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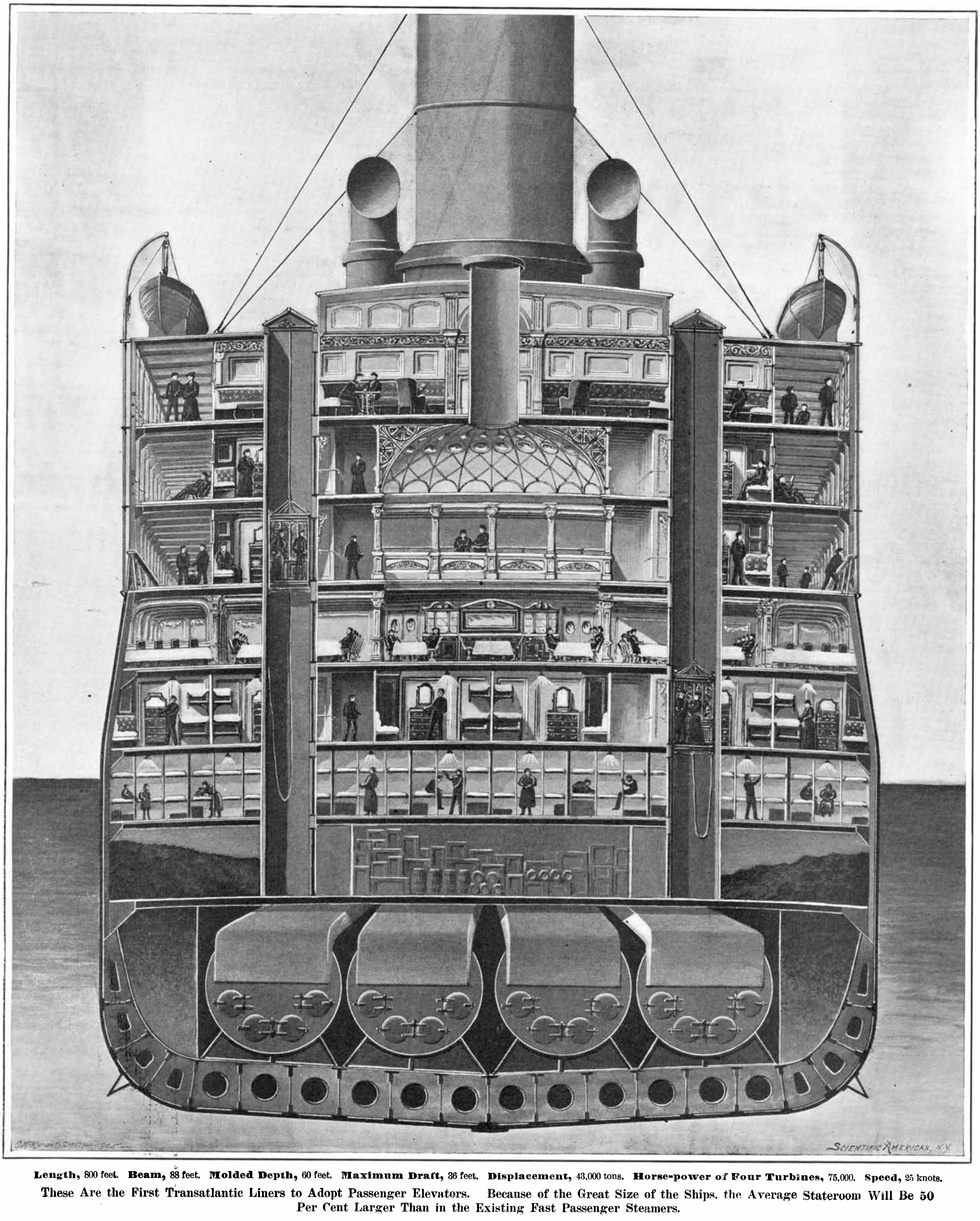

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SECTION THROUGH ONE OF THE GREAT 25-KNOT CUNARD LINERS.—[See page 66.]

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ESTABLISHED 1845

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NEW YORK, SATURDAY, JULY 22, 1905.

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.

FACING AND TRAILING SWITCHES.

The facing switch is one of the most fruitful causes of railroad accidents in this country. The switch is an absolutely necessary feature in railroad operation; for without it it would be impossible for trains to be moved from the main line onto sidings and into freight yards. The unquestionable peril which attaches to switching arrangements, especially on lines of fast passenger traffic, is not inherently necessary. It may be removed entirely by a reconstruction, the cost of which would be cheap in comparison with the great security that would be gained by the lines that made the change. There are two methods by which a train running on the main line of traffic can be moved on to a siding. One is by what is known as a facing-point switch which, when it is set for the siding, enables the train to turn out without stopping, as it merely has to slow down sufficiently to take the rather sharp curve without risk of derailment. If, by mistake or malice, the switch has been "left open," a fast train, traveling at a higher speed than that at which it is possible for it to take the siding safely, will jump the switch, and a derailment and probable wreck will ensue. The "trailing switch," on the other hand, opens backward in the opposite direction to the traffic, that is to say, a train taking the siding at a trailing switch, must run entirely past it and then back up into the siding. If a switch of this kind be left open by mistake or malice, a train will run through it without any risk of derailment, the flange of the wheels automatically thrusting the switch open as the train passes.

