurately adjusted as not to differ sensibly from the tables of astronomy in some thousands of years.

"When the machine is put in motion, by the turning of a winch, there are three indices which point out the hour, day, and year; answering to that situation of the heavenly bodies then presented; and so continually for a period of 5,000 years forward or backward.

"In order to know the situation of a planet at any period, the indices are first adjusted to the time. Then a small telescope, made for the purpose, is applied to the central ball, and directing it to the planet, its longitude and inclination will be seen on a large brass circle, properly graduated, representing the zodiac, and having a motion of one degree in seventy-two years, agreeable to the precession of the equinoxes. Similarly, the position of a planet in regard to the earth may be found.

"Of the lesser faces (Fig. 2), one shows all the appearances of Jupiter and of Saturn, with their attendant satellites. And the other all the phenomena of the moon, particularly the exact time, quantity, and duration of her eclipses and those of the sun occasioned by her interposition." Such is a condensed account of the orrery as outlined by Rittenhouse.

The orrery was commenced in 1767 and completed in 1770. A competition for its possession at once arose between Princeton College and the College and Academy of Philadelphia. Much to the disgust of the latter, Princeton stole a march on them, and for £300 became the possessor of the treasure. Philadelphia was wildly jealous, hinted that Dr. Rittenhouse had not been loyal to his own colony, and felt that only the aberration of genius could account for his action in letting the masterpiece go "to a village." Rittenhouse remained calm under the excitement and suggested that he could make a second and a better one for the College and Academy of Philadelphia. This appeased the city, and the £300 requisite was raised largely by lectures. To a friend Rittenhouse sagely remarked that, having made one, a second would be easy, and hinted at the possibility of "the other colonies catching the contagion."

This second orrery was completed within twelve months. People came to gaze on its multitude of little wheels, its polished brass, even its mahogany case. But troublous times were ahead. The British and American troops successively occupied Princeton and Philadelphia, and the souvenir hunters of two armies carried off little wheels and ivory balls, the Princeton orrery suffering much more than that in Philadelphia. After the trouble was over, Rittenhouse was approached to restore his masterpieces, but from ill health or other causes he never did so.

For many years the Philadelphia orrery figured on the seal of the University of Pennsylvania, and the orrery itself was its chiefest possession. Now the seal has been changed, and the machine is a forgotten curiosity.

In 1769 Rittenhouse was one of a little band of astronomers who observed the transit of Venus. In 1791 he succeeded Dr. Franklin as president of the American Philosophical Society. Eight years later he died, having lived to sixty-seven in spite of a chronic weakness caused by overstudy when young. As a good American, his ambition was that his country should lead the world alike in science and in manufacture, and in his own particular line he achieved his wish.

Steam Turbines in the German Navy.

In view of erroneous statements in the German daily and technical press, that steam turbines find no favor in the German navy, it is interesting to record the extremely satisfactory performance of the torpedo boat G137, recently launched from the Germania shipyards, Kiel.

This boat, which has been equipped with a set of Parsons turbines, attained a speed of 37.78 knots in the official tests made on August 10. This result is the more remarkable, as it was obtained with an average displacement of about 580 tons; while by the conditions of the contract, a speed of 30 knots with an initial displacement of 571 tons was all that was required.

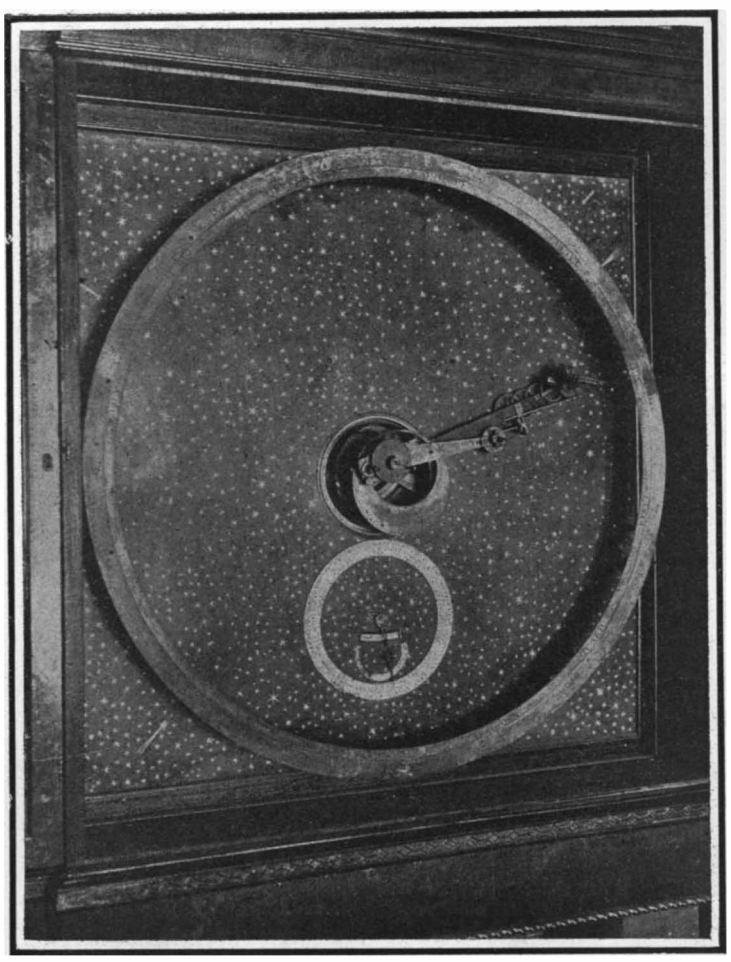


Fig. 1.—The Large Face of the Orrery.

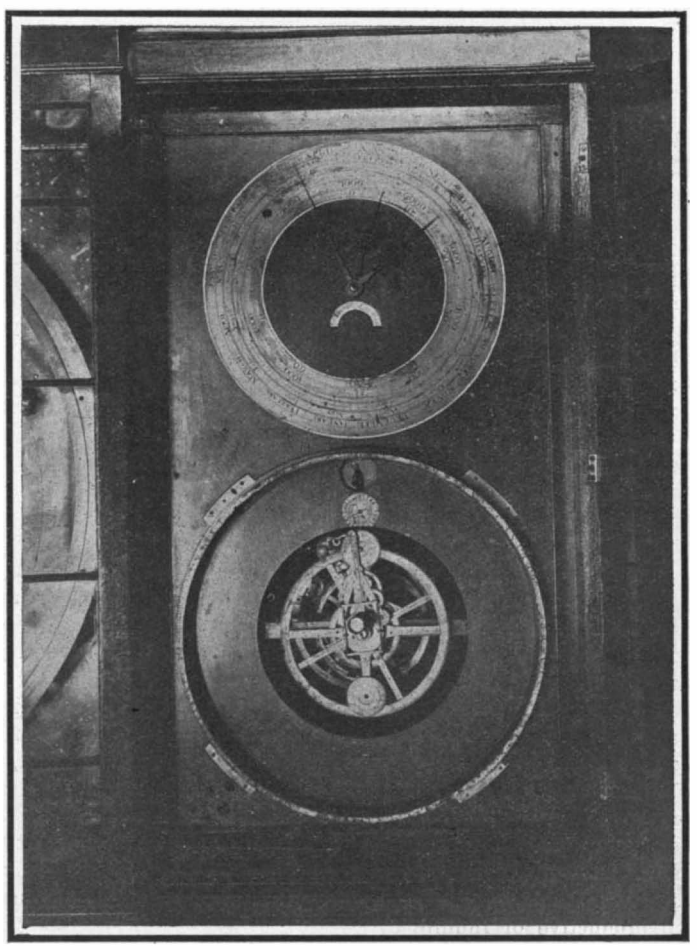
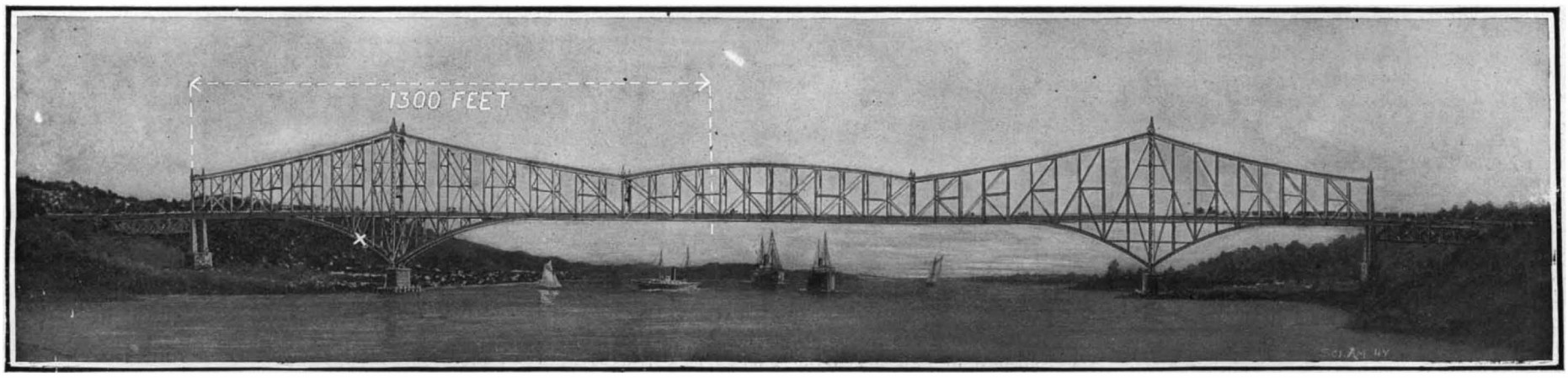


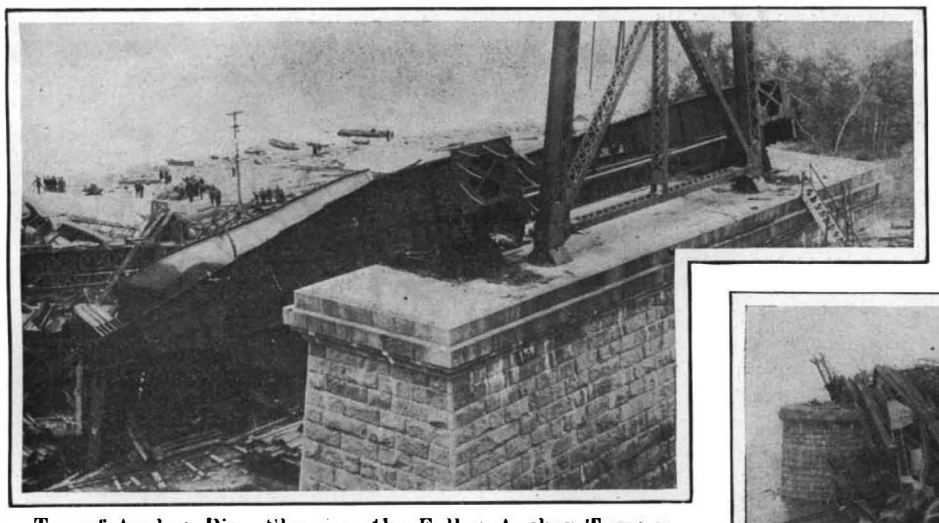
Fig. 2.—The Smaller Faces of the Orrery.

A FORGOTTEN MASTERPIECE.

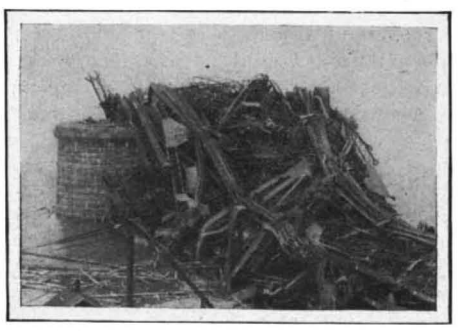


Bridge failed in lower chord at point shown by cross. The 1,300 feet, as marked above, is now in the river.

The Quebec Bridge as Designed. Center Span, 1,800 Feet. Anchor Arms, Each 500 Feet. Depth Over Piers, 315 Feet. Weight, 38,500 Tons.



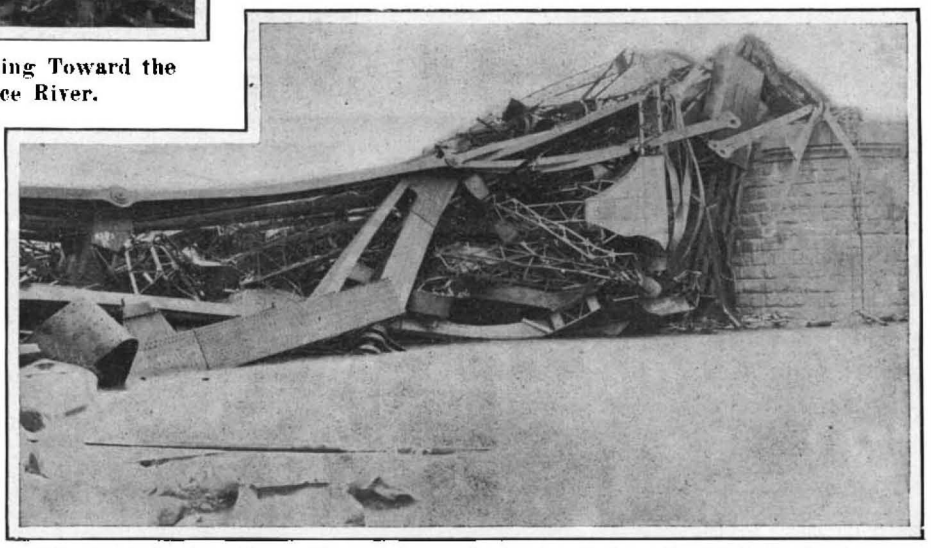
Top of Anchor Pier, Showing the Fallen Anchor Towers and the Bent Supporting Approach Span.



Main Tower Looking Toward the St. Lawrence River.

The Top of 315-Foot Main Tower With Top-Chord Eyebars Still Attached; Viewed from the River.

Wreck of Anchor Span, Viewed from the West. Note Complete Crumpling Up of Compression Members.



Wreck of Anchor Span, Viewed from the East. Before the Fall the Eyebars Were Over 300 Feet Above the River.

Note the two lines of the top-chord eyebars, still pinned together, and stretching continuously across the mass of wreckage.

General View of the Wreck, Showing How the Trusses Fell in Their Own Vertical Planes.

FALL OF THE QUEBEC BRIDGE—THE GREATEST BRIDGE DISASTER IN HISTORY.—[See next page.]

THE QUEBEC BRIDGE DISASTER.

The fall of the magnificent cantilever bridge across the St. Lawrence River at Quebec, which occurred on the afternoon of August 29, 1907, is without question the greatest of all bridge disasters. As a tragedy, it will always be memorable for the fact that it happened at the close of a day's work, when eighty-five men were scattered from end to end of the structure, and that of these only eleven were rescued, the other seventy four being carried down to death in the enormous tangle of twisted and broken steelwork. Sad as is this disaster when viewed in relation to the great loss of life, it takes on equal importance, as we have shown editorially, from the fact that the fallen bridge embodied the highest technical knowledge and skill of the leading bridge engineers of this country, and the workmanship of one of our largest bridge works. Nor is our shaken confidence to be restored by any suggestion that there was carelessness in erection, or any untoward accident involving suddenly applied stresses in the bridge, to which circumstances its failure may be attributed. All the evidence at hand points to the fact that the bridge failed under stresses which, if the theories upon which such bridges are built are correct, were far below the breaking stress of the steel of which the bridge was built.

The fallen structure, which was designed to cross the St. Lawrence River a few miles above Quebec, consisted of two deck spans, each 210 feet long, reaching from the abutment to the anchor piers, and a huge cantilever construction, with a total length of 2,800 feet between the anchor piers. Each cantilever consisted of an anchor or shore arm 500 feet long and a cantilever arm 562½ feet long. Suspended between the ends of the cantilever arms was a 675-foot truss span, the longest simple truss span ever built. It will be seen from the above dimensions that the central span had a clear width of 1,800 feet and was, therefore, the longest in the world, the next longest spans being those of that other great cantilever construction, the Forth Bridge near Edinburgh, which contains two clear spans each 1,710 feet long, or 90 feet less than the main span in the Quebec Bridge.

The bridge was intended to form a connection in the system of Canadian steam railways, and provision was also made for trolley lines, roadways, and footpaths. The Canadian government and the city of Quebec were largely interested in the enterprise. Indeed, the bridge will mean so much to the Dominion that, although its completion may be delayed, it will not be indefinitely postponed by the late disaster. The contract price for the steelwork alone was about $3,000,000, and the probable ultimate cost, had it not been for the present disaster, would have been between $6,000,000 and $7,000,000.