The facing switch becomes dangerous only in the presence of carelessness or malicious interference. It can be used with safety as a part of a system controlled from a signal tower, or in positions where it is under full observation and surveillance at all times. For use at remote country stations on the main line of a railroad that runs fast expresses at all hours of the day and night, the facing-point switch is a distinct menace to the safety of passengers. In such cases it should be abolished and the trailing switch substituted. It is, of course, too much to ask our railroads to make this change at every station; but there are a large number of insignificant sidings where it should be made, and made at once. There would be some delay at times, due to long freight trains having to run entirely past the switch before backing into the siding; but on a well organized road, this matter, like the other difficult problems of transportation, could be properly adjusted.

BELOW THE BELT.

It is semi-officially stated by the Russian Admiralty that the battleships "Navarin," "Borodino," "Alexander III.," and "Kniaz Souvaroff" "turned turtle" during the battle of the Sea of Japan and went down with all hands. Of all forms of destruction that can befall a warship, this is the most terrible, for it involves the all but total loss of the ship's company. In a recent letter to the London Times Sir Nathaniel Barnaby, the well-known naval constructor, draws attention to the fact that the capsizing of these large ships has been attributed to some fault in their design, and he refers to statements which he has made in a book written a few years previously, to the effect that the modern ship of war, whether of the protected or armored type, was in danger of capsizing when wounded under water, to an extent unknown fifty years ago. He had also claimed that the increased risk of capsizing before sinking of the wounded ship of war of to-day was not peculiar to any particular class of ships or to any particular navy.

We are of the opinion that the capsizing of the Russian ships was probably caused by hits below the water-line belt of armor. The possibility of such hits being made was greatly increased by the fact that there was a heavy sea running, and that in rolling the ships must at times have rolled the bottom edge of the armor entirely out of the water. Furthermore, it has happened in naval engagements of this war fought in smooth water, that vessels have suffered from shot holes below the water. In reply to our inquiry as to how this happened, one of the captains of the Port Arthur fleet informed us that shells fired from long range and striking the water a short distance from the side of the ship, would pass through the water and strike below or near the bottom edge of the belt. A case of this kind occurred on the battleship "Czarevitch," and several other vessels were similarly damaged. It cannot be urged that in the battle of the Sea of Japan the shot-holes which admitted water to these ships were made through the unprotected ends; for with the exception of the "Navarin," the belt armor was carried entirely from stem to stern.

The talented French designer of the "Borodino," "Alexander III.," and "Kniaz Souvaroff" paid particular attention to the under-water defensive qualities in these ships, and the fact that they were protected with a 9-inch belt of Krupp armor renders it probable that, at the range at which the earlier phases of the battle were fought, the belt armor itself was not penetrated. It begins to look as though the water-line armor will have to be carried down deeper, and it may be that it will also be carried to a higher level above the water line. This means bigger ships and larger displacement; but it will probably have to be done. Another change which may be necessary to prevent the capsizing of badly hulled warships is the elimination of longitudinal bulkheads, or rather, we should say, the provision of means for allowing an unrestricted flow of the water in any damaged compartment from side to side of the ship. The three ships of the "Borodino" class above mentioned carried a vertical wall of armor from end to end of the ship at a distance of about 12 to 15 feet inboard. It is possible that the water that entered on the sides exposed to the fire of the enemy collected between the outside hull and this inner wall of armor, and quickly brought the ship into the capsizing condition. It is true that in order to trim the ship provision is made for flooding compartments; but it may well be that in the confusion of a terrible sea fight like this, the necessary knowledge as to what compartments need to be flooded to preserve an even keel may be wanting to the very men whose duty it is to open the valves or control the pumps.

THE SECOND CITY IN THE WORLD.

The incomplete census figures indicate that the population of New York is now just under 4,000,000, or, to be exact, 3,987,154. The probabilities are that Manhattan and the Bronx alone will be found to have a population of 2,378,696. It is interesting to go back and compare the population of New York in the successive stages of its growth with that of to-day. The first federal census, taken in 1790, shows that the population was 33,131. In 1800 it had risen to 60,515, and in 1810 it was 96,373. In the next twenty years it more than doubled, having reached 202,589 in 1830. By the middle of the century it had passed the half million mark. Thirty years later, in 1880, it had again more than doubled, the population being 1,206,293. From 1900 to 1905 New York has grown from 3,437,000 to 3,987,154, or at the rate of over 100,000 a year. The standing of New York among the big cities of the world is shown by the following figures: London comes first with 4,536,641 people, and next to New York are Paris, with 2,714,008; Berlin, with 1,888,848, and Chicago with 1,698,575. Then follow Vienna, Canton, Tokio, and Philadelphia, all of which have over 1,000,000 inhabitants, the last named having 1,293,697 in the census of 1900.

As to the possibility of New York city becoming the largest city in the world, there is no indication that London will lose the first place for many decades to come, for within the metropolitan and city police limits that city contains 6,581,372 souls, this being the population of what might be called Greater London. To put it another way, London's "Manhattan" contains 4,613,812 souls as against New York's Manhattan population of 2,127,602; while her Greater London has 6,581,372 people as compared with Greater New York's population of just under 4,000,000. The rate of growth, however, is faster in New York than in London and if the present rates should continue, it will only be a question of time before the largest city in the world will be found in the Western Hemisphere.

FASTEST LONG-DISTANCE RAILROAD RUN.

The publication of the high speeds that were made by the eighteen-hour trains in their preparatory tuning-up runs, has re-awakened interest in the question of fast long-distance runs. One of the most interesting contributions to the subject is that of the English railway expert, Mr. W. M. Acworth, who, during his visit to the International Railway Congress in this country, was enabled to take notes of some very fast work by the famous American expresses that run during the summer months from Philadelphia to Atlantic City. These trains are scheduled to travel at average rates of 66.6 to 68.1 miles an hour, and on the occasion of Mr. Acworth's trip, a speed of 80 miles an hour was maintained continuously for a distance of 30 miles. In a recent article on the subject, in the London Engineer, Mr. Acworth raised the question whether anything like this performance had been accomplished on the Great Western Railroad's record run from Bristol to London. This was made last year by one of the Ocean Mail Specials from Plymouth to London, when the distance from Exeter to Bristol was made at the rate of 70.5 miles an hour and from Bristol to London at the rate of 71.5 miles an hour, the whole distance of 193¾ miles being thus covered at an average speed of 71 miles an hour. Mr. Rous-Martin, who was on the engine during this performance, states that a speed of 80 miles an hour was sustained, with virtual continuity, for 73 miles consecutively, the only time that the speed fell below 80 being while water was being taken from a water trough, the resistance of which reduced it to 75 miles an hour. During the fastest run recorded by Mr. Acworth on the Philadelphia-Atlantic City line, a distance of 55½ miles was covered in 42½ minutes. The same distance was covered during the Great Western's run in 42 minutes, which brings the average up to 79.3 miles an hour. The American and English runs for this distance were, therefore, almost identical in speed; but it is claimed that the remarkable feature of the Great Western engine's work was the long distance (193¾ miles) during which the high speed was maintained, and the fact that the engine which did the work was of a somewhat old-fashioned type. The American load was heavier; but on the other hand, the American engine was able to exercise double the tractive power of the English single-wheel type; and it is claimed, very properly, that the wonderful speed achieved on this road proves that for running fast trains, of which there are so many in England, the single driver type is admirably adapted.

The United States possesses in its 18-hour trains from New York to Chicago the fastest long-distance trains, the Pennsylvania maintaining an average speed of 50.3 miles for 905.4 miles, and the New York Central covering 959.4 miles at the rate of 53.3 miles an hour.

TESTING THE TOURING CARS.

The automobile tours which have just been carried out under the direction of one of the leading national associations have done much toward emphasizing the necessity of good roads for both touring and business transportation purposes; and one of these tours—that to the White Mountains for the Glidden trophy—has also demonstrated anew the cheapness of transportation by auto as opposed to that by rail, especially when a pleasure journey is being undertaken. With a touring car carrying five persons, from the results obtained on the tour, it appears that each person can be carried for about one-fourth the rate charged by the railroads, or in other words, for one-half cent a mile. This rate, however, is for transportation on good roads and exclusive of tire repairs. On poor roads the cost of fuel will be found to be augmented somewhat; but the greatest drawbacks are the low average speed possible to be maintained and the discomfort the passengers are obliged to undergo. In the western 500-mile tour from Chicago to St. Paul, so much rain was encountered that the roads were well-nigh impassable, and many of the tourists shipped their cars by rail after completing half of the journey. No less than eleven machines, however, made the journey under the most trying conditions. Instead of a pleasure tour, the automobilists made an endurance run of which they may well be proud. Among the cars that completed the journey were three White steam machines, three Knox air-cooled cars, a Pierce, a Packard, a Rambler, a Jackson, a Reo, and an Adams-Farwell air-cooled machine with a revolving-cylinder motor. These cars were three representative types of American machines, and they demonstrated once again the capability of the domestic car even under the worst weather conditions and roads that America is able to produce.

In the Glidden tour, thirty-four representative machines started from New York on July 11, and of these some twenty-eight reached Mt. Washington on July 14. A feature of this tour was the employment of a Packard and a Knox truck to transport the baggage of the tourists. These machines made very good daily runs, and generally delivered the baggage at its destination sooner than if it had been sent by express. Some interesting data on the cost of long-distance hauling based on their performances should be available at the conclusion of this 1,000-mile tour.

Within three years, at most, practically worthless land, so heavily charged with injurious salts as to be unfit for any form of agriculture, may be reclaimed to grow any ordinary field crop. The method of doing this is simple; and the expense involved is such that the work may in many instances be economically undertaken by individual, corporate, or State initiative. The total expense of reclamation, taking everything into consideration, is but a small fraction of the enhanced value.