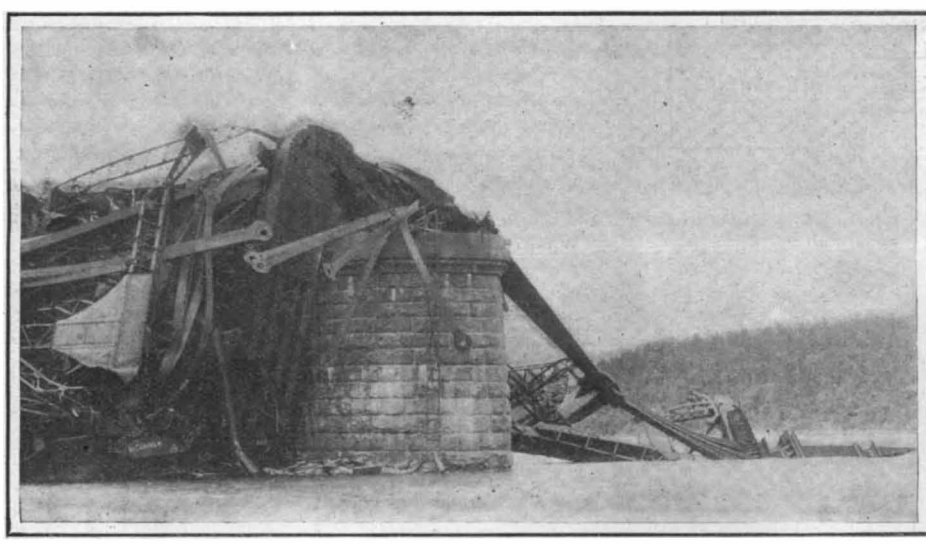
Not only was the bridge of unprecedented proportions in the length of its span, but its capacity for traffic was also large, provision being made for two steam railroad tracks to carry the heaviest modern freight locomotives and trains; for two electric railway tracks; two roadways, and two footwalks. All of this was to be carried on the same level, the width center to center of the trusses being 67 feet. Necessarily, all the dimensions for the bridge are on a large scale. Thus, the least depth of the trusses, which occurs at the portals or ends of the cantilevers, is 97 feet, and the greatest depth, over the main piers, is 315 feet. The clear headway from the under side of the bridge to the water at high tide was to have been 150 feet for a width of 1,200 feet. The height of the peaks of the main posts above the river is 400 feet. In the whole bridge, as completed, there would have been 38,500 tons of steel. Naturally, the individual members reached large proportions, although, as events have proved, these sizes, at least in the compression members, were probably insufficient. Thus, the main vertical posts at the towers measured 5 feet by 10 feet, and the bottom chord sections 4½ feet by 5½ feet. Some of the sections as built up at the works and lifted into place at the bridge weighed 100 tons each. The eye-bars were from 1 3/8 to 2¼ inches thick, 15 inches in width, and in some cases were 76 feet in length; and the tensional stresses which had to be provided for were so large, that in one case there was a maximum number of fifty-six of these bars assembled on one eye-bar pin. These pins, moreover, were of enormous size, varying in diameter from 12 inches to 24 inches, while some of them were 10 feet in length.

The building of the steelwork of the bridge commenced in 1902, when the 210-foot deck trusses were erected. Work on the main cantilever construction commenced July, 1905, when steel falsework of a special design was erected beneath the south cantilever arm, to carry the weight of that arm during its erection. This falsework alone weighed 1,000 tons, and upon this were erected during that season six panels of the south anchor arm, weighing altogether 5,346 tons. During the season of 1906 (because of the severe winter season, work is restricted to about six months of the year), the south anchor arm was completed, and the south cantilever arm erected. During the present season, up to the time of the disaster, about one-third of the central suspended truss had been built out by overhang beyond the south cantilever arm, until on the afternoon of August 29 the steelwork projected about 800 feet out over the river from the main pier. At the extreme end of the arm was a small 250-ton traveler, which was used in the erection, while near the end of the cantilever arm was a huge gantry traveler, 300 feet in height and weighing about 750 tons, which had been used in erecting the cantilever. The completed work, from the anchor pier to the end of the completed work over the river, measured about 1,300 feet in length, and its greatest depth, as already stated, was 315 feet. The weight of the steel work, that is, of everything above the piers, was, as estimated by the Phœnix Bridge Company, the builders of the bridge, 18,000 tons. Adding the weight of the two travelers, or say 1,000 tons, we reach a total weight of the structure of say 19,000 tons. Although some of the flooring of the bridge had not yet been built into place, it is probable that the weight of the travelers, and the particular conditions of loading at the time of the accident, produced maximum stresses in the various members of the bridge which were as large, if not greater than those which would occur when the bridge was completed, and subjected to the combined stress of full live load and heavy wind pressure. We are informed by the Phœnix Bridge Company that the engineers kept very careful records of the deflections and movements of the bridge under the changing loads as the work advanced; and that not only were these observations carefully made, but the varying stresses under these changing conditions were also carefully calculated. These calculations showed, that at the time of the failure of the bridge, the maximum compressive stresses under the conditions which existed on the afternoon of the disaster were about 16,000 pounds per square inch in the lower chord of the anchor arm near the tower pier, or only 45 per cent of the maximum safe stress to which these chords might be theoretically subjected without risk of failure.

Nevertheless, there is at this hour an ever-accumulating mass of evidence to show that the bridge fell because of the buckling of the lower chord of the south anchor arm, at the point marked by a white cross in our engraving showing the appearance of the bridge when completed.

At the present writing, any analysis of the cause of failure must necessarily be speculative; but the accompanying photographs, which were taken by the representative of the Scientific American two or three days after the disaster, coupled with our own investigation of the wreck, and the evidence which has already been given before the coroner, render it possible to determine, with some certainty, not merely where the break in the cantilever first occurred, but the sequence of events as this mighty 18,000-ton mass of steel settled down into its present position. In the first place, because of the lamentable death of the skilled workmen, there is no eyewitness of the disaster who can give any intelligent description of how it went down; but such testimony as there is agrees that the bridge did not fall over sidewise, but that it settled vertically upon itself, slowly at first and then with a rush. A careful study of our photographs supports this supposition; for it will be noticed that, in the view looking parallel with the axis of the bridge, the mass of wreckage lies practically in the same vertical plane in which the two trusses stood when the bridge was in position. It is well understood among bridge engineers that if failure is to be looked for in the main members of a bridge, it will come in the compression rather than in the tension members, and the condition of the wreck proves the truth of this supposition; for the tension members, and particularly those of the top chord, may be traced practically intact from the top of the anchor pier, where they are exposed under the overturned anchor pier towers, through these towers, clear across the top of the mass of wreckage, over the main cantilever pier, and down into the water of the main channel of the St. Lawrence. Probably they continue intact out to the end of the cantilever arm, 150 feet below the surface of the water. Moreover, that the bridge did not fail by lateral distortion is rendered probable by the fact that the lateral bracing between these top chords lies symmetrically, though of course twisted and broken in places by the impact of its fall, between the top chord members. Furthermore, had the bridge failed through the rupture of the tension members, that is, of the top chords or of the diagonal ties, the parting of the metal would have been instantaneous, and accompanied by a report louder than that of the most powerful piece of ordnance in the world to-day. Witnesses seem to agree, however, that although there were subsequent thunderous crashes while the bridge was falling, the commencement of its settlement was not marked by any loud report. Since, then, it seems evident that there was no failure of the tension members, that is of the eye-bars, it follows that we must look to the compression members, either in the tower, in the vertical posts, or in the bottom chords, for the point of failure. The evidence already given before the coroner points to the failure as having occurred in the lower chord of the anchor arm, in the second panel out from the foot of the tower, at the point marked with a cross in the accompanying engraving. It is also generally admitted by those who were responsible for the design and erection of the bridge, that it was the anchor arm which gave way. This is further verified by the fact that, although the other sections of the bottom chords have suffered only such distortion and fracture as might result from the impact and wrenching of the fall, this particular section had been bent into the form of a letter S, being literally bent back upon itself. Such a distortion is exactly of the kind which one would expect to occur when a compression member fails through excessive loading.

Now, the theory that the fall of the bridge was due to the crumpling up of the bottom chord at the point indicated, is strongly borne out by the present condition of the wreckage, which is lying in just the very



Showing Tower Post Broken Across Main Pier; Also the Top-Chord Eyebars.

Anchor Pier With Anchor Posts Dragged Forward by the Fall of the Bridge.

THE QUEBEC BRIDGE DISASTER.

positions which the various parts of the bridge would take consequent upon the buckling of the lower chord at the point indicated. As the buckling took place, the now unbalanced lateral thrust in the lower chord of the cantilever arm would bring an enormous lateral shearing force to bear upon the foot of the tower, pushing the foot of the towers inwardly toward the anchor arm, until they slipped off to the ground on the shore side of the tower pier. Meanwhile the whole of the cantilever would be pivoting forward and settling swiftly into the river, the shore arm falling to the ground between the main pier and the anchor pier. The enormous impact as the bottom chords struck the ground would cause the heavy vertical posts to crumple in upon themselves, until the whole mass had sunk down into the position shown in our engravings, the top chord eye-bars being drawn forward above the mass of wreckage, a condition of things which is shown very clearly. That the foot of the towers were thrust shoreward, and that the towers were bent across the piers with the heads far out in midstream, is shown by one of the photographs, in which the lower part of the tower with its four webs will be seen against the shore side of the tower, while the crest of it is showing about 100 feet out in midstream.

As to the future of the Quebec bridge, while it is probable that it will eventually be built, we doubt whether it will be built upon the present plans, unless indeed they are subject to modification, at least as regards the posts and chords. We are informed that practically the whole of the steelwork for the northern half of the bridge, some 20,000 tons in all, has been constructed and is ready for erection. It may be possible that, in the revised plan, the compression members may be strengthened, among other means, by the substitution of cover plates for the present open latticing, and the bridge completed, except for this modification, on the original lines. This change, however, would mean a great increase of dead load, and necessitate the employment of higher unit stresses in the eye-bars.

The Current Supplement.

The American Museum of Natural History in New York recently added an exact model of a large whale to its mammalian collection. This technical achievement is explained with the aid of very excellent illustrations in the opening article of the current SUPPLEMENT, No. 1654. Dr. Rabes writes on the heart weights of various animals, and shows that the relative size of the heart is a measure of metabolic activity. The connection between physical and psychical conditions is set forth by Dr. O. Mueller. What was perhaps the most exhaustive study ever made of a single problem of ventilation was recently concluded for the Rapid Transit Subway of New York by Dr. G. A. Soper. His report is published in full. Prof. Ernst von Halle, the distinguished German authority of shipbuilding, reviews the rise and tendencies of German transatlantic enterprise. The progress of the submarine boat is critically analyzed in the light of the recent experiments conducted by the United States government. The aeroplane experiments of M. Louis Bleriot are described by Capt. Ferber, himself a well-known aeronaut. His article is a *résumé* of what has been accomplished to date in France with aeroplanes of various types, including the type invented by the late Prof. Langley. Mr. J. H. Morrison's excellent history of armored war vessels passes to a third installment, in which armor plating in the United States is discussed. Dr. Richard Wiesner contributes an instructive article on the germicidal effect of sunlight. At various times we hear the question asked: How did the ancient masons raise the enormous blocks of stone which they used in their temples and pyramids to the heights and positions in which they are now found? Mr. Clement E. Stretton endeavors to answer this question by describing some mechanical contrivances with which the ancients were probably familiar, and which answered all requirements. It is difficult in this year of grace to realize that it is only one hundred years since navigation by steam actually reached the position of a recognized commercial means of transport. For that reason an article is published in the current SUPPLEMENT commemorating Robert Fulton and the centenary of steam navigation. The recent announcement by Sir William Ramsay that he has discovered a means of degrading copper to lithium, renders of peculiar timeliness and interest a paper on the disintegration of atoms, in which the entire subject of radio-activity is authoritatively reviewed in the light of the most recent investigations. The usual notes and formulas appear in their accustomed places.

An apparatus for life saving at sea has been invented by Mr. R. Lavachery, a Belgian engineer residing at Chapultepec, Mexico. It consists of a rifled cannon from which a projectile is fired; to the projectile are attached a cable, an anchor, and a rocket. The mechanism is said to be very simple, and for humanitarian reasons the inventor has not patented it.

Correspondence.

The Evils of Train Telephone Orders.

To the Editor of the SCIENTIFIC AMERICAN:

The recent accident that occurred at Mattoon, Ill., in which fifteen people lost their lives, owing to a misunderstanding of "meeting orders," given over the telephone, proves that as yet the telephone has not reached the stage of perfection where it can with safety to the traveling public supersede the telegraph for the handling of trains. It would be a very simple matter to have a set of telegraph instruments in the telephone boxes, at sidings, and either the conductor or motorman on each car be required to know telegraphy, and on regular train order blanks the superintendent or dispatcher could arrange for meeting points, the conductor or motorman signing for the same, thus avoiding in a great measure the possibility of collisions.

F. H. SIDNEY,
Signal Dept., B. & M. Terminal Div.
Boston, Mass., September 3, 1907.

Drying Kilns.

To the Editor of the SCIENTIFIC AMERICAN:

As the rapid drying of timber has rendered drying rooms or kilns a necessity to many, the following suggestions will no doubt be of value. A very useful kiln may be constructed as follows: Walls of brick, roofing of rubberoid, ceiling of galvanized iron, and floor of battens laid on joists and kept apart. Under the floor are laid steam pipes, to heat the air which enters the room below them. The ceiling is perforated with holes equally distributed over its entire area, Through these holes the air from the room is drawn by either exhaust fan, ventilators, or chimney.

For those who prefer to have the steam pipes outside the kiln, the usual arrangement of motor, fan, and pipes in a separate room is satisfactory. The heated air is delivered to the kiln preferably at the top and escapes through small holes distributed equally over the floor space. As the sides and top of the kiln are made practically air tight, the coolest air escapes first; and by making the outlets of less area than the inlet, a slight pressure may be maintained in the room, and thus create an even temperature throughout.

As the result of considerable experience with drying kilns, the writer considers them only suitable for timber that has been partially seasoned.

Carlton, near Sydney, Australia. T. HUMPHREY.

Panama Canal Problems.

To the Editor of the SCIENTIFIC AMERICAN:

I have found your editorial on "Safeguards for the Panama Canal Locks" quite interesting. For ten years or more I have given careful thought to every engineering phase of the Isthmian problem, and I am glad the commission realizes the immense loss that might follow a collision with lock gates of the ordinary type.

Perhaps any of the devices which you state have been considered by the commission may be made to give full protection against such a disaster, but would it not be best to make the gates of such enormous structural strength that they would resist any collision that might happen? In that event the ship would get the worst of it. Still it would be wise to make the head gates so that they could easily be closed even if the lower gates were carried away. That can be done, and I think it ought to be. I would rather depend upon gates that are used in everyday service, than any device designed for use only in emergencies.

There are many reasons why the work at Panama should be completed as soon as possible, and no good citizen should even think of putting the slightest obstacle in the way to that end. Now, or never, seems to be the time for helpful suggestions or to show how the general scheme of the commission could be improved, for if any defects can be discovered now, it will be wise in Congress to have them removed before the contracts are let, and it will exhibit the courage of true greatness in the President to call a halt until a right start can be made. Better a slight delay now, than to complete the task in record-breaking time only to be confronted with troubles that cannot be evaded without great delay and expense.

It seems to me that as the site at Gatun is almost as large as could be wished for three locks in flight, a single lock with a usable length of 1,200 feet could be substituted for the three, with a saving in cost of building and operation. The time to pass through a single lock with 85-foot lift would be less than to pass two or three locks having in the aggregate the same lift. I know it may be said it is not possible to build gates for such a lock, and in reply I would say that at the proper time I shall show how it can be done.

In preference to any canal plan I have seen, I would suggest that it be built with a single lock at Gatun with a lift of 70 to 75 feet, and with a second lock between Gamboa and Obispo with a 70-foot lift to reach the 140-foot summit level. Three locks on the Pacific side would be required to complete the scheme. By this plan the work on the Culebra Cut might possibly be completed in another year. The Gatun Lake at any level from 68 feet, as proposed by the French, up to 85 feet, will submerge much swampy area, but it should not be forgotten that, unless the topography is very peculiar, there will be a new area of swamps created.

I would have a concrete dam built at Gamboa as near to the line of the canal as may be and carried from the bedrock (about sea level) to an elevation of 75 feet at the crest. Sloping from the crest I would continue the dam up the Chagres Valley with rock-fill construction and at intervals of 500 feet or more have a concrete curtain cross the valley extending from the surface of the rock-fill down to bedrock. This would make it water-tight, and if the strata of rock-fill were thick enough it would be safe against any possible erosion. Hydraulic giants and the Chagres would furnish the means—the water and the power—to wash almost any loose material from the slopes of the banks of Gamboa Lake to fill in back of the dam up to the level where rock-fill should begin. As soon as the 150-foot level was reached by this process the water supply for the 140-foot summit level would be assured. As a higher level was attained with a corresponding increase of lake area, increased power would be available to extend the fill back of the crest of the rock-fill dam even for a mile or more (with shallow depth). Such a dam would be safe from the start and could be made more and more safe each year. It might be that a variation of 20 feet in the lake level would, with the possible flow through the flumes to the turbines, prevent any flow over the dam except at rare intervals. It seems reasonable to believe an effective control of the Chagres would thus be gotten, but not until the lake area for the different levels was known could its nature be determined with exactness.

The available power of the Chagres might in future years wash out enough of the Culebra Cut so that the summit level could be brought down to 70 feet.

The canal will be subject to shoaling by sediment and debris carried into it by the various streams which must flow into it. How to remedy this condition is a serious matter. I have not learned that an adequate solution of the problem has been found by the commission. I have a plan, partly developed, that may be successful, but I am not ready yet to make it public. I want, however, to suggest in closing that the power of the Chagres can be made to help in the removal of such deposits. HENRY FITCH.

Washington, D. C.

Official Meteorological Summary, New York, N. Y., August, 1907.