ROMAN TEXTILE MANUFACTURES.

BY ALEX DEL MAR, M.E.

Weaving is an art of the highest antiquity. In the Vedas, VI, ix, 2, the Rishi declares that he knows "neither the warp nor the woof of religious rites." In the Iliad, the Bible, the Zendavesta, in the earliest writings of every nation of antiquity, it is distinctly described. Whether man learnt it from the weaver-bird, or it grew out of platting, we know not. Its origin is plainly Oriental; and a loom of apparently the most elementary form is still used in India; and what is yet more strange, it is capable of producing the most delicate tissues known to the art. There the village weaver stretches his warp between two bamboo rollers, one of which is suspended from a tree, while the other is fastened to the earth by wooden pins driven into the turf. The earth also forms his seat, and two holes dug into it accommodate his legs. The shuttle which carries the woof is shaped like a netting-needle, and being somewhat longer than the breadth of the fabric, it is employed also as a batten, to shove the threads of the woof close up to each other.

From the Orient, the names of staples, tissues, and fabrics enable us to trace the art of weaving into Asia Minor, Egypt, and Europe. In the Augustan age the woolen industry had been established in the Levant for upward of a thousand years; the weaving of silk, both from unraveled Indian tissues, from Oriental yarns, and from the threads of native silk-worms, had been practised in the island of Cos for over 500 years. The weaving of cotton cloths belongs practically to the Alexandrian age; while the manufacture of linens in Rome was comparatively new, it having but recently been imported from Egypt. The Roman manufacture of other textiles, such as hemp, esparto, and asbestos, though interesting, was comparatively unimportant.

We are indebted to Ovid, Met. vi, 53, for an account of the woolen manufacture; dressing the wool; picking or teasing, combing, and carding it; spinning the yarn with distaff and spindle; winding, or forming the thread into clues, and dyeing. The earlier looms, like their Indian prototypes, were perpendicular, hence the warp was called *stamen* and the woof *subtemen*, and the shuttle, *radius*. The looms, the fulling-mills (for cleaning, scouring, and solidifying the cloth) and the dyeing-works, were run by water power; and although the principal works were in the city of Rome, numerous others were established in all parts of the empire, especially in Spain, Gaul, and Britain. Among the woolen fabrics were *phrygians*, a coarse shaggy cloth, made in the Asiatic provinces, and out of which the Roman tailor fashioned the brown lacerna, or great-coat, a garment with a hood, like the French military tunic of the present day. A shorter overcoat or cape, also with a hood, was called penula. It was made of a hairy cloth called *gausapa*. Another fabric called *frigus*, was like the Scotch and Irish frieze of modern times. A fabric similar to our broadcloth was called *rasa*, or smooth. *Virgata* was a striped cloth; *scutulata*, a spotted or figured tissue; *galbina*, a green or grass-colored fabric, worn by women; *palla* meant black or gray mourning-goods, etc. Among the other products of the Roman woolen looms were damasks; embroideries made on the loom, sometimes with gold and silver threads and figures; tapestries, shawls, bunting, rugs, and carpets. The bunting was used for signal flags and for the colors carried by contestants in the chariot races. These last were organized in four companies, the Greens, Reds, Blues, and Whites; and they were championed with such *esprit de corps* and zeal that even the women became partisans, and wore silk ribbons of their favorite colors.

Before that great influx of the precious metals which followed the conquests of Scipio, Titus, Mummius, Lucullus, Sylla, Pompey and Cæsar, the linen industry, like many other industries of Rome, consisted of importing the fabric from other countries, in this instance from Egypt. The culture and treatment of flax and its manufacture into a variety of fabrics had grown to considerable perfection in that country; and until Rome became a great center of capital, but feeble efforts were made to transplant this great branch of trade. With the reign of Augustus came that unity of the empire and universal peace which afforded security and assurance to its overflowing treasuries; and among the industries adopted or greatly extended was the culture of flax and manufacture of linen, either in Italy or in the Roman provinces, of which, of course, Egypt was now one. Among the various fabrics mentioned in the works which are left to us are damask tablecloths, table-napkins, and handkerchiefs, *sudaria*. A fine linen cloth from Sidon was called *sindon;* although Martial says that the same or similar stuff came also from Egypt. A twilled linen fabric, or diaper, had long been worn in Asia Minor, Egypt, and Greece. This industry was now taken up by the Romans and introduced into Italy and several of the western provinces. Linen sails for ships were also made in various parts of the empire.

The Roman costume consisted chiefly of the woolen toga and tunic; the shirt, *camisia;* and leg-cloth, *tibialia*. The overcoat, mittens and cap, *pileus*, were only for cold weather. Of these various articles, the shirt and leg-cloth were of linen, sometimes, also, the tunic. The purple border to the toga was a survival of the purple thread of the Hindu. The latter was made from the staple of the purple cotton plant; the former was dyed with the famed murex of Tyre.

Flax was cultivated successfully in many parts of Asia Minor, including Palestine, and in most of the Greek states. Pausanias wrote that "the fine flax which is produced in Elea, is a very proper subject of admiration; for it is not to be found (in such perfection) in any other part of Greece. . . . But the fine flax (produced) within Elea, is not inferior in tenuity to that of the Hebrews; while it is less yellow." After being retted in running water for about a month, it was taken out, dried, and made ready for extracting its fibers. For this purpose a bunch of it was taken in the hand, laid upon a table, and beaten with a wooden instrument. It was afterward drawn forcibly over the angle of the table, in order to free it from fragments of the stem. Then it was heckled or passed through iron combs, beginning with coarse and ending with finer ones. In this condition the fibers were free and ready for spinning into threads or yarn. The various machines and devices for retting, heckling, spinning, and weaving this staple, though derived from the older industry of hemp-manufacturing, were much improved by the Romans, who paid great attention to the details of the linen trade and exported their products to numerous places in Asia Minor and Europe.

The cotton plant and cotton fabrics are mentioned as of Indian origin by Herodotus, 450 B. C. The culture was brought westward by the followers of Alexander and Seleucus, and established in Egypt under the Ptolemies. After the battle of Actium, Egypt became a Roman province, and both the cotton fields and cotton mills of that country fell into the hands of Roman capitalists. The earlier Roman name for cotton was probably *byssus*, because its fabrics resembled linen ones, just as in England it is still called "cotton-wool," because the staple looks like bleached wool. The later Roman name was *gossypion*. *Xylon* rather meant the cotton-tree; though it was sometimes used to mean the staple. It is well known, of course, that cotton-fabrics have been found in Egyptian graves older than the Ptolemaic period; but this does not prove that they were made in Egypt, any more than a silk fabric found in an American grave of the present day would prove it to be American, the probability, amounting almost to certainty, being that it was manufactured in Europe or Asia. Cotton fabrics, however, do not appear to have become popular in Italy. The finer cotton tissues still came from India, and were very expensive; while the coarser ones were hardly so well suited to the Roman climate as linens. Before the Egyptian cotton manufacture became sufficiently improved in quality and cheapened in price to command the Italian market, it fell into the hands of the Arabians, and Rome lost the control of what was destined to become the greatest of the textile industries.

Silk, though it had been imported from the Orient for many centuries, and cultivated to a small extent in some of the Greek islands, was nevertheless so scarce during the Augustan period as to command its weight in gold. The common name for it was *serica*, or *vestis serica*, sometimes *bombycina*, from *bombyx*, the silk-worm. The Roman ladies wore a broad ribbon around the waist called *strophium*, which served for the modern bodice, or stays. This ribbon or sash was made of silk. Soft clinging stuffs of silk for the *stola* were next worn; and finally the *palla* came to be made of the same expensive material. Its use was forbidden to men. Elagabalus is said to have been the first male Roman who wore a robe of pure silk; and Aurelian to have refused the empress, his wife, a garment of this fabric, on account of its exorbitant price. Yet in Pliny's time, which was much earlier, the importation of Indian silks, to be unraveled by Roman girls in order to work up the threads with woolen yarns and so make from them new and less expensive fabrics, appears to have become an important industry; from which it would seem that stories about the parsimony of distinguished people are not always to be relied upon for historical accuracy.

Hemp is an East Indian plant which was brought into Europe probably during the first Buddhic period. Herodotus mentions a species so closely resembling flax that the Thracian women made fabrics from it which could hardly be distinguished from linen. The best hemp known to the Romans was grown at Alabanda, on the banks of the Meander, and the next best at Mylasa, near the Gulf of Jasus, both of these places being in Asia Minor. In Italy it was chiefly cultivated in the territory of the Sabines, a very ancient people. Hemp was at first employed for the ropes and rigging of ships. Moschion, about 200 B. C., records the use of hempen ropes for rigging the ship "Syracusia," built for Hiero II. some fifty years previously. Twine, hunting nets, and finally coarse fabrics, for household use, were successively made of it. The various machines and devices for retting, heckling, combing, spinning, and weaving this staple were applied to flax when that textile came to be manufactured in Rome.

Human hair was also employed as the basis of several Roman industries, chiefly by wig-makers and jewelers. A Roman matron's wig, of a beautiful brown color, full, rich, glossy, and ending in a heavily plaited chignon, is preserved among the curiosities of the York Museum. Although 1,800 years old, it can scarcely be distinguished from a modern peruke of the most fashionable design.

The grass fibers employed by the Roman weavers, such as esparto, corn-husks, and straw, the latter for ladies' hats, were as numerous as they are at the present day. Many of them were also used for stuffing mattresses and upholstering furniture—for example, corn-husks, wool-flocks, and grasses of various sorts.