Atmospheric pressure: Highest, 30.33; lowest, 29,71; mean, 30.00. Temperature: Highest, 91; date, 8th; lowest, 59; date, 29th; mean of warmest day, 80; date, 8th; coolest day, 65; date, 24th; mean of maximum for the month, 79; mean of minimum, 65.1; absolute mean, 72; normal, 72.7; deficiency compared with mean of 37 years, —0.7. Warmest mean temperature of August, 77, in 1900. Coldest mean, 69, in 1903. Absolute maximum and minimum for this month for 37 years, 96 and 51. Average daily deficiency since January 1, —1.4. Precipitation: 2.48; greatest in 24 hours, 1.66; date, 23d and 24th; average of this month for 37 years, 4.53. Deficiency, —2.05. Accumulated deficiency since January 1, —5.79. Greatest August precipitation, 10.42, in 1875; least, 1.18, in 1886. Wind: Prevailing direction, south; total movement, 6,766 miles; average hourly velocity, 9.1 miles; maximum velocity, 28 miles per hour. Weather: Clear days, 10; partly cloudy, 16; cloudy, 5; on which 0.01 inch, or more, of precipitation occurred, 10. Thunderstorms, 13th, 24th. Mean temperature of the past summer, 71; normal, 71.83. Precipitation of the past summer, 6.95; normal, 12.16.

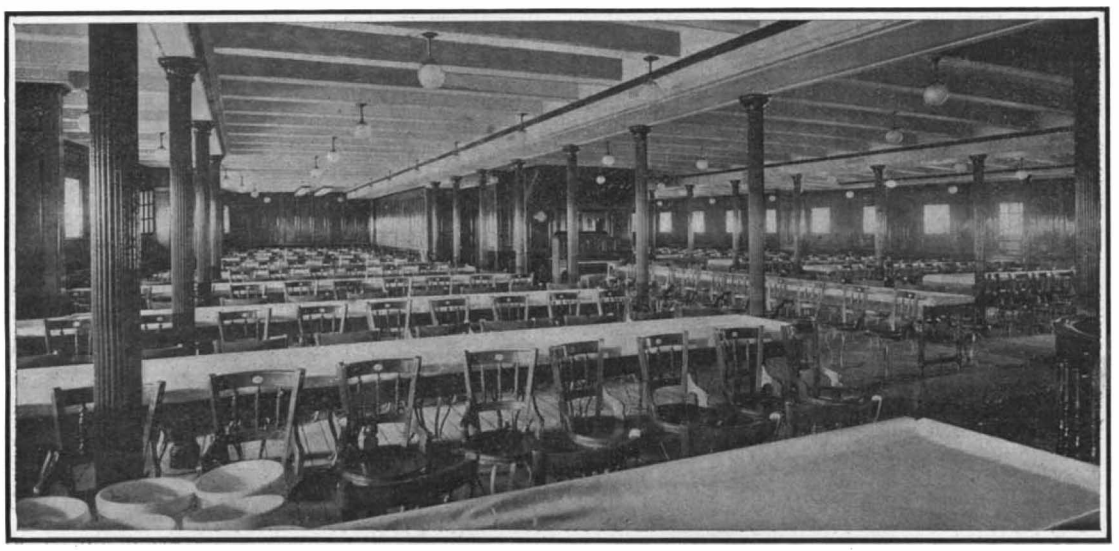
Micro-Photography in Colors.

Micro-photography in colors by the new Lumière process was the subject of a paper read before the Académie des Sciences by C. F. Franck. He used the Lumière color photography plate which we recently described. The experiments with micro-photography on the new plates were commenced last March in the laboratory of the Lumière firm at Lyons, and are the first of the kind which have been made. The author is now continuing his researches at Paris, at the College de France, where he has a well-equipped micro-photographic laboratory at his disposal. He has succeeded in making enlargements of microscopic specimens from 30 to 1,000 diameters. These enlargements are photographed in their natural colors, and some interesting specimens of such photographs were shown to the Académie. Among these were gneiss crystals, and a longitudinal section of the vertebral column of an embryo, showing the ossification. Different organs of the frog and insects were also shown. Preparations which require the use of polarized light are taken upon the plates as easily as the others. As an instance we find the gneiss of Mont Blanc, with all the different colors and tints, well shown upon the color plate. The great advantage of colored micro-photographs will at once be appreciated and the method will no doubt be used to a large extent in the future.

THE NEW TURBINE LINER "LUSITANIA."

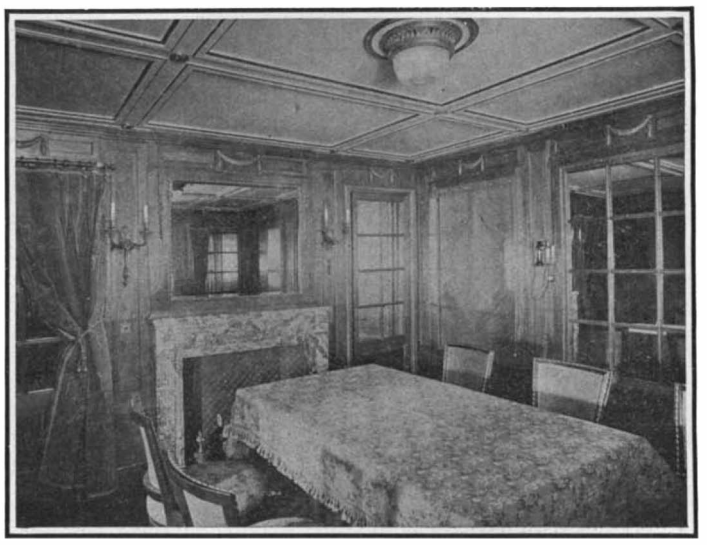
By the time this issue is in the hands of our readers the "Lusitania," the first of the two express turbine liners which have been built by the Cunard Company, will have completed her first trip to New York. This magnificent vessel is so much larger and faster than her predecessors, and possesses so many features of novelty in her construction and motive power, as to place her in a class by herself; and in the romantic history of the development of the transatlantic steamship she will always clearly mark the beginning of a new epoch, as being the first high-speed liner to adopt the steam turbine in place of the reciprocating engine. She embodies a far greater advance in speed, size, and spacious accommodations than has ever before been recorded in any one ship. It is true that the use of turbines was anticipated in the "Carmania" of the same company; but as she belongs rather to the intermediate type of moderate-speed boats, she is in a distinctly different class; moreover, the adoption of turbines in the "Carmania" really formed a part of the costly experimental work which was undertaken to obtain the necessary data for the design of the larger and faster ship.

The statement that the "Lusitania" stands in a class by herself will be borne out by a study of the accompanying table showing the development of the transatlantic liner during the past half century; or in the period intervening between the "Great Eastern" of 1858 and the "Lusitania" of 1907. The "Great Eastern" was built very much before her time; and it was not until the "Oceanic" made her maiden trip to New York in 1898, that any ship was seen in this port that was comparable with her. The "Great Eastern" was 680 feet long measured on deck, 83 feet broad, and of 27,000 tons displacement. The "Oceanic" is 685 feet long between perpendiculars, 68 feet 5 inches broad, and of 28,500 tons displacement. Next to the "Oceanic" in point of size came the "Kaiser Wilhelm II.," 678 feet between perpendiculars, 72 feet broad, and of 26,000 tons displacement; but over all she is 1 foot longer, being 706 feet as against the 705 feet of the "Oceanic." The "Lusitania" is 760 feet between perpendiculars, 785 feet on deck, 88 feet broad, and of 38,000 tons displacement. The greater displacement of the "Oceanic" as compared with the "Kaiser Wilhelm II." is due to her greater draft and fuller lines, her draft being 32 feet 6 inches as against 29 feet of the "Kaiser Wilhelm II."; and so also the vast increase in the displacement of the "Lusitania" is due to beam and draft, the beam having gone up to 88 feet, or 5 feet greater than that of the "Great Eastern," and the draft to 33 feet 6 inches. At her maximum draft of 37 feet 6 inches the "Lusitania" will displace 45,000 tons. In regard to horse-power and speed, the figures are also full of interest. The combined horse-power of the paddle-wheel and screw engines of the "Great Eastern" was 7,650, and her best speed was 14.5 knots. The "City of Rome," which came out in 1881, may be called the pioneer of the modern liners of great length and size, for she measured 543 feet between perpendiculars, and displaced 11,230 tons. With an indicated horse-power of 11,900, her best speed was 18.23 knots. In the "Umbria," 1887, 500 feet between perpendiculars and of 10,500 tons displacement, the Cunard Company had the satisfaction of producing the first vessel to maintain a



Note provision for individual comfort as compared with former steerage conditions.

The Spacious Third-Class Dining Saloon.

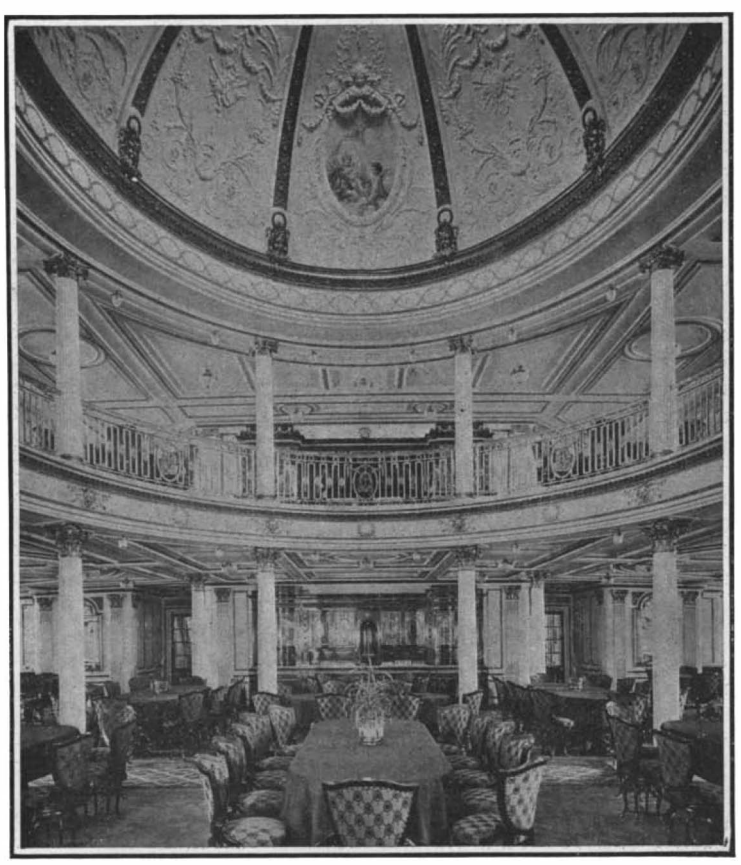


Note the large square-headed windows.

Private Dining Room in Regal Suite.

COMPARISON OF TRANSATLANTIC STEAMERS.

Name.	Date.	Dimensions. Length bet. perps.	Breadth.	Depth.	Draft.	Displacement.	Cylinders. Diameter in Inches.	Stroke.	Boilers. Heating Surface.	Grate Area.	Working Press.	Indicated Horse-Power.	Speed on Trial.
		ft.	ft. in.	ft. in.	ft. in.	tons.		in.	sq. ft.	sq. ft.	lb.		knots.
Great Eastern	1858	680	83 0	57 6	25 6	27,000	Screw, four 84-in.; paddle, four 74-in.	S., 48 P., 17	....	....	30	7,650	14.5
Britannic	1874	455	45 0	36 0	23 6	8,500	Two 48-in., two 83 in.	60		....	70	5,500	16
City of Rome	1881	543	52 0	38 9	22 0	11,230	Three 46-in., three 86-in.	72	29,286	1398	90	11,900	18.23
Umbria	1885	500	57 0	40 0	22 6	10,500	One 71-in., two 105-in.	72	38,817	1606	110	14,321	20.18
Paris	1888	528	63 0	41 10	23 0	13,000	Two 45-in., two 71-in. and two 113 in.	60	50,265	1293	150	20,000	21.8
Teutonic	1890	565	57 6	42 2	22 0	12,000	Two 43-in., two 68-in. and two 110-in.	60	40,072	1154	180	19,500	21
Campania	1893	600	65 0	41 6	23 0	18,000	Four 37-in., two 79-in., and four 98-in.	60	82,000	2630	165	30,000	22.01
St. Louis	1895	536	63 0	42 0	26 0	16,000	Four 28-in., two 55-in., two 77-in., four 77-in.	60	40,320	1144	200	18,000	21.08
Kaiser Wilhelm der Grosse	1897	625	66 0	43 0	28 0	20,880	Two 52-in., two 89-in., and four 96.4-in.	68.8	84,285	2618	178	30,000	22.5 to 23
Oceanic	1899	685	68 5	49 0	32 6	28,500	Two 47.5-in., two 79-in., four 93-in.	72	74,686	1962	192	27,000	20.72
Deutschland	1900	662.9	67 0	44 0	29 0	23,620	Four 36.61-in., two 73.6-in., two 103.9-in., and four 106.3-in.	72.8	85,468	2188	220	36,000	23.25 to 23.5
Kronprinz Wilhelm	1901	663	66 0	43 0	29 0	21,300	Four 34.2-in., two 68.8-in., two 98 4-in., and four 102.3-in.	70.8	93,685	2702	213	36,000	23.25 to 23.5
Kaiser Wilhelm II	1903	678	72 0	52 6	29 0	26,000	Four 37.4-in., four 49.2-in., four 74.8-in., and four 112.2-in.	70.86	107,643	3121	225	38,000	23.5
La Provence	1906	597 ft. 1½ in.	64 7½	41 8	26 9	19,160	Two 47.2-in., two 76.2-in., four 88.18-in.	66.9	58,342	1571	200	30,000	22.5
Lusitania	1907	760	88 0	60 4½	33 6	38,000	Turbines.	....	158,350	4048	195	68,000	25.5



Upper and Lower First-Class Dining Saloons, Seating 500.

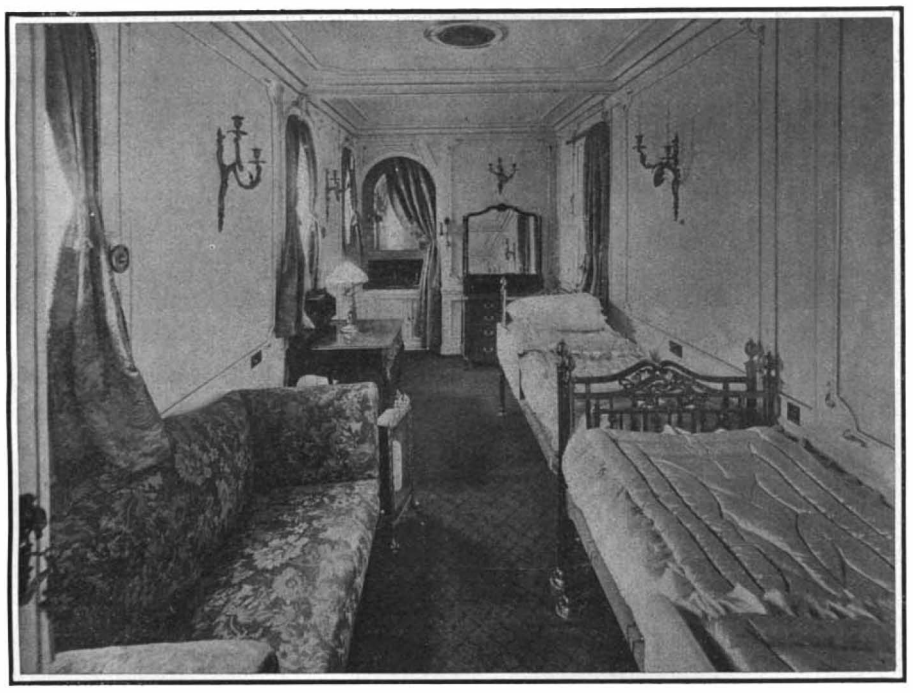
Lower First-Class Dining Saloon, Seating 350.

THE NEW 25½-KNOT CUNARD TURBINE LINER "LUSITANIA."

speed of over 20 knots an hour across the Atlantic, her best record being 20.18 knots for the whole trip. Then came the "Paris" in 1888, the first of the twin-screw vessels, whose best record was 21.8 knots, which was obtained with the development of 20,000 horse-power. The next record-breaker was the "Campania" of the Cunard Company, the first ship to reach the length between perpendiculars of 600 feet. She was of 18,000 tons displacement, and with 30,000 horse-power she maintained an average speed of 22.01 knots across the Atlantic. In 1897 the North German Lloyd Company entered the competition with that most successful ship "Kaiser Wilhelm der Grosse," 625 feet between perpendiculars. She was of 20,880 tons displacement, and with 30,000 horse-power she raised the record to an average speed of 22.5 knots. From her the record was taken by the "Deutschland," of the Hamburg-American Line, a vessel 663 feet between perpendiculars and of 23,620 tons displacement, which, with a development of 38,000 horse-power, moved the record up to 23.5 knots. This was equaled, and indeed slightly surpassed, by the "Kaiser Wilhelm II.," which with 40,000 horse-power averaged a fraction over 23.5 knots. The "Lusitania" on her trial trip averaged over a 1,200-mile course 25.4 knots, at which mark the record is likely to stand for many years to come. In doing this her engines averaged the enormous figure of 65,000 horse-power.

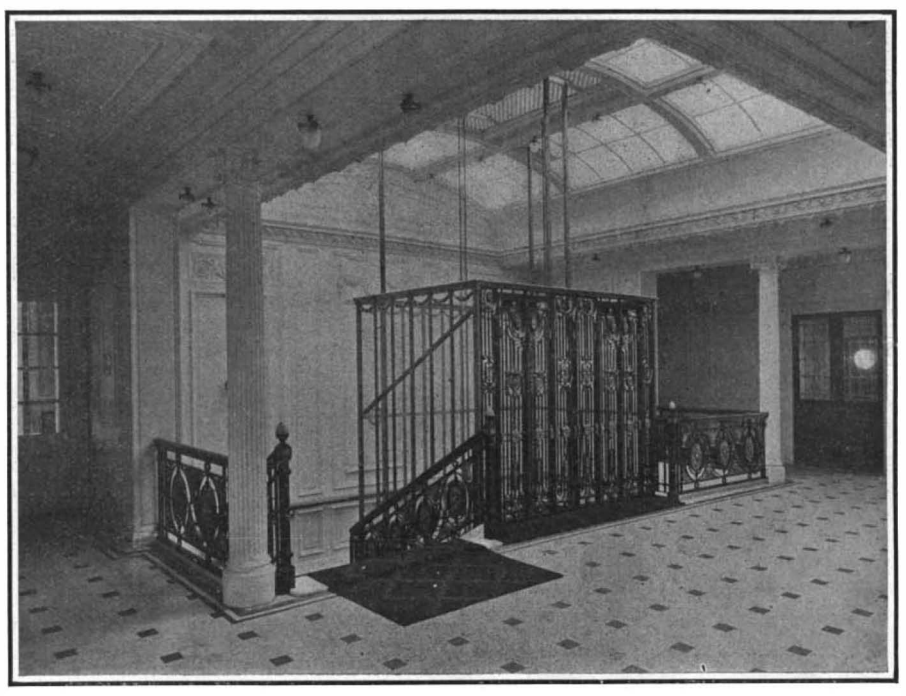
The "Lusitania" and her sister ship the "Mauretania" were built for the distinct purpose, among other things, of winning back the "blue ribbon" of the Atlantic, which had been taken from the British lines and held for a period of ten years by the splendid German liners. If these ships live up to the preliminary promise of the "Lusitania," they should easily accomplish this; for if the latter vessel can maintain the speed which she showed on her trial trip, she should have a margin of at least two knots to her credit, and should bring the transatlantic record down to about four and a half days. The two ships were built with the assistance, both professional and financial, of the British Admiralty, the government advancing the necessary sum of about $13,000,000 for the construction of the two ships, and guaranteeing the payment of a considerable annual sum in consideration of the ships carrying the mails, being held available as cruisers in the event of war, and embodying in their construction such features as would render them quickly convertible for this purpose. For service as cruisers it is necessary that their steering gear and the propelling machinery should be fairly well protected, and that they should be strengthened in the decks for the mounting of a battery of rapid-fire guns. The steering gear is protected by being located entirely below the waterline, and a considerable amount of protection is afforded to the motive power by the fact that it also is located entirely below the waterline, and that there will be about 12 feet of coal in the bunkers extending the full length of the engine and boiler rooms to resist the entrance of explosive shells. The vessels are provided with twelve platforms for the mounting of as many 50-caliber rapid-fire 6-inch guns, each with a velocity of 3,000 feet per second, and a muzzle energy of about 6,000 foot-tons. With such protection and armament, and their ability to maintain a sea speed of say 24½ to 25½ knots an hour, these vessels should be capable of overtaking and capturing any of the fast scouts, and a large proportion of the fast protected cruisers and commerce destroyers, of any possible enemy. For scouting purposes, also, they should prove of the greatest value.

When it was decided to build two ships of 25 knots speed, it was realized that they would necessarily have to be of exceptional size and great refinement of form, and that unless serious problems connected with the forging of shafting of the necessary size were to be encountered, some other type of motive power than the reciprocating engine would have to be employed. Attention was naturally directed to the then somewhat experimental steam turbine, and the joint efforts of the technical staff of the Admiralty, of the Cunard Company, and of the two large shipbuilding firms, Swan & Hunter on the Tyne and John Brown & Co. on the Clyde, united in working out the problem of



Note the unusual height, 11 feet, of ceiling.

Bedroom in the Regal Suite.



Adopted at the suggestion of the SCIENTIFIC AMERICAN before they had been proposed for any other ship.

The Two Passenger Elevators.

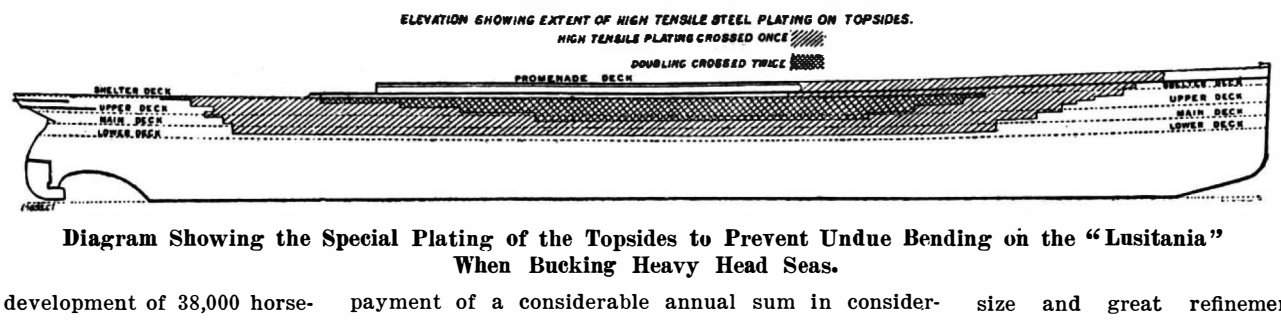
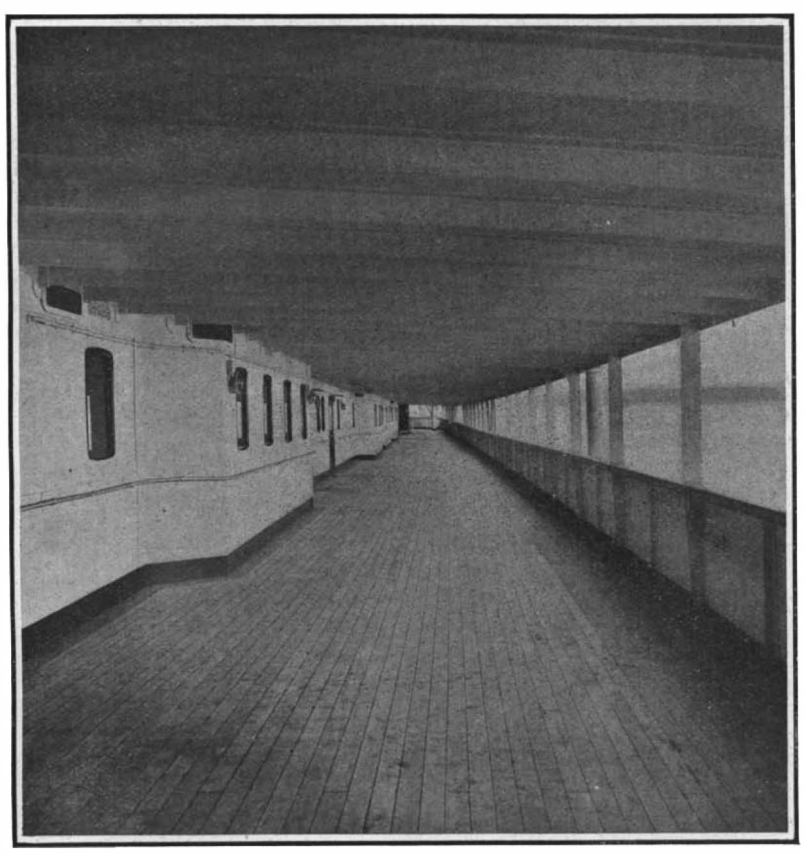
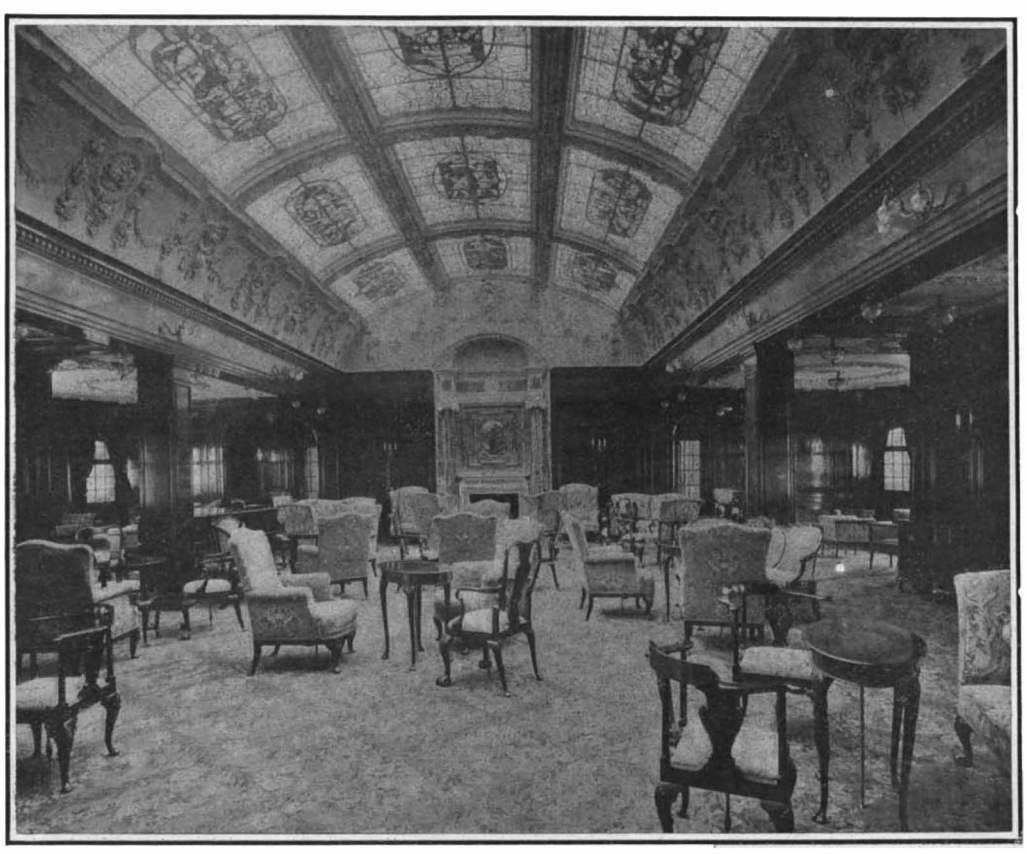


Diagram Showing the Special Plating of the Topsides to Prevent Undue Bending on the "Lusitania" When Bucking Heavy Head Seas.



The Great Beam Permits Unusual Width of Promenade.



Note the large square-headed windows.

The Spacious Drawing Room on the Top Deck.

THE NEW 25½-KNOT CUNARD TURBINE LINER "LUSITANIA."

the size, model, and necessary horse-power of the new ships. An elaborate series of tests was made in the Admiralty tanks and by the two shipbuilding firms, with the result that it was found necessary to build ships of unprecedented dimensions and power, the required length being nearly 800 feet, the beam 88 feet, and the draft from 33½ to 37½ feet, with an estimated horse-power in turbine equipment of 68,000. The contract called for a trial speed of 25¼ knots, and an average sea speed for the round trip across the Atlantic of 24½ knots. In the recent trials of the "Lusitania" the contract was very largely exceeded, a maximum speed of 26½ knots being obtained on the shorter courses, and of 25.4 knots on a long cruise of 1,200 knots.

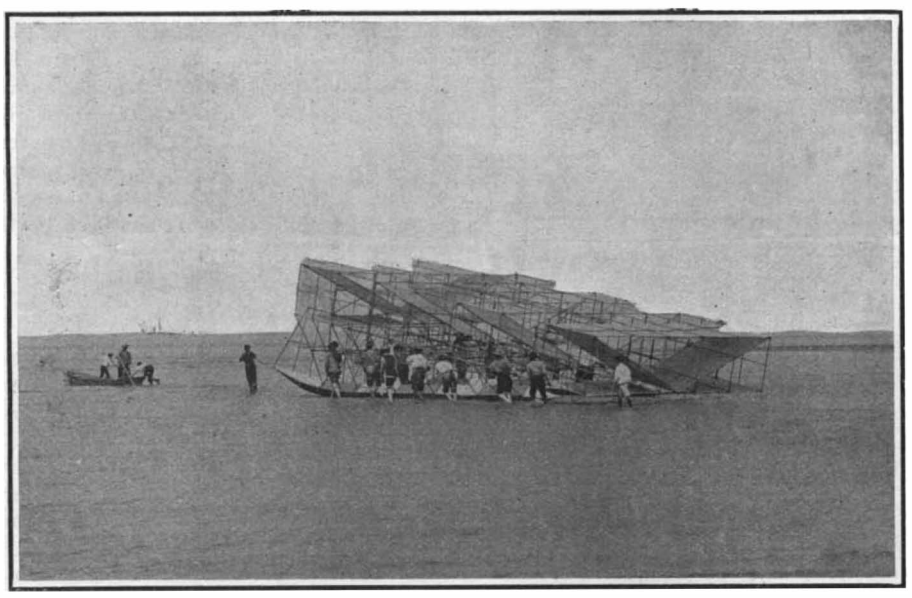
The model of the "Lusitania" shows the finest and sweetest lines of any of the existing transatlantic steamships. Unlike any of her predecessors, the form of the "Lusitania" runs in a continuous curve (without any of the customary straight section amidship) from stem to stern, and the correctness of the design is shown in the remarkably small wave-making which occurs even when the vessels are driven at their highest speed. In an investigation made many years ago by the SCIENTIFIC AMERICAN to determine some of the leading characteristics of a four-day liner, it was pointed out that the length of such a ship was so great as to call for special stiffening to enable her to withstand the great bending stresses to which she would be subjected when steaming across the seas; and it was suggested that double-plating should be worked into the vessel amidships along the top strakes and at the turn of the bilges; and also it was deemed desirable to work a longitudinal bulkhead down the center of the ship. In the design of the new Cunarders this feature has been given special consideration, and the upper strakes of the side plating have been built of a special steel, of high tensile strength, the plating being doubled for a considerable length amidships, and extra plating being worked continuously along the shelter and upper decks for the same purpose. Considerable longitudinal stiffness is also afforded by the vertical plating that forms the inner wall of the coal bunkers. The arrangement of this high-tensile steel plating is shown in the accompanying diagram, for which and the table of transatlantic ships we are indebted to our esteemed contemporary Engineering.

A mere statement of dimensions conveys only an inadequate idea of the proportion of these vessels. Their size can best be appreciated when it is compared with some object with which the public is generally familiar, and to this end we have chosen the Capitol at Washington. On reference to our front-page engraving, in which the "Lusitania" is combined in a shadow picture with a photograph of the Capitol, both on exactly the same scale, it will be seen how in a front elevation this vessel exceeds the Capitol on every point of comparison except that of the height of the dome. If the keel of the ship were resting at the ground level at the Capitol, several of its upper decks would project above the top of the balustrade of the main building, which is exactly 69 feet 6 inches above the ground. Thus, the boat deck of the "Lusitania" would be 78 feet, the top of the boat deck cabins would be 89 feet, and the top of the captain's cabin 100 feet above the ground. The top of the smokestacks would reach nearly to the springing of the dome, this point of the ship being 155 feet above the ground, or twice the height of the main building. The diameter of all the smokestacks is 25 feet. In length the "Lusitania" would considerably exceed the main building, which latter measures 751 feet, as compared with the "Lusitania's" over-all length of 785 feet.

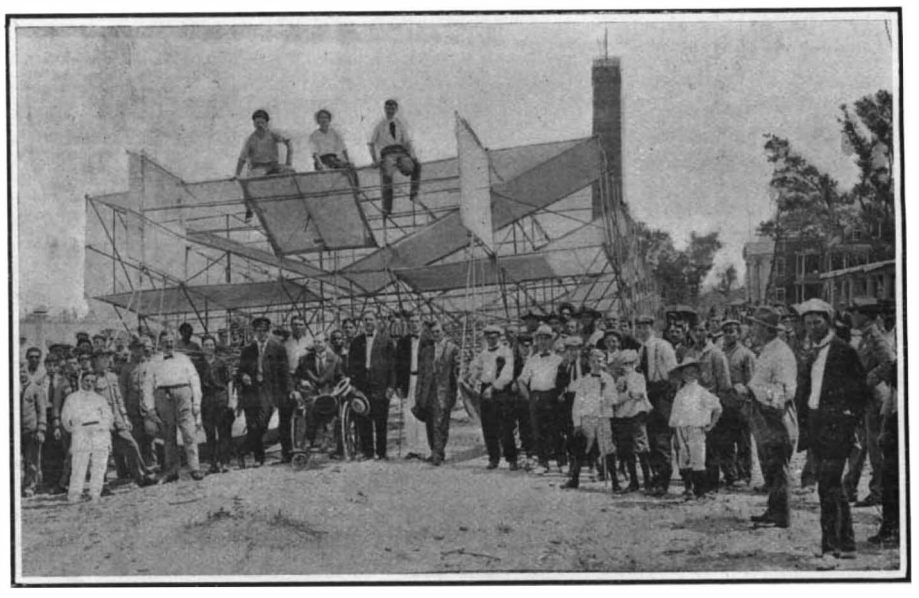
Again, if the keel of the "Lusitania" rested upon the street surface of Broadway, and one side of her was placed against the face of the buildings on one side of this thoroughfare, the other side of the ship would extend 28 feet into the buildings on the opposite side, and the roof of the cabins on her topmost deck would be level with the coping of an ordinary six-story building.

It can be readily understood that to drive the huge bulk of such a ship through the water at a speed of about thirty miles an hour requires enormous power; and the tank investigations showed that to exert the necessary thrust calls for about 68,000 horse-power. This total thrust has been divided between four propellers, actuated by four turbines, there being a high-pressure turbine on each outer shaft and a low-pressure turbine on each inner shaft; a pair of go-astern turbines being carried also upon the inside shafts.