Asbestos, like many other substances which formed the bases of Roman industries, was originally obtained from India, but afterward from Arcadia. The Greeks gave it the name of *asbestinon*, which means inextinguishable; while the Romans called it *vivum*, or live (linen). They made table-napkins of it, which could be cleansed during the meal, by throwing them for a minute or so into the fire. Shrouds for the dead were also made of this substance, though it was so excessively dear that only the wealthiest people could afford to purchase it. In the year 1702 there was dug up near the Nævian Gate at Rome a funeral urn, in which human remains of the classical period were found wrapped in asbestos cloth, many yards in length. This interesting example of Roman textile art is still preserved in the Museum of the Vatican.

SCIENCE NOTES.

That common simile in which the various divisions of science are represented as branches of the tree of knowledge, is a grotesque survival of a time when neither trees nor science were understood. No simile is perfect or even approximately correct, but one better than the tree and its branches for the origin and relationships of any inductive science is that of a river, rising from various and often obscure sources, growing in size and importance as it proceeds both from the springs within its own bed and by the entrance and contributions of tributary streams, and finally pouring its substance into the mighty ocean of accumulated human knowledge.

Some of the arts are nearer to the welfare of man than others, and the same is true of the sciences. Two arts, however, lie very near human welfare, and if we were called upon to give up all of the arts but two there would be little difference in choice as to which two should be preserved. The one most important would be the art of agriculture and the next the art of healing. Man first of all must be nourished, and next to this, kept in health. We might look forward to a time when lawyers would disappear. We might even grow so perfect as to be able to do without ministers of the gospel. Even the histrionic art might be abandoned, and yet mankind be reasonably happy. But strike down agriculture and you strike a blow which is fatal; banish the healing art and you leave man to the ravages of disease.

Enormous as is the annual loss which may now be fairly charged to insects, it would undoubtedly be vastly greater if such pests were left absolutely unchecked and no efforts were made to limit their operations. Were it not for the methods of controlling insect pests, resulting from the studies of the Bureau of Entomology and of the official entomologists of the various States, and the practice of these measures by progressive farmers and fruit-growers, the losses from insects would be greatly increased. Familiar illustrations of savings from insect losses will occur to anyone familiar with the work in economic or applied entomology in this country. The cotton worm, before it was studied and the method of controlling it by the use of arsenicals was made common knowledge, levied in bad years a tax of $30,000,000 on the cotton crop. The prevention of loss from the Hessian fly, due to the knowledge of proper seasons for planting wheat, and other direct and cultural methods, results in the saving of wheat to the farm value of from $100,000,000 to $200,000,000 annually. Careful statistics show that the damage from the codling moth to the apple is limited two-thirds by the adoption of the arsenical sprays, banding, and other methods of control, representing a saving of from $15,000,000 to $20,000,000 in the value of this fruit product alone. The existence and progress of the citrus industry of California were made possible by the introduction from Australia of a natural enemy of the white scale, an insect pest which was rapidly destroying the orange and lemon orchards, this introduction representing a saving to the people of that State of many million dollars every year. The rotation of corn with oats or other crops saves the corn crop from the attacks of the root worm to the extent of perhaps $100,000,000 annually in the chief corn-producing regions of the Mississippi Valley. The cultural system of controlling the boll weevil is already saving the farmers of Texas many millions of dollars, and, in fact, making the continuance of cotton growing possible; and scores of similar illustrations could be cited.

THE SMALLEST WORKING MODEL OF A TRIPLE-EXPANSION ENGINE.

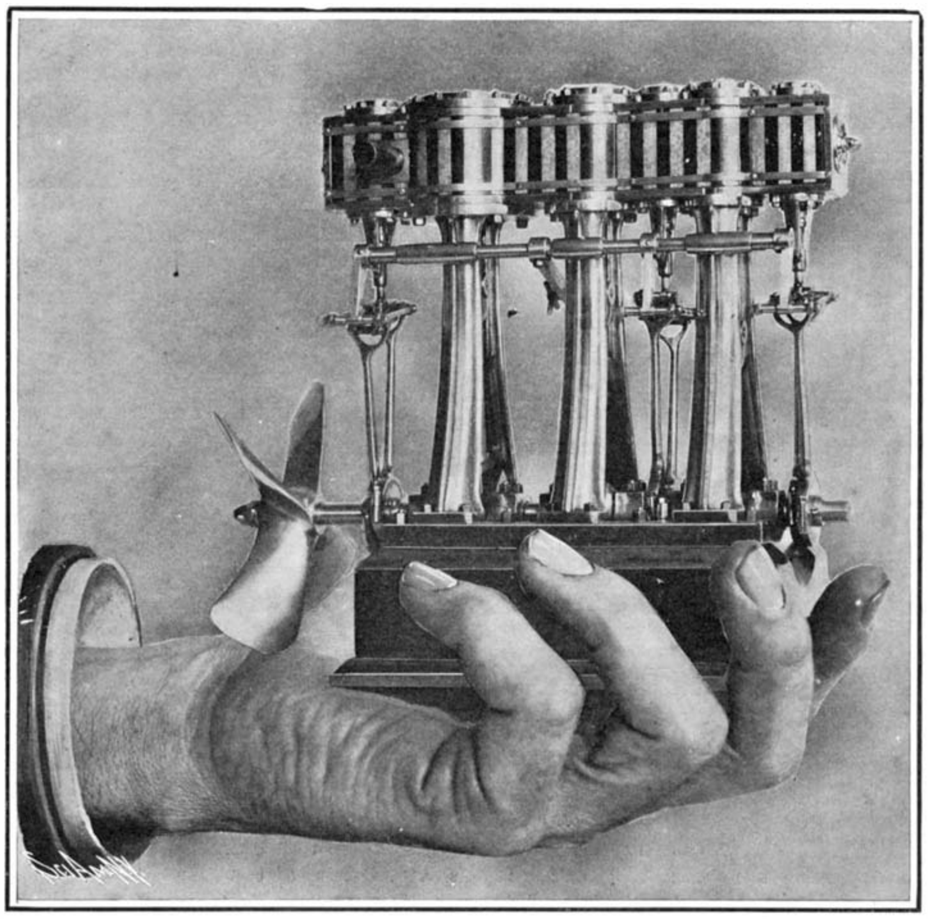
The model of the engine illustrated in the accompanying engraving is, perhaps, the finest piece of skilled work of its kind that has ever been brought to our attention. The little engine, which is of the marine triple-expansion type, was built by Mr. Robert Bunge, of New York city, an expert on machinery, who has made the construction of miniature machines his pastime.