Limitations of space prevent any extended reference to the passenger accommodation, the sumptuous character of which is well shown by the accompanying illustrations. The most noticeable improvement is the fact that, because of the great beam of the ship, the average cabin possesses fifty per cent more space than is to be found in similar cabins on any previous steamship. The decorations, although rich, are simple and marked by great refinement. A feature which will meet with general approval is the double passenger elevators, which are arranged with the main stairway around them, with landings on each deck of the vessel. The suggestion to install these was made to the Cunard Company several years ago, when these ships were first proposed, and plans were made to incorporate them long before their adoption by any other steamship. The "Lusitania" will accommodate 540 first-class, 460 second-class, and 1,200 third-class passengers; and as her crew will number 800, the full complement of the ship will be some three thousand souls. If the "Lusitania" does as well in regular service as she did on trial, she should make the trip in four and a half days, and to drive her at this speed will call for the consumption of about 1,100 tons of coal per day—a huge amount in the total it is true, but not unusually large in proportion to the size of the ship, the number of passengers carried, the very superior accommodations provided, and the reduction of the time of passage by half a day.



SIDE VIEW OF LUDLOW'S NEW AEROPLANE, SHOWING IT MOUNTED ON PONTOONS FOR TOWING ON THE WATER.



FRONT VIEW OF LUDLOW'S AEROPLANE, SHOWING THE ONE HORIZONTAL AND TWO VERTICAL RUDDERS.

ONE OF THE COMPETING AEROPLANES FOR THE SCIENTIFIC AMERICAN AERONAUTICAL TROPHY.

The two photographs which we reproduce above show the front and side elevation of Mr. Israel Ludlow's new aeroplane, which he has just completed at the Jamestown Exposition, with a view of entering it in the first competition for the SCIENTIFIC AMERICAN trophy. The machine is patterned largely after Ludlow's former box-kite aeroplane, which collapsed and fell with the inventor in Florida a year and a half ago, and permanently injured his spine. In place of the two compartments, Ludlow's latest aeroplane has no less than four, within each of which are placed auxiliary planes, set at a dihedral angle. The entire four compartments are mounted upon pontoons at a considerable angle with the horizontal. One horizontal and two vertical rudders are provided at the forward end. The machine is to be propelled by twin screws driven by two gasoline engines.

In constructing this large aeroplane, Mr. Ludlow believes that he has improved considerably in the design and construction of his new machine over his earlier ones, which were simply large box kites. He has been aided in building the machine by the War Department, which detailed ten soldiers to help in constructing it at the Aeronautical Building at Jamestown. After suitable tests have been made by towing the machine with a torpedo boat, for the purpose of ascertaining the pull required to fly it, and also to find out how it acts in the air with regard to stability, the motors and propellers will be quickly fitted, and it is hoped that the machine will be ready to compete for the trophy on the appointed day.

The Cement Industry of 1906.

The production of cement in 1906 amounted to the enormous total of 51,000,445 barrels, valued at $55,302,277, exceeding by 10,897,137 barrels in quantity and $19,370,744 in value the production of 1905, which had been the banner year. Classified according to character the production was as follows:

	Barrels.	Value.
Portland cement	46,463,422	$52,466,186
Natural cement	4,055,797	2,423,170
Puzzolan cement	481,224	412,921

These figures are reported by the United States Geological Survey in an advance chapter from "Mineral Resources of the United States, Calendar Year 1906," and are somewhat greater than those given in the preliminary statistics of production issued by the Survey early in the year, the difference being due to the fact that some of the returns were received too late for use in the first statement.

The most prosperous branch of the industry is, of course, the Portland cement branch, whose growth has been of the most phenomenal character. Twenty years ago, when the Portland cement output of the entire United States stood at about 250,000 barrels against nearly 7,000,000 barrels of natural cement, the first attempt was made to introduce the rotary kiln for the manufacture of Portland, the company exploiting the new process, proudly claiming the ability to produce 30,000 barrels of cement per annum, and to triple this quantity as soon as the necessary grinding machinery should be added. To-day it is not considered in the least sensational if a company announces the capacity of its plant at 3,000 to 5,000 barrels a day, while the yearly production of the large plants runs well into the millions of barrels.

The decline of the natural cement industry has been gradual, but as steady as the increase of the Portland branch. In 1906 the effect of this decline has seemed to be even more widespread than in the preceding year. The owners of many plants have allowed them to remain idle, some have turned their attention to lime-burning and kindred employments, and a few have dismantled the old plants and established buildings and machinery for making Portland cement. Since some of the lime-stone, known as "cement rock," from which the natural cement is made, forms an equally good base for Portland cement, the last course would seem to be both logical and wise.

The growth of the slag or puzzolan branch of the cement industry is interesting because of its steadiness. The advantage of the industry is that it consumes a product of steel and iron foundries which has for years been troublesome to dispose of, and has been regarded as waste. This variety of cement is not burned in rotary kilns and should not be confused with Portland cement made with slag as a basis and burned in rotaries.

Although the prices at which cement was sold in 1906 were higher than those which prevailed in 1905, they were not inflated but resulted from a normal growth in demand. The producers made no complaint of prices, but protests against the insufficient car service provided for the delivery of orders were made from every part of the United States.

The statistics of the industry have this year, as in the past, been prepared by L. L. Kimball, and the report is prefaced by a chapter on Advances in Cement Technology by Edwin C. Eckel. The pamphlet is now ready for distribution and may be obtained without cost by applying to the Director of the United States Geological Survey at Washington, D. C.

THE SCIENTIFIC AMERICAN TROPHY FOR FLYING MACHINES HEAVIER THAN AIR.

The handsome silver trophy illustrated on this page was originated with the idea of stimulating the development of the science of aerial navigation. For many years past, and especially since the development of the dirigible balloon, the aim of all inventors in this line has been to construct a machine which would fly at a high rate of speed without the use of gas to support it. Nearly four years ago the Wright brothers, in this country, announced the successful application by them of a gasoline motor to an aeroplane, and the flight which they made upon December 19, 1903, is presumably the first one of any considerable distance which has ever been made by a motor-propelled aeroplane carrying a man. After two years of experimenting the Wright brothers finally announced that they had perfected their machine. No public demonstration has ever been made by them, however; and although, according to their own statements and those of eye-witnesses, they have solved the problem, still many people doubt this. At any rate, it is probable that progress in the new science will be made by others, and that in time there will be several kinds of heavier-than-air machines perfected. It is with the idea of encouraging inventors in this line by giving them a valuable object of art worth winning, that the SCIENTIFIC AMERICAN trophy has been completed and presented to the Aero Club of America. This club will hold annual competitions for the trophy, and, if it is impossible for an inventor to enter his machine in such competitions, he may obtain a special trial by arranging therefor with the club. The trophy is to be open to international competition, and any foreign competitor who wins it may take it to his native land, to be held by the aero club of which he is a member until it is won back by an American. In years to come the trophy may, therefore, be to aerial navigation what the "America" cup is to yachting.

In conducting the annual competitions for the trophy, the Aero Club of America will vary the conditions of winning it, in accordance with the progress that is being made with flying machines. In view of the fact that Santos-Dumont and other French experimenters have already flown considerable distances in a straight line with aeroplanes, it was decided that to win the trophy the first time, a competitor should be required to surpass these distances; and as there have been no prizes offered for a flight of one kilometer (3,280 feet) in a straight line, this distance was determined upon as the one required to be covered. Arrangements have been made to hold the first competition at the Jamestown Exposition on September 14, and two machines, at least, are expected to make a trial. Should the trophy be won at this or a subsequent contest this year, the conditions next year will be changed, so that a longer flight with turns will be required. The rules under which the present competition is to be held provide that no flight need be attempted if there is a wind of over twenty miles an hour, and also that the machines should be flown against the wind, if possible. Thus it will be seen that every opportunity will be given inventors to make a successful demonstration of their machines. Should any competitor win the trophy three times in separate years, it will become his property.

The trophy, as can be seen from the photograph which we reproduce, is a handsome piece standing 32 inches high and containing 218 ounces of silver. It commemorates Langley's aerodrome, which was the first motor-driven model aeroplane to make a successful flight of over half a mile. Prof. Langley's model made its first flight over the Potomac River May 6, 1896, and recent experiments with a full-sized machine of this type by Bleriot have shown that it possesses good stability, and is an altogether practical model. As Prof. Langley was the first man in this country to experiment with aeroplanes and to build a practical working model, we felt that both he and his machine should be commemorated; and it is for this reason that we have caused his model to be reproduced upon the trophy.

This new aeronautic trophy consists of a globe representing the firmament, and carrying on one side an aeroplane which is seen soaring through the clouds, illuminated from above by rays of sunlight. Some swallows are noticed vying with the aeroplane in flight, while in other places stars shine through the clouds. On the opposite side of the globe is modeled in relief the North American continent. The globe is carried on a whirlwind rising from a suitable pedestal, at the base of which, on each side, are three winged horses. The middle horse of each trio is mounted by a rider who holds aloft a palm branch. On top of the globe a large American eagle has just alighted with a wreath of victory in its beak.

No engraving can satisfactorily reproduce this beautiful piece of silver, which is a masterpiece of the silversmith's art. It has justly been called "The Blue Ribbon of the Air." We also illustrate the elaborately engrossed "Deed of Gift."

Deed of Gift
of the
Scientific American Trophy.

The Scientific American Trophy for heavier-than-air flying machines is offered for annual competition under the rules and regulations formulated and promulgated by the

Aero Club of America.

It is distinctly understood that the trophy is to be the property of the Club and not of the members thereof, except in the event that any one person shall win the trophy three times, in which case it is to become his personal property.

Should the trophy be won by the representative of some foreign Aero Club, it shall become the property of such Club, but it shall be subject to competition under the same terms and conditions as if it were still held by the Aero Club of America.

Should the holding Club, for any reason, be disbanded, the trophy shall revert to the donors, to be competed for, however, under the same terms and conditions as if it were held by the Aero Club of America.

The conditions under which the competitive tests and trials shall be made shall be determined by the Committee of Control of the Aero Club of America, and such conditions shall be made progressive in their severity of test, as far as possible, in order to foster and develop the progress of the art of aerial navigation.

Charles Allen Munn
President.
Frederick Converse Beach
Secretary and Treasurer

DEED OF GIFT MAKING OVER THE TROPHY TO THE AERO CLUB OF AMERICA.

THE SCIENTIFIC AMERICAN TROPHY FOR HEAVIER-THAN-AIR FLYING MACHINES.

"The Blue Ribbon of the Air" to be Competed for September 14, 1907, at the Jamestown Exposition. Height, 32 Inches.

Waste of Artesian Waters.

Millions of gallons of artesian waters are going to waste every day in Indiana, according to estimates made by F. G. Clapp, geologist of the United States Geological Survey, who is now investigating the water resources of the northern part of that State. Over a million gallons a day are wasted in a single county. Along Fall Creek, Lick Creek, White Run, and other streams, in the shallow valleys of which there are a great many flowing gas wells, each well pours out from 5 to 20 gallons of water a minute, and the amount of water thus drawn from the underground reservoirs and unutilized in Madison County alone is sufficient to supply a city of 10,000 inhabitants.

In only a few places is this water put to use. The farmers do not seem to realize that a hydraulic ram or a windmill placed on a flowing well will raise a large portion of the water to their houses on the hills above. Immense volumes of good water are therefore suffered to waste, and in this way the "head," or height of water in the wells, or the height to which it rises above the surface, has been lowered several feet. Many wells that once yielded copious and strong flows have ceased to flow entirely. By this means, also, the ground-water level in this region in ten years has been lowered over 10 feet.

This loss of head, not only in Indiana but in other parts of the country, has served to call attention to the fact that the available artesian supplies are by no means inexhaustible. Our "inexhaustible" supplies of natural gas and petroleum are rapidly being depleted, and the geologists and coal experts of the National Survey have computed with probable accuracy the date of exhaustion of our coal beds. Our "inexhaustible" forests are so dangerously threatened with speedy exhaustion that national legislation is now deemed necessary to protect them. The effect of deforestation on stream flow is at last well recognized. Since the forests of Indiana have been cut off the ordinary flow of many of the streams of the State has notably dwindled and the freshet flow is far more destructive.

The conservation of the artesian water supply should not be very difficult. By simply capping unused wells, or by providing them with such means of stopping and controlling their flow as is now applied to ordinary municipal supplies, the head of the wells can be preserved and the height of ground water maintained somewhat near its old level. Legislation may be required to accomplish this result, yet some of the students of the matter, and among them are geologists of the Survey, hope that an intelligent understanding of the conditions will lead to practical means to check this enormous waste and its consequent immense losses in values.

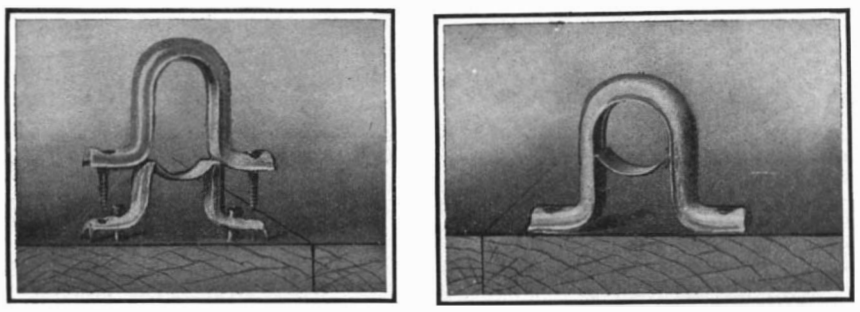
Shipbuilding in Germany during 1906 showed a marked increase over 1905, the gross registered tonnage of merchant vessels constructed, including ocean steamers, sailing vessels, river steamers, etc., having been 367,820 tons, as against 277,731 tons in the previous year. This represents an increase for the year of 32.4 per cent. The tonnage of war vessels constructed fell off from 30,630 to 23,671. At the close of the year 1906 there were under construction merchant vessels of various types aggregating 323,244 tons, and war vessels of a total of 72,444 tons.

The Russian cruiser "Rurik" on a preliminary trial easily kept up 21.5 knots.

Patent Department

A CONVENIENT PIPE-HANGER.

Pictured in the accompanying engravings is an improved split pipe-hanger, adapted for attaching a pipe to a wall or other support. The hanger is of very simple but strong construction and may be conveniently adjusted to support the pipe. It consists of



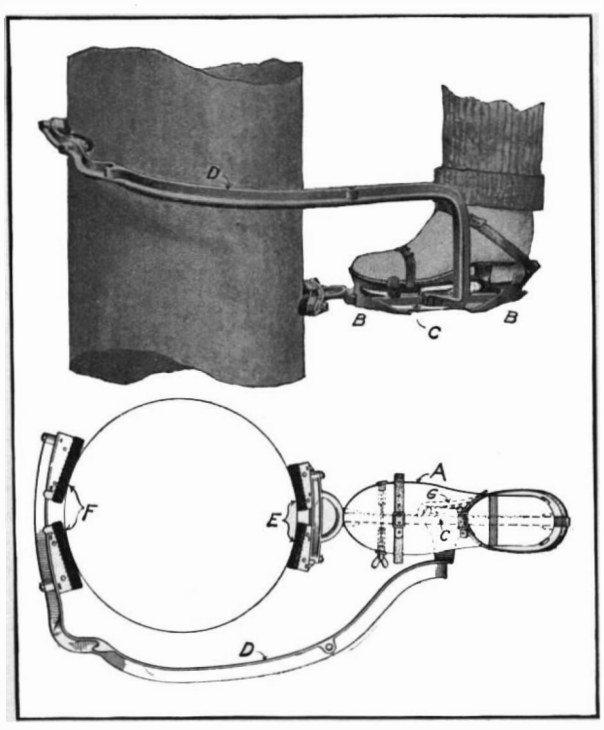
A CONVENIENT TYPE OF PIPE-HANGER.

two parts, one adapted to fit under the pipe and the other over it. The general form of the two members is indicated in the engravings, one cut showing the parts separated to receive a pipe and the other showing the parts fitted together in position to hold the pipe. Both parts of the hanger are stamped out of sheet metal, bent to U shape in cross-section. The U-shaped walls of the inner member of the hanger are adapted to snugly fit within the walls of the outer member. Both of the members are provided with foot extensions at each side, and on the extensions of the inner member prongs are formed, which are adapted to be driven into the support. In addition to this, the inner member is held in place by nails driven through the extensions. After the pipe is seated on the inner part the outer member is fitted into place and fastened with a couple of screws which pass through the foot extensions of both parts. When desired the outer part may be readily removed without disturbing the position of the inner part. Owing to the simple form of the two members, the hanger can be economically manufactured and the U-shaped form of the stock renders it very strong. Mr. W. D. Van Brunt, of Southampton, N. Y., has recently procured a patent on this improved pipe-hanger.

IMPROVED POLE-CLIMBING SHOE.

In the accompanying engraving we illustrate an improved type of climbers, adapted for the use of linemen and others, in climbing wood or metal telegraph, telephone, flag poles and the like. The ordinary climbers are provided with spurs, which are driven into the pole to support the lineman. Such climbers obviously can not be used on metal poles and even on wooden poles do not always furnish a perfectly secure foothold. These deficiencies are overcome in the new climbers, which also enable the lineman to ascend and descend the pole with greater facility and less exertion.