The engine here shown measures 3½ inches across the bedplate, and stands 3¼ inches from the bottom of the bedplate to the top of the cylinder covers. Every part is perfect. It is even equipped with the link reversing motion. With a steam pressure of 100 pounds, 7,260 revolutions per minute are made, turning a screw 2½ inches in diameter by 7 inches pitch.

The high-pressure cylinder is 5-16 of an inch in diameter, the intermediate cylinder 8-16, and the low-pressure cylinder 10-16 of an inch. Something of the wonderful refinement and precision with which this model has been made may be gathered from the fact that the valves are of the regular piston type for all cylinders, and measure five, seven, and nine thirty-seconds of an inch in diameter. The shaft, the cranks, and crank-pins are all turned from one piece of steel, which in itself is a rather neat piece of work.

The eccentrics are split, and are exact miniature duplicates of those used on engines actually in service. The smallness of the studs and nuts used to hold down the cylinder covers is almost incredible. The nuts used in the construction of the model are for the most part a fraction less than 1-16 of an inch in diameter; and yet each is perfectly hexagonal in shape. The studs are a little less than 1-32 of an inch in diameter, and are threaded at both ends, one end screwing into the machine, and the other receiving the nuts.

The crossheads are made of steel, and are fitted with brass shoes that can be taken up whenever wear occurs. The steam pipe is 1-8 of an inch in diameter, and the exhaust is 3-16 of an inch in diameter. The maker may well claim for this model that it is the smallest triple-expansion engine in the world. To appreciate its diminutive perfection at its true worth, it must be seen in actual operation.



THE SMALLEST WORKING MODEL OF A TRIPLE-EXPANSION ENGINE.

An accompaniment of the introduction on shipboard of surface condensation, which was at first supposed to be a result of it, but which as a matter of fact was not, was a tremendous increase in the corrosion of the boilers and a shortening of their life. This was especially noticeable in the tubes which, as the thinnest part of the boilers, give out first. All sorts of theories were advanced to account for it, some of which we can now see to have been utterly ridiculous. Probably one of the most fanciful was that which regarded the boiler and condenser as forming a gigantic galvanic battery, the copper condenser tubes forming one pole, and the boiler the other. The real facts were developed as a result of the investigation by the Admiralty Committee on boilers in the 70's, which showed that boiler corrosion was simply rusting and had been due to gross but unintentional neglect. It had been a very common practice, particularly in naval boilers, when they were not in use, to blow out the water and take off the manhole plates "to let them air." It was this "airing" which caused the corrosion. Now when boilers are laid up, they are filled with water which is made slightly alkaline, and this effectually prevents corrosion.

A LIGHTHOUSE OF REINFORCED CONCRETE.

BY EMILE GUARINI.

A lighthouse of reinforced concrete has recently been constructed at the mouth of the Boug, a river flowing into the Black Sea. It is situated 115 feet from the river shore and serves, with an existing but lower lighthouse, to guide vessels in the direction of the maritime canal excavated in the river and connecting with the sea the city of Nikolaew, which is situated about 100 versts from the mouth of the Boug. The construction of the lighthouse of reinforced concrete was decided upon after a comparative study of other projects, some calling for the use of bricks and others of iron. Reinforced concrete was found to give a saving of about 40 per cent with an equal stability.

The system consists of a tower of which the walls are from 5 to 10 inches in thickness and are constructed upon a foundation, likewise of reinforced concrete, and imbedded in the sandy soil to the depth of 10 feet.

The stability is assured by the weight of the sand resting upon the foundation. The maximum of pressure upon the ground is about 7 pounds to the square inch. The coefficient of stability at the level of the ground is 4.

The frame is formed of round iron bars of 1¼-inch diameter. The calculation is so made that it shall be able, without the concrete, to resist a wind pressure of 55 pounds to the square foot. The height up to the lantern is 110 feet.