The device comprises a foot-plate *A*, slightly depressed at the heel to prevent the foot from slipping when strapped thereon. A pair of blocks *B* are secured to the foot-plate, one at the heel and the other at the toe. Each block carries a pair of jaws adapted to engage the sole of the shoe, the jaws at the toe being adjustable. Passing longitudinally through the blocks *B* is a rack bar *C*, the forward end of which projects beyond the toe and terminates in a forked jaw *E*. Mounted to slide on the rack bar *C* is an arm *D*, which rises to about the height of the ankle of the user and then curves around until it terminates in a jaw *F* diametrically opposed to the jaw *E* but some distance above it. The jaws *E* and *F* are fitted with rubber pads to provide gripping surfaces when climbing iron poles. The rubber pads may be removed when the climbers are to be used on wooden poles. Mounted on the arm *D* is a spring-pressed pawl *G*, adapted to engage the teeth of the rack *C*. By adjusting the arm *D* along this rack the distance between the opposed jaws may be varied to suit different poles. The user by throwing his weight on one foot will bind the jaws of this shoe against the pole. Thus supported, he can release the jaws of the other shoe by raising his heel to increase the diametrical distance between the jaws. This foot is then carried upward and the jaws automatically engaged with the pole by throwing his weight upon it. Thus the climbing proceeds. A patent on this improved pole-climbing shoe has been secured by Messrs. C. F. and C. G. Youngquist, of 912 Michigan Street, San Francisco, Cal.



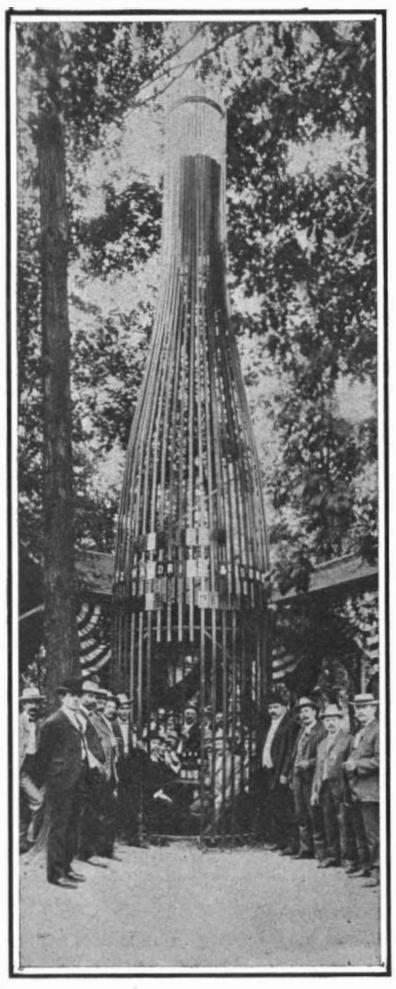
IMPROVED POLE-CLIMBING SHOE.

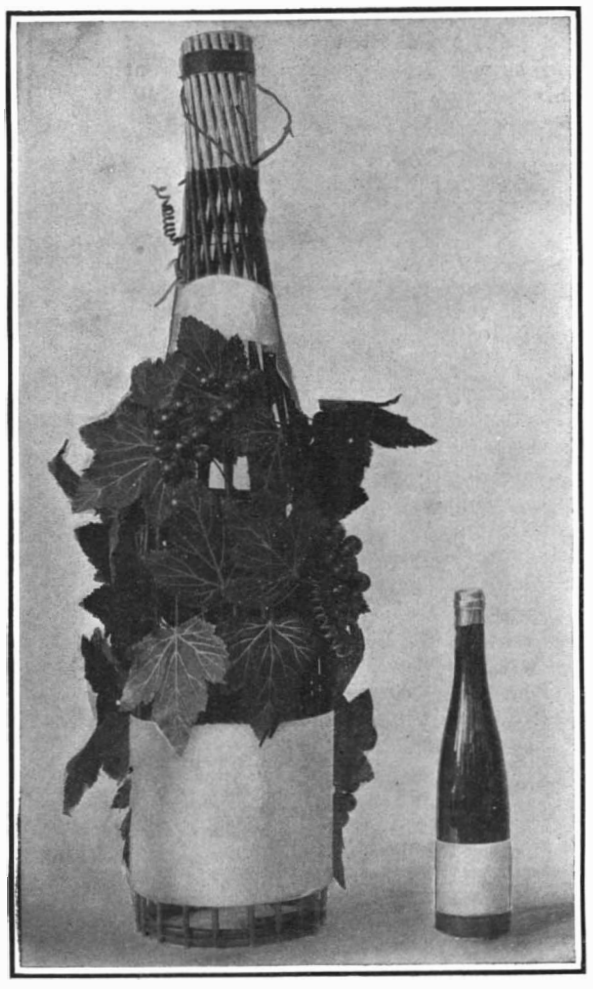
A NOVEL ADVERTISING DEVICE.

While advertising methods have reached a high development along certain lines, in one direction at least there seems to have been little improvement. Ugly signboards continue to deface the city skyline and mar the landscape along railroads and prominent highways. It is useless to attempt to do away with this form of advertising. Legislation has failed to stop it. It has come to stay. But it can be improved, and competition will compel improvements when a start is made in the right direction. Already attempts have been made to relieve the monotony of signboard scenery by cutting the signboard to the form of the article that is advertised. A further improvement, particularly adapted for advertising beverages, has been devised by Mr. Herman Soellner, of 81 Pilling Street, Brooklyn, N. Y. It consists in constructing a large frame of bottle form to represent a gigantic bottle, and training vines to grow on the frame. One of these novel advertising signs was recently erected in a popular picnic ground in this vicinity. The accompanying photograph of the device shows the huge proportions of the bottle. It is thirty-two feet high, and measures six feet ten inches in diameter at the base and three feet in diameter at the mouth. A modest label is the only lettering on the bottle, and without detracting from the appearance of the novel sign gives due prominence to the advertiser. Vines are being trained on the framework, and doubtless will soon conceal it entirely.

Carrying out the same idea, a large bottle trimmed with artificial vines as in the accompanying engraving, or covered with climbing flowers planted in a pot behind the bottle, makes an attractive indoor advertising device. A patent on these methods of advertising has been secured by Mr. Soellner.

Pouring Mixture for Imitation Cameos. — Litharge 50 parts by weight, concentrated glycerine 15 parts, intimately mixed by stirring, is poured into the molds and allowed to stand until it solidifies. By the addition of ochers, ultramarine, etc., this pouring mixture can be colored as desired.

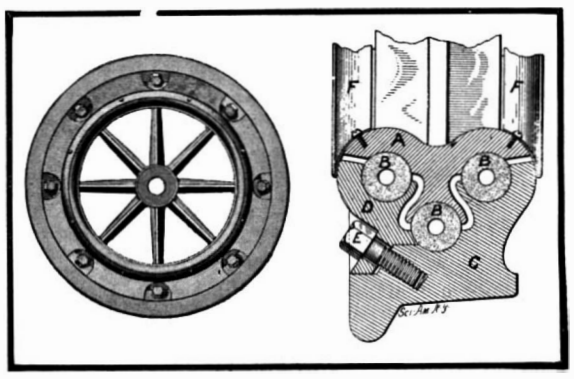




A NOVEL ADVERTISING DEVICE.

CUSHIONED CAR WHEEL.

With a view to reducing noise in city streets, Mr. Benjamin Gastal, of Pelotas, Brazil, has devised an improved wheel adapted to be used on all classes of vehicles, but more especially on street and railroad cars. Of course, the ordinary expedient of equipping the wheels with pneumatic tires is not applicable to wheels which travel on rails, but Mr. Gastal has invented a special form of wheel, in which the pneumatic cushion is placed between the rim and a flanged tire, so that without changing the character of the tread surface, the wheel is cushioned and the usual noise and



CUSHIONED CAR WHEEL.

vibration materially abated. In the accompanying engraving, one of the figures shows the improved wheel complete, and the other, which is a cross section through the rim, shows the details of construction. The rim *A* of the wheel is provided with a central annular flange. In this flange and in the main body of the rim at either side of the flange annular grooves are formed, which serve as seats for the pneumatic tubes *B*. The rim *C* of the wheel is provided with seats, which bear against the tubes *B* at the center and outer side of the wheel. A side section *D*, which is fastened to the tire section *C*, and bears against the inner pneumatic tube and the inner side of the central pneumatic tube, serves to hold the tire section to the wheel and prevent it from being moved laterally off toward the outer side. The section *D* is held in place by a series of countersunk screws *E*. The space which separates the rim *A* from the tire section *C* and side section *D* is covered by a pair of annular covering flaps *F*.

One can hardly look out of a window in contemplation of the roofs without seeing a number of metal-hooded ventilators, which have come into general use for the purpose of creating an air current in lofts or air chambers. The only disadvantage connected with their use is that in case of fire they act as a chimney and aid materially in the spread of the flames. In a recent improvement made in these ventilators, the hood is held in an open position by a lever movement controlled by a fusible link. In case of fire this link is melted, and the hood is allowed to fall of its own weight, and in doing so it closes the air passage and cuts off the draft.

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

TROLLEY.—N. J. GREENISON, New York, N. Y. The purpose of the inventor is to provide a construction that will be automatic in its action relatively to the line wire, and to provide a pivotal support for the trolley wheel and adjustable means for regulating the rotary movement of the wheel support, whereby the wheel will automatically accommodate itself to any curve or obstruction, and will maintain constant contact with a line wire, while the car carrying the trolley remains on the track.

TIMER.—H. A. BUTLER and F. C. PETERSON, Haverford, Pa. The invention refers to improvements in timers or distributers intended especially for passing the electric spark in gas or oil engine ignition. The device does not require adjustment after once being set, since the manner in which the parts are arranged allows the elements to take up wear automatically. Wear is evenly distributed and there is no lost motion, as is commonly the case in timers or commutators.

Of Interest to Farmers.

EGG-CASE.—H. S. WOOD, Mount Pleasant, Iowa. The invention is an improvement in egg cases, and particularly in folding the cases, and has for an object to provide a novel construction of crate for holding eggs which may be knocked down or folded into compact form for shipping when empty, and can be readily erected and secured in position for use.

CANE-CUTTER.—E. M. HIBBLER, Clarksdale, Miss. The blade will cut any way moved, facilitating its use and rendering handling of the cutter easier because the operator can vary cuts in such manner as to relieve muscles which would be tired quickly if the operation were limited to one movement. The blade may be adjusted to any angle with respect to handle and secured rigidly in such adjustment to place the blade in the handle to project from one side or the other or straight out in alinement with the handle and with either the hooked edge or opposite edge nearest the operator.

FRUIT-PICKER.—E. GIER, Rhineland, Texas. In this case the invention relates to means for detaching fruit from a tree, and has for its object to provide means adapted to conveniently detach the fruit without injury thereto and also to enable the picker to be used with fruit of various sizes.

COTTON-CULTIVATOR.—J. E. DEER, Fairfax, S. C. This implement is particularly adapted for listing or bedding cotton plants, but which may be used with equal advantage for cultivating other plants, such as beets, and also corn in its first stages of growth. The cultivator may be drawn by two draft animals, but it is practicable, owing to lightness of draft of the cultivator, to employ but one, a side attachment of the beam being in such case provided.

THERMOMETER ATTACHMENT FOR INCUBATORS.—T. W. BICKEL, Alva, Oklahoma Ter. Practically an even temperature must be maintained during incubation, and for this purpose Mr. Bickel has found that the thermometer should be kept in close proximity to, and, in fact, for best results, in actual contact with the eggs. He has devised and constructed a tray or holder for the eggs, and a support for the thermometer whereby the bulb of the latter may be held in contact with certain of the eggs.

GREEN-CORN HUSKER.—C. H. BENNETT, Mount Morris, N. Y. The object of this improvement is to provide means simple in construction, effective in operation, and durable in use, adapted to husk green corn without injury to the ear. After the husk has been stripped from the ear means provide for bringing the husking fingers into the bearings of the inner ends of a shaft the edges of which bearings serve as cleaners to remove silk and husk from the husking fingers, leaving shafts and fingers in position to receive another ear.

COTTON PICKING OR HARVESTING MACHINE.—A. B. AMES and H. SCHWENDENER, Watonga, Oklahoma Ter. The general plan of the machine is that of a straddle row harvester, in which the animals of the draft team go on opposite sides of the row and plants pass through the machine and between a pair of cylinders provided with picking devices which gather the mature cotton, which, in turn, is doffed by brushes from the picking spindles and delivered to elevators which convey it to bags carried on the machine, which bags can be unloaded or removed at the ends of the row or otherwise. One man, only, riding on the machine, can drive and govern the operation.

Of General Interest.

BUILDING-BLOCK.—H. L. PEGRAM, Mulvane, Kan. The improvement refers to building blocks adapted to be formed of cement or other material when in a plastic condition, and has for its object to produce a block adapted to be laid in courses or tiers to form a wall, and so constructed as to provide air chambers in the blocks themselves, and continuous air chambers between the blocks when they are arranged in series to form one of the courses of the wall.

ADJUSTABLE PACKING-BIN FOR FRUIT, ETC.—C. F. MATHERS and A. R. STEVENS, Riverside, Cal. This bin is for use in facilitating the gathering and packing of fruit, and similar products; said bin to be used in an intermediate relation between the gatherer and packer and being especially constructed to avoid bruising the fruit and to adjust itself automatically to its load of fruit and also to feed the fruit to one end within easy reach of the packer so as to expedite the packing with the minimum amount of handling.

MALLET.—C. KNOPF, New York, N. Y. This mallet is adapted for use of workers in soft metal, as, for instance, tinsmiths, coppersmiths, and the like. The inventor's object is to provide a double faced mallet having the head formed of two separate pieces of nonmetallic material, such as wood, so constructed that they are rigidly held in place by insertion of the handle, and so formed that the metallic inclosing sheath or casing cannot come in contact with the article being pounded into shape by the mallet.

SPEED-INDICATOR.—C. KNOPF, New York, N. Y. The device is for use in indicating the speed of rotating parts, and more particularly to a device adapted to be attached to vehicles to indicate the speed of travel. The object of the invention is to provide a device provided with a minimum number of parts, and capable of indicating the speed.

HAIR-COMB.—H. COOLEY, Victoria, British Columbia, Canada. The improvement is for use in drying the hair. The heater may be an ordinary electrical resistance coil, or any other form of heater. A coil employed, wires may lead therefrom through a handle. The handles extend from opposite ends of a casing, and are of any material, but preferably of material of low conductivity of heat or non-conductors so as to insulate the user's hands. While handles are at both ends of the casing, one might be omitted, or the double-handled comb may be manipulated from one or the other as desired.

ROLLING-STICK FOR OIL-CLOTH.—M. F. ANDERSON, New York, N. Y. The stick is such as used for forming rolls of oilcloth, matting, and similar material. When materials of this kind are rolled upon the stick, the coils or layers of the rolled material tend to slide longitudinally upon the roll so as to throw their edges at the end of the roll out of alinement. This tends to injure the quality of the goods and causes waste of time in attempting to keep the edges in line.

FAUCET.—G. W. TRIBBEY, Marshfield, Ore. This invention relates to turning-plug faucets. The faucet is adapted for general use, but more particularly for drawing beer or other liquids from barrels, kegs, etc. The faucet is of inexpensive manufacture and may be furnished with each barrel or keg of liquid sold without necessity of charge therefor to the customer.

LADDER.—H. H. THOMSON, Lawrence, Kan. The invention has reference to certain improvements in ladders, whereby the same may be supported in an upright position, irrespective of the inclination or unevenness of the ground upon which the ladder stands or the nature of the body against which the upper end of the ladder rests.

RAZOR-STROP PROTECTOR.—S. D. PHELAN, Okemah, Indian Ter. One purpose of the invention is to provide a protector device for razor strops, which will effectually guard the strop from grit and dust and from which the strop may be speedily and readily withdrawn for use from either side of the barber's chair with equal facility by a right or left-hand operator, which strop when released will be automatically returned within the protector.

FACING FOR EMBANKMENTS, DAMS, AND THE LIKE.—R. R. L. DE MURALT, Zierikzee, Netherlands. The invention relates to a facing of ferro-concrete for the protection of the slopes of dams, banks, walls of canals, and other trenches or cuttings. Hitherto in such works armored concrete has been used in monolithic form or in the form of somewhat large slabs simply joined together and separated by artificial joints of different kinds. Through certain causes fissures are created and water secretly undermines the slopes in such a way that the real is always greater than the apparent injury. Mr. De Muralt's invention completely obviates these objections.

TOBACCO-PIPE.—O. A. BUSE, Lima, Peru. The invention pertains to improvements in tobacco pipes, an object being to provide a pipe made of separate sections so that it may be readily taken apart for cleaning. Another is to so construct the stem of the pipe that saliva will not enter and mingle with the smoke and tobacco. Another is to provide means for cleaning the smoke of nicotine or the like before it enters the smoker's mouth.

Hardware.

ICE-CRACKER.—P. M. THORN, Westchester, New York. The device splits or sub-divides blocks of ice or other crystalline substances easily separated along lines of cleavage, and the inventor's object is to provide a tool which after being inserted a short distance in the ice, may be rotated to exert lateral pressure and cause the ice or other substance to readily split much more evenly than by the use of an ordinary pick or other ice sub-dividing means.

HAND-BRACE.—O. GRANUM, Amery, Wis. The invention pertains to boring and drilling and more particularly to drill braces, such as shown and described in the Letters Patent of the U. S., formerly granted to Mr. Granum. The object of the present improvement is to provide a brace having a setting device to permit quick and convenient converting of the brace into an ordinary crank-brace or a ratchet-brace.

Heating and Lighting.

GAS-GENERATOR.—V. SEPULCHRE, Paris, France. In this patent the invention has for its object a blast gas generator for the production, in a closed receptacle, with combustibles of all kinds, coal, coke, lignite, peat and in particular with the waste of these combustibles which are but little utilizable, or utilizable with difficulty of gases adapted for all purposes.

WATER-HEATER.—E. E. KEHNERT, Lorain, Ohio. The heater is adapted for domestic and shop use. The water is heated by gas, and the volume of the latter admitted to the burner is automatically regulated by the quantity of hot water drawn off. Springs, stuffing-boxes and some of the other usual adjuncts of heaters of this class are dispensed with, and the inventor arranges the gas and water controlling valves, and means for operatively connecting them in one and the same casing, whereby he attains a maximum of simplicity, and efficiency in operation.

COKE-PULLER.—J. W. HURD, Dona, Va. The puller combines a car on which is pivotally mounted a carriage carrying a chain or conveyer, and a rake, the latter being novelly driven to draw the coke from the oven upon the conveyer, which by its movement in one direction only, discharges on the yard or in convenient means for receiving it. Power for driving the conveyer and rake is also utilized for moving the car from one oven to the other, means being provided for reversing movement of rake or car and bringing them to a stop without interfering with motor or other power means.

LAMP-BURNER.—G. W. GIBBS, Ronceverte, W. Va. The lamp burner is of that type which are provided with extinguishing attachments. The inventor obviates the difficulty of preventing the destruction of balance of flame, by forming a closed pocket for the extinguisher, which pocket opens upwardly through the foraminated base plate to house and contain the extinguisher and give room for its play, without any passage for the uprising current of air.

HOT-WATER HEATING APPARATUS.—H. V. JORGENSEN, Aarhus, Lille Torv Nr. 2, Denmark. In this invention the increased circulation is obtained by producing a local development of steam within the rising tube, the tube being connected at its top with an expansive chamber, the return water from the radiators being employed to slightly reduce the temperature of the water in the expansion chamber before passing to the boiler.

APPARATUS FOR THE PRODUCTION OF MIXTURES OF GAS AND AIR.—H. L. KARGER, 26 Frankfurter allee, Berlin, Germany. This apparatus is designed for use in producing mixtures of gas and air in connection with illuminating burners. The more particular objects of the invention are to secure uniformity in the admixture as the same is employed under varying degrees of pressure, and also to produce a comparatively simple and efficient form of apparatus. The construction attains great sensitiveness in the obturating valve.

FURNACE-GRATE.—J. C. BOWRING, Sydney, New South Wales, Australia. The object of the invention is to provide a furnace for the production of steam, or for any other purpose where intense heat, economically produced, is required, and further, to provide a furnace which shall enable the fireman to gain the highest furnace efficiency with the least possible trouble.

Household Utilities.

HOIST.—R. H. BEEBE and J. TRIMBLE, St. Johns, Ore. In this instance the object of the invention is to provide a powerful hoist which may be easily operated and conveniently controlled, and to this end a drum is provided with peculiar driving mechanism and with a brake device coacting with the mechanism, by means of which brake the rotation of the drum may be retarded to any desired degree.

ADJUSTABLE CLOTHES-LINE SUPPORT.—A. Z. BOUDREAUX, Berwick, La. In this case the invention refers to means for raising and lowering clothes lines, and has for its object to provide a device to enable the lines to be brought within convenient reach of a person standing on the ground and to be raised at will out of reach to the desired height.

FOLDING SCREEN-DOOR.—B. F. PATSCHKE, SARAH A. PATSCHKE and H. BOYER, Lebanon, Pa. In the present patent the invention has reference to doors for buildings, and the object is to provide a new and improved folding screen door, made in sections capable of folding to permit convenient handling and storing of the door during the winter months.

EXTENSION-TABLE.—C. INZIRILLI, New York, N. Y. In this case the invention has reference to improvements in extension tables, and has for its primary object the provision of means for raising the extension leaves into position or lowering the same, the several leaves being at all times in connection with the table.

WATER-CLOSET.—N. FROST, Bloomington, Ill. One purpose of the inventor is to provide an automatic double-acting valve adapted to be used preferably in connection with an air-tight tank, the valve being so arranged that the seating or unseating thereof is not dependent upon springs as is usually the case, the only spring used being an auxiliary medium for normally holding the seat elevated for ventilating purposes, and when water pressure is insufficient, the principal medium to such end, being the water pressure in the valve.

Machines and Mechanical Devices.

DITCH-DIGGING MACHINE.—G. M. SCHNELL and C. N. SCHNELL, Kellogg, Iowa. The invention has reference to certain improvements in machines for digging ditches or trenches, and more particularly to that type which is provided with an endless chain supporting buckets, which as the machine is moved along are operated to remove soil to any required depth, thus forming a continuous trench adapted for use as a drain or any similar purpose.

TYPE-WRITER ATTACHMENT.—G. W. CAMPBELL, New York, N. Y. The improvement is in attachments for typewriters, the object of the invention being to provide a simple means for holding the paper in engagement with the platen roller upon reaching practically the extreme end of the paper, on shifting from the lower to the upper case type, thus permitting a line to be printed close to the end of the paper, as sometimes desired.

CORKING-MACHINE ATTACHMENT.—A. F. BIEHLER, Hoboken, N. J. The object of this invention is to provide means adapted to enable corks of various sizes to be moved into position under a plunger without danger of injuring the plunger, as sometimes happens when corks are placed by hand beneath the plunger, as is common practice.

SHEARING-MACHINE.—J. J. VALLIERE, Fair Oaks, Cal. The aim sought in the present instance is to provide means whereby one of the cutting members is moved in a curve to a position substantially parallel to the other cutting member before the two are brought together. Thus the curved cutting member serves not only to sever the material being cut, but also serves to draw the same into the comb.

BLOCKING-MACHINE.—F. L. ATHERTON, Paterson, N. J. The invention pertains to machines for winding ribbons onto spools or blocks, and its object is to provide a blocking machine arranged to permit the convenient insertion of a spool or block, to securely hold the latter in place during the winding operation and to allow the quick removal of the block and the ribbon wound thereon.

LOOM FOR WEAVING PILE FABRICS.—F. C. PFEIFFER, Philadelphia, Pa. The object of the inventor is to provide improvements in looms employed for weaving a plush fabric in which the ground warp threads pass over, cover and bind in place the backs of the pile loops, to prevent the piles from being pushed out at the under side of the fabric when the latter is used and brushed. It can be used for weaving fabrics other than pile fabrics, and in this case the pile thread becomes a binding warp.

COIN-CONTROLLED APPARATUS.—M. F. PRICE, Iowa City, Iowa. The present invention relates to an apparatus intended particularly for use in connection with collar button vending machines, but useful with various others. It is an improvement on mechanism forming the subject-matter of a prior patent and a co-pending application of Mr. Price. The present relates to the peculiar arrangement and inter-connection of stops, and to the peculiar connection between the same and the coin chute, whereby coin on insertion serves automatically to bring about the said alternate operation of stops and individually the articles.

TUNNELING-MACHINE.—R. B. SIGAFOOS, Helena, Mont. This machine is for use in driving tunnels, sinking shafts and the like, the invention having among other objects the provision of a machine which will make a uniform clean bore through rock and other materials with comparative ease and facility, and accomplish this without undue strain on the machine frame even although the material at one side of the bore is harder than that at the other.

MULTIPLE PUNCH.—F. C. M. SILVERS and E. F. SILVERS, New York, N. Y. The invention has reference to certain improvements in the punch selecting mechanism of multiple punches used especially for punching beams, girders, and the like in architectural and other engineering work. Primarily the object is to dispense with the employment of skilled labor in the operation of the machine and construction of the patterns, and to insure accurate and speedy work.

CHARGING DEVICE.—T. F. WITHERBEE, and J. G. WITHERBEE, Durango, Mexico. The principal objects of the invention are to enable the distribution of the charge to be under more perfect control than has hitherto been the case; also to provide for a more efficient mixing of the elements of the charge, and to provide a gas seal; the apparatus being adapted to the use of the modern skit-hoist. It overcomes the defects of the single bells and all apparatus with fixed and unvarying method of distribution; and locates the charge in places at the stock line.

WEIGH-CRANE.—E. SCHENCK, Darmstadt, Germany. The invention adapts the jib of the crane to act as the weigh-beam and arranges the chain, cable, or the like to pass through the rotary point or fulcrum of the jib before reaching the drum. This avoids the accuracy of the machine being affected by the chain, cable or the like, running to the drum. By the swinging of this lever no movement of chain or cable is occasioned in the pulling direction, and no disturbing frictional resistances are set up.

BELL-RINGING MOTOR.—C. SIMON, Avilla, Ind. This device automatically rings a bell. The invention is expected to be useful in many connections, but has its greatest utility when used as an attachment for ringing a locomotive bell. The object is to produce a device which is simple in construction and which will be operated from a moving part of the machinery of a locomotive.

SELF-ACTING SPINNING-MULE.—J. H. RYALLS, Charlottesville, Va. Mr. Ryalls' invention is embodied in improved means for locking pawls when released from a ratchet wheel, leaving the gearing free. The sole purpose is to lock the weighted and counterbalanced lever when required. When the lever is forced down and locked the pawls are out of engagement with the ratchet wheel, and when the locking device is tripped, the cone releases the pawls and thus leaves the connected gear free to rotate.

WASHING-MACHINE.—C. E. MITCHELL, Fort Payne, Ala. The object of the invention is to provide means by which clothes may be quickly and thoroughly washed and without danger of tearing or damaging the finest fabrics. Clothing first passes from the water to disks, so that the water is partly pressed out between the disks and drum and returns to the tub, and then as the clothing passes between the drum and roller the dirt is scrubbed out.

FAN ATTACHMENT FOR SEWING-MACHINES.—S. E. HARTMANN, New York, N. Y. The invention pertains to improvements in sewing-machines, and more particularly to an improved fan attachment for use in connection with power-operated machines, whereby the fan may be continuously operated directly from the power shaft independent of the machine proper.

COMPRESSED-AIR WATER ELEVATOR.—F. ALLISON, Chattanooga, Tenn. In this invention twin chambers, or cylinders, are submerged in water, or otherwise adapted to be filled automatically with water under greater or less pressure, and air under pressure is admitted alternately to the chambers or cylinders so as to expel the contents of one chamber as the other fills. The novelty is embodied in the construction and arrangement of automatic valve mechanism, air cylinders and pistons slidable therein; also air pipes connecting chambers and their passages, and an automatic device for holding one of the valves temporarily in the position into which it is thrown.

Musical Devices.

MUSIC-TUNER.—J. F. YOUNG and E. L. BRENNAN, Morristown, N. J. The object of the improvement is to produce a device simple in construction, and which will operate substantially automatically to turn the leaves of the music, and further to provide such an arrangement as will enable the leaves to be returned to their normal condition when the piece is to be played a second time.

HARMONICA.—W. B. YATES, Alviso, Cal. The improvement is in harmonicas or mouth organs. The object is to arrange the harmonica music scale into separate distinct octaves. The instrument provides a perfected mouth harmonica, perfect in octave, harmonic, diatonic, and numeral progression, and capable of producing a greater variety of music than those instruments now in use.

Prime Movers and Their Accessories.

MEANS FOR PACKING VALVE-RODS OR SHAFTS UNDER PRESSURE.—O. E. LEIB and E. B. WITTE, Trenton, N. J. The invention refers to new means whereby a fluid may be prevented from escaping by a valve rod, a shaft, or other rotating or reciprocating member while the ordinary packing is being replaced or other parts being repaired. The object is to so construct the rod and the bushing within which the packing is seated that by a longitudinal movement of the rod a tight joint may be effected entirely independent of original packing, and this joint firmly held until the original packing is readjusted or replaced.

VALVE.—B. V. CONSTANTINOV, New York, N. Y. In this patent the invention relates to improvements in valves for water, steam, or like pipes, and the object is to so arrange a pressure-actuated valve that it will open uniformly throughout the circumference, thus permitting of an even and uninterrupted flow of liquid around the valve.

GAS-ENGINE SYSTEM.—J. L. TATE, Jersey City, N. J. The object in this case is to provide means for cooling the cylinder of the engine by the circulation of cold air through the jacket, thus eliminating the water jacket commonly used and avoiding the necessity of maintaining a constant supply of cooling water. Further, to provide means for utilizing the heat of exhaust gases from the engine and converting this waste heat into mechanical energy.

REVERSING-VALVE FOR STEAM-ENGINES.—W. A. FLOWERS, Aberdeen, Wash. In the present patent the invention is an improvement in reversing valves and particularly for steam-engines of that class in which a steam-chest is dispensed with, the cylinder being provided with small longitudinal bores to receive rocking valves that control admission and exhaust of steam.

ROTARY VALVE FOR STEAM-ENGINES.—W. A. FLOWERS, Aberdeen, Wash. This invention has reference to steam engines, and more particularly to the means employed for controlling the admission and exhaust of steam from the piston cylinder. It provides a single rotary valve operated from the crankshaft and adapted to be oscillated by a cam or eccentric located thereon. Also improved means whereby the engine may be more easily reversed and controlled.

PRODUCTION OF FLUID FOR POWER.—F. MILLER, Turin, Via S. Anselmo 1, Italy. According to the present invention liquid fuel, such as for instance benzin, is mixed with and led to burn into a receptacle wherein water comes in close contact with the burning mixture whereby it is vaporized, so that the fluid under pressure, composed of vaporized water, and the gases generated by the combustion of the fuel with air, is produced which can be utilized for working power machines.

INTERNAL-COMBUSTION ENGINE.—H. A. W. DRECHSLER, Männedorf, Switzerland. This invention relates to engines of the two-cycle type and is intended to provide certain improvements in the means of compressing the explosive charge, and delivering it to the cylinder. Means are also provided whereby the time of admission of the gas to the cylinder may be controlled, rather than the time of ignition, thus permitting of the use of platinum or the like as the igniter. Provision is made for the escape of exhaust gas through the piston rod after the main exhaust port has been closed.

Railways and Their Accessories.

CAR-FENDER.—S. ISHII, New York, N. Y. This patent discloses a fender in which canvas is stretched over a frame of special construction and portions of the canvas being preferably folded back and forth on itself, a multifold giving the desired strength. At the front of the fender rollers are mounted to rotate in approximately horizontal planes and around these a leather strap or belt extends to increase the protective means afforded by the fender.

BRAKE.—N. J. CLUTE, Schenectady, N. Y. This invention relates to brakes, and it is particularly useful in connection with devices of this class used upon railway or other cars. The object is to provide a brake which can be manually controlled and which utilizes the movements of the wheels to set the brakes. Means provide for setting the brake instantly, or gradually and smoothly.

MAIL-BAG CATCHER.—T. E. SHEFFEY, Decatur, Ala. The invention pertains more particularly to that class of devices adapted to be secured at the door of mail cars to engage a bag located adjacent to the track and to hold it when a train is moving, whereby the mail can be taken aboard the mail car without stopping the train. An object is to provide a catcher having a movable laterally extended fork rod for engaging the bag, and means for securing the fork rod in different positions.

MINE-CAR AXLE.—C. A. KELLER, Rosedale, Ind. One purpose of the invention is to provide a form of axle especially adapted for application to mine and similar cars, the construction of the axle being such that the wheels may freely revolve without rubbing against the sides of the body of the car even under the roughest conditions of use, and so that the body will be prevented from shifting on the axle.

RAILWAY-SWITCH.—T. J. BURKE, New Orleans, La. By raising a hand lever the horizontal plate may be placed at any height to enable it to pass over obstructions in the path of the car and when the lever is set vertically a shaft and the above mentioned plate will be held locked in raised position, the lever being engaged by a spring catch secured in the platform guard. This is the normal position of the lever when the switch-operating mechanism is out of use; and the lever may be instantly lowered and shifted laterally so as to lower and rotate the shaft as required to operate the switch in one operation.

Pertaining to Recreation.

POLYCYCLE.—J. MÜLLER, New York, N. Y. The invention relates to polycycles, and the object is to produce a skate which is adapted to be operated by a movement of one's foot. A further object is to provide a construction which is simple, not likely to get out of order, and which will enable the polycycle to be steered.

FISHING-FLOAT.—W. N. SIMMONS, Pass Christian, Miss. The invention has reference to an improved float or barb for use on fishing lines, and the object thereof is to provide means by which the same may be securely held to the line at any desired point and whereby it may be easily and quickly adjusted thereon.

Pertaining to Vehicles.

AXLE.—G. G. SMITH, Binghamton, N. Y. In this invention the improvement is designed to overcome the disadvantages in the common form of axle now in use. It overcomes some present objectionable features by forming the spindle of the axle angular in cross section, preferably tapering, and covering it with a removable, cylindrical thimble which may be replaced when it becomes loose from wear.

WHEEL.—H. F. BROADHURST, 7 Barnstap Mansions, Rosebery avenue, London, E. C., England. The object here is to provide a spring road-wheel for vehicles, the invention being specially (although not exclusively) designed to provide a construction whereby a wheel having a broad tread may be capable of always maintaining contact with the roadway across virtually the entire width of the tread of the wheel, notwithstanding that the plane of the wheel-rim may not be perpendicular to the surface of the roadway.

FOLDING VEHICLE.—R. J. EHLERS, New York, N. Y. The invention pertains to baby carriages, go-carts and similar vehicles, and the object is to provide a vehicle, arranged to securely hold the parts in position when extended, and to allow quick changing of the vehicle from an extended to a folding position and vice versa, the vehicle when folded forming an exceedingly compact flat parcel, which can be conveniently carried about or stored in a small space, or packed into a suit case, trunk, or the like.

HANDLE-BAR.—C. ALTENBURGER, Chicago, Ill. The invention relates to improvements in handle bars for bicycles or the like, the object being to provide a bar so constructed as to have the required rigidity for steering purposes, but to yield vertically under pressure, thus relieving the rider's arms from the strain or jar incident to a rigid bar.

WHIFFLETREE.—P. L. VINSON, Newbern, N. C. The invention pertains to spring whiffletrees, the object being to cause the moving strain to be transmitted to the body of the vehicle and sudden strains on the shoulders of the horses and on the vehicle prevented. In use with a double team where a pair of whiffletrees are used attached to a doubletree, the latter may also be made as an elliptic spring and the spring whiffletrees hung to each end thereof.

MOTOR-VEHICLE.—C. MESSICK, JR., Hackensack, N. J. The invention relates to devices for operating a motor bicycle through the pedal mechanism. One purpose is to provide a spark-control for the motor, operated by back-pedaling, or by hand, which will reduce the speed more or less, or permit it to travel at full speed, which control when placed in position to drive the motor at low speed will yet permit it to continue running while the brake section is in intermediate or coasting position, or in actual braking position. Releasable means are provided by pedaling for maintaining the coasting or other positions of the device against the main spring.

END-GATE.—A. ROBERTS, Damar, Kan. The invention relates to an improvement in end gates of vehicles and particularly to means for securing the same in working position. The gate may be placed in vertical position, when it performs the function of an end-gate, or it may be supported in an inclined position, when it is adapted for use as a shovel-board in loading a wagon.

Designs.

DESIGN FOR A BARBER'S SIGN.—J. C. SMITH, Marion, Ind. In this design, a triangular upright sheet metal casting has alternating bands of red, white, and blue painted transversely across the sides, with rows of lenses seated in the bands and of the same color as the bands, which lenses are to be illuminated from a lamp or other source of light within the casing.

DESIGN FOR A CLOCK-STAND OR SIMILAR ARTICLE.—C. G. CANIVET, JR., New York, N. Y. In this stand design the center is a circle for the reception of the clock or other article. From this circle there is a slope to the base of stand, the slope being ornamented with sitting and reclining figures of nude children amidst fruit, leaves, and draperies.

DESIGN FOR AN ADVERTISING DEVICE.—H. F. C. SOELLNER, New York, N. Y. The ornamental design in this instance consists of a light skeleton open-work frame representing the form of a very plain but graceful bottle. A shield occupies the usual place for a label on a bottle.

DESIGN FOR A PORTABLE STANDARD FOR LIGHTING-FIXTURES.—H. T. HOWELL, Woodside, N. Y. In this portable standard for lighting fixtures the top of the column has a fluted edge. Under this the standard takes a bulb form and then is straight half way down, when it gradually broadens. The flanged base is very broad, making the design very graceful and substantial. Leaves reach up the standard about two-thirds the length.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Notes and Queries.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.
References to former articles or answers should give date of paper and page or number of question.
Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.
Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.
Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.
Scientific American Supplements referred to may be had at the office. Price 10 cents each.
Books referred to promptly supplied on receipt of price.
Minerals sent for examination should be distinctly marked or labeled.

(10609) C. L. T. asks how to exterminate mites. A. Mix together 10 parts of naphthalene, 10 parts of phenic acid, 5 of camphor, 5 of lemon oil, 2 of thyme oil, 2 of oil of lavender, and 2 of the oil of juniper, in 500 parts of pure alcohol.

(10610) M. T. F. asks for a paste for cleaning gloves. A. Take 4 parts of water and dissolve in it 3 parts of soft soap to which add 1-16 of a part of oil of lemon, and make a paste of desired consistency by adding a sufficient quantity of prepared chalk. This paste is particularly suitable to kid gloves.

(10611) J. N. T. asks for a blue ink for writing upon glass. A. In 150 parts of alcohol dissolve 20 parts of rosin, and add to this drop by drop, stirring continuously, a solution of 35 parts of borax in 250 parts of water. This being accomplished, dissolve in the solution sufficient methylene blue to give it the desired tint.

(10612) J. B. W. asks for ironing preparations. A. Ironing wax: Melt carefully together Japan wax 200, paraffine 200, stearic acid 100, and pour into mold, pass the hot flat iron over this mass, which causes the iron to slide better and the laundered work to become glossy. Laundry gloss: Heat potassium carbonate 15, spirit 100, stearic acid 15, and water 200, until the mass is uniform, thin with hot water 650, and stir until cool. Scent with oil of lavender as desired.

(10613) C. L. asks how to remove oil spots from leather. A. To remove oil stains from leather, dab the spot carefully with spirits of sal-ammoniac, and after allowing it to act for awhile, wash with clean water. This treatment may have to be repeated a few times, taking care, however, not to injure the color of the leather. Sometimes the spot may be removed very simply by spreading the place rather thickly with butter, letting this act for a few hours. Next scrape off the butter with the point of a knife, and rinse the stain with soap and lukewarm water.

(10614) M. E. E. asks for a formula for waterproof glue for cardboard. A. Melt together equal parts of good pitch and guttapercha; of this take 9 parts, and add to it 3 parts of boiled linseed oil and 1½ parts of litharge. Place this over the fire and stir it till all the ingredients are intimately mixed. It may be diluted with a little benzine or oil of turpentine, and must be warm when used.

(10615) J. G. B. asks for a formula for Japan bronze. A. The formulæ that we give below contain a large percentage of lead, which greatly improves the patina. The ingredients and the ratio of their parts for three sorts of modern Japanese bronze follow: 1. Copper 81.62 per cent, tin 4.61 per cent, lead 10.21 per cent. 2. Copper 76.60 per cent, tin 4.38 per cent, lead 11.88 per cent, zinc 6.53 per cent. 3. Copper 88.55 per cent, tin 2.42 per cent, lead 4.72 per cent, zinc 3.20 per cent. Sometimes a little antimony is added just before casting, and such a composition would be represented more nearly by this formula: 4. Copper 68.25 per cent, tin 5.47 per cent, zinc 8.88 per cent, lead 17.06 per cent, antimony 0.34 per cent.

(10616) J. G. B. asks how to cement celluloid. A. If celluloid is to be warmed only sufficiently to be able to bend it, then a bath in boiling water will do. In steam at 120 deg. C., however, it becomes so soft that it may be easily kneaded like dough, so that one may even imbed in it metal, wood, or any similar material. If it be intended to soften it to solubility, the celluloid must then be scraped fine and macerated in 90 per cent alcohol, whereupon it takes on the character of cement and may be used to join broken pieces of celluloid together. Solutions of celluloid may be prepared: 1. With 5 grammes of celluloid in 16 grammes each of amyl acetate, acetone, and sulphuric ether. 2. With 10 grammes of celluloid in 30 grammes each of sulphuric ether, acetone, amyl acetate, and 4 grammes camphor. 3. With 5 grammes celluloid in 50 grammes alcohol and 5 grammes camphor. 4. With 5 grammes celluloid in 50 grammes amyl acetate. 5. With 5 grammes celluloid in 25 grammes amyl acetate and 25 grammes acetone. It is often desirable to

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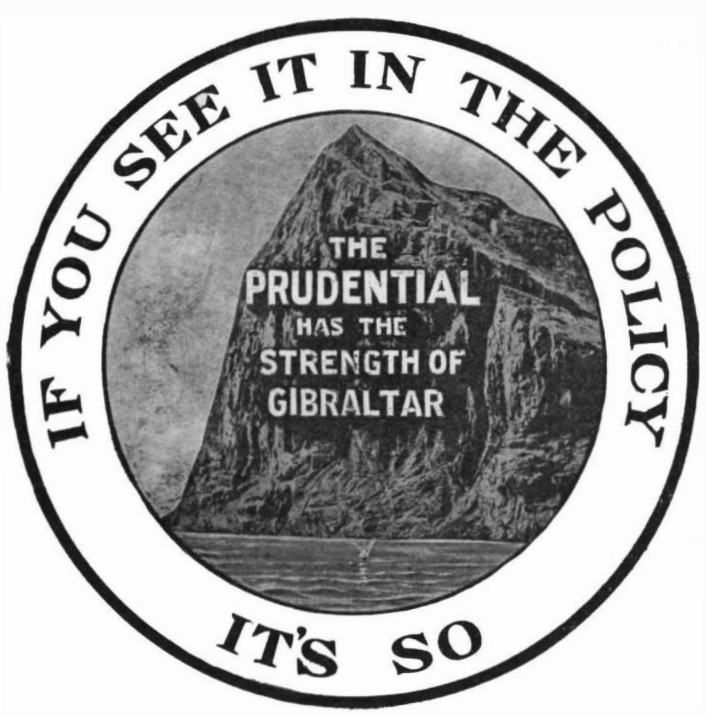

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soften celluloid so that it will not break when hammered. Dipping it in water warmed to 40 deg. C. will suffice for this. Any factory will furnish soft celluloid if ordered in sufficiently large quantities to pay.

NEW BOOKS, ETC.

RUMFORD FIREPLACES, AND HOW THEY ARE MADE. By G. Curtis Gillespie, M.E., architect. New York: William T. Comstock. One 12mo. vol.; cloth. Price, $2.

This work, based on the original Rumford essays, which are given in full with the original drawings, is an elaborately illustrated essay on fireplaces, ancient and modern, and their fixtures. The author has given much study to this subject, not as a mere dilettante, but as a practical worker. As an architect of experience in the construction of residences he has found a great demand for fireplaces on the part of owners, but a lack of ability on the part of mechanics to construct them on lines that were at once artistic and efficient. In this respect the book follows carefully in its drawings and descriptions the technical treatment necessary to secure the best results. He claims that Rumford discovered the form and proportions best suited to insure good heating, and that no later designer has been able to compete with him. This portion of the book will be read with much interest by the architect, the mason, and the heating engineer. While elaborately illustrated and containing many designs for mantels, fireplaces, and their accessories, which will render it valuable to the decorative designer, the book is thoroughly practical and the diagrams and drawings can be worked up into actual fireplaces which will not only adorn but heat the rooms they are in without blinding the eyes of their occupants with smoke.

CONCRETE STEEL BUILDINGS. Being a Companion Volume to the Treatise on Concrete Steel. By W. N. Twelvetrees. London and New York: The Macmillan Company. With 331 illustrations. 12mo.; cloth; 408 pages. Price, $3.25.

A presentation of detailed particulars of buildings in concrete designed for different uses in Great Britain, on the Continent, and in America. The works chosen are variously noteworthy, some for their size, some for their strength, and others for the manner in which difficult problems have been solved. All of the buildings show the adaptability of concrete to structural requirements of every description.

PRACTICAL METAL TURNING. A Handbook for Machinists, Technical Students, and Amateurs. By Joseph G. Horner. Illustrated with 488 engravings. New York: The Norman W. Henley Publishing Company. 8vo.; cloth; 404 pages. Price, $3.50.

In this work little is said of the lathe itself, preference being given to the practice of turning rather than to lathe design, a wide subject, undergoing rapid changes. Although it would be a hopeless task to attempt to treat the subject exhaustively in one small volume, few matters of importance seem to have been omitted. The principles and practice in the different branches are considered, and well illustrated. All the different kinds of chucks of usual form as well as some less usual ones, are shown. The important section devoted to modern turret practice is a feature of the book; boring is another subject which is fully treated; and the chapter on tool holders illustrates a large number of types. Screw-cutting is discussed at reasonable length. The last chapter contains a generous body of information relating to high-speed steels and their work.

NOTES ON CONSTRUCTION IN MILD STEEL. By Henry Fidler. With illustrations from working drawings, diagrams, and tables. London and New York: Longmans, Green & Co. 8vo.; cloth; 448 pages. Price, $5.

The object of this work is to bridge the gap that often occurs between the carefully calculated stress-sheet or correctly drawn graphic diagram and the completion of a working drawing which will successfully pass the ordeal of criticism in the girder maker's or bridge or roof builder's yard. No attempt has been made to treat the subject from the point of applied mechanics as ordinarily understood, nor are the theories of construction or the calculations of building or engineering structures referred to, except as may be required incidentally in connection with the legitimate subject matter. The great range of the topics of which the notes treat, however, and the severe limitations which are necessarily imposed, form an excuse for the apparent insufficiency of discussion.

WATER WORKS MANAGEMENT AND MAINTENANCE. By Winfred D. Hubbard and Wynkoop Kreisted. New York: John Wiley & Sons. 8vo.; cloth; 429 pages. Price, $4.

The maintenance and operation of a system of water works is often believed to be a purely business proposition, requiring generally a business management. Regarded in a broad and comprehensive sense, this view may be correct, but a far-seeing business manager will not overlook the purely technical or scientific considerations which are of necessity involved in the management of a modern water works system. The selection of a water supply drawn from an unpolluted source is highly desirable, and inspires the confidence of the public in the management of water works. This confidence, however, may be also secured in a water drawn from polluted sources, provided the water be properly purified for use. It is the object of this work to present all the problems of water works management, both of systems where the water is drawn from polluted and from unpolluted sources. Its scope is broad, even dealing with the legal aspect of the case, and with the financial management of the properties.

ARMATURE CONSTRUCTION. By H. M. Hobart and A. G. Ellis. With 420 illustrations, including numerous colored diagrams. London and New York: The Macmillan Company. 8vo.; cloth; 348 pages, Price, $4.50.

The design and manufacture of dynamo-electric machinery is so extensive a subject, that it cannot be handled in a single treatise with sufficient comprehensiveness. The present work deals with the subject from a constructional and practical standpoint rather than from a designing and calculating standpoint. The theoretical and designing elements have not been allowed to predominate, and are only inserted in so far as they facilitate an intelligent appreciation of the various methods and points encountered in the construction. A novelty which makes the figures much more readily followed is the introduction of colored diagrams in the study of polyphase windings and multiplex continuous current windings. Although to a mind which is continually dealing with such windings these colored diagrams are not so necessary, in the present case, however—where the desire is to reach those more or less unfamiliar with the subject—this innovation is a great assistance.

RAILROAD MEN'S CATECHISM. By Angus Sinclair. New York: Angus Sinclair Company. 16mo.; cloth; 216 pages. Price, $1.

This is a book which gives information that will be useful and acceptable to all classes of railroad men from the president to the newest brakeman. The questions are intended to impart information covering the entire practice of train operating, and to explain all details of mechanism. The questions and answers are the outcome of Sinclair's Locomotive Engine Running and Management, and are an enlarged code that grew up through many small forms, the best known having been the Questions and Answers prepared by the Traveling Engineers' Association.

SOUTHERN SHIPPER'S GUIDE DIRECTORY. A List of the Shippers of Foodstuffs in the Southern States. Houston, Texas: Thomas-Willson Publishing Company. 8vo.; cloth; 300 pages.

ANNALS OF THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE. Edward C. Pickering, Director. Vol. LII. Part I. Eclipses of Jupiter's Satellites. 1878-1903. Cambridge, Mass.: Published by the Observatory.

HIGH ELECTROMOTIVE FORCE. Its Application to the Study of Powerful Electrical Discharges and to Spectrum Analysis. By John Trowbridge. Cambridge: John Wilson & Son, 1907. 185-215 pages; 3 plates.

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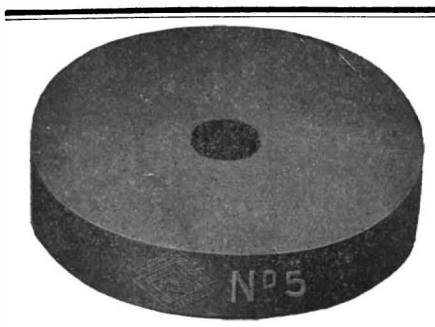

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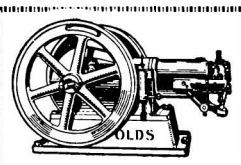

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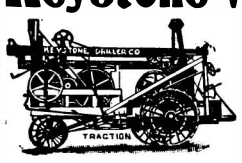

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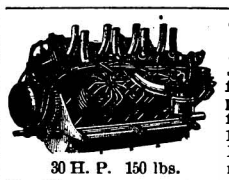

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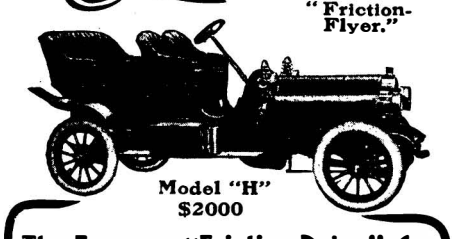

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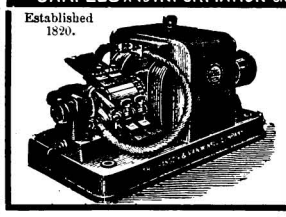

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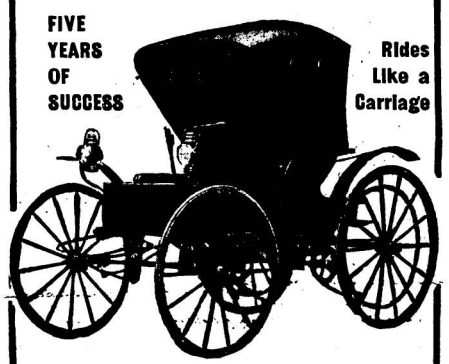

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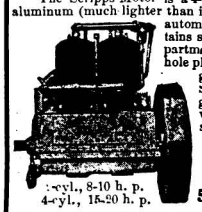

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