The diameter of the tower is 21 feet at the base and 6½ at the lantern.

The lantern is divided into two parts, one of which serves as the dwelling of the keeper, while the other is arranged for the lighting apparatus.

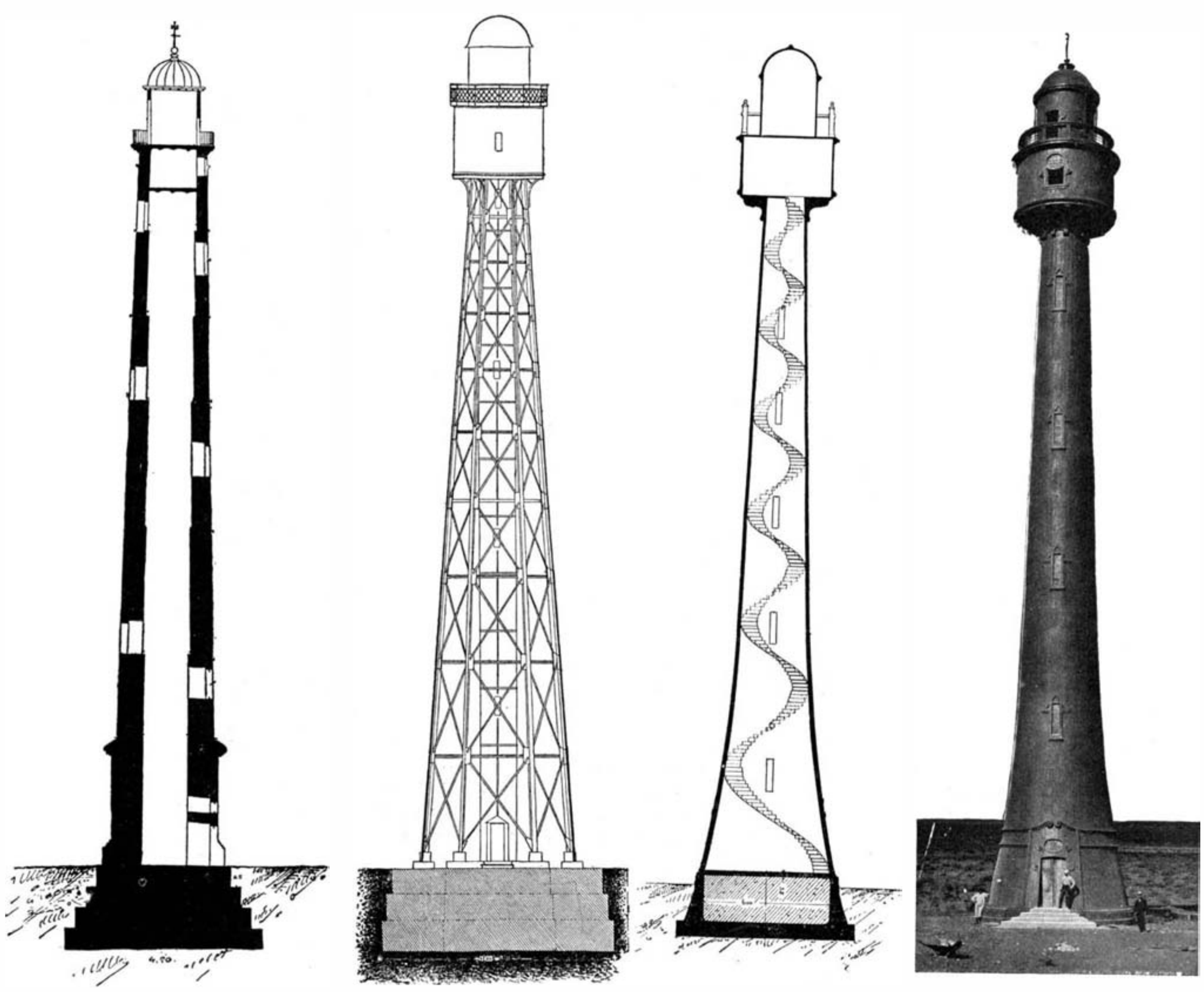
For the concreting there was constructed an external wooden wall having exactly the form of the tower. The concreting was done from the interior. The concrete was formed of sea gravel, coarse sand, and Portland cement in the proportion of 1:2:4.

The concreting was done in winter, in the space of two weeks, with the aid of heat in the interior. The external woodwork required two months for its construction.

The external woodwork was removed in the spring of 1904, and, up to the present, although the tower has been submitted to the action of very high winds, no evidence of strain has been detected.

The cost of the structure, exclusive of the lighting apparatus, was about $6,000.

The project, the calculations, and the execution are due to M. N. Piatnitsky, engineer of ways of communication, and the architecture is the work of M. A. Bauchnikow, likewise engineer of ways of communication.



Brick Lighthouse. Iron Lighthouse. Concrete Lighthouse. Armored Concrete Lighthouse.

A COMPARISON OF THE CONSTRUCTION OF SEVERAL TYPES OF LIGHTHOUSES.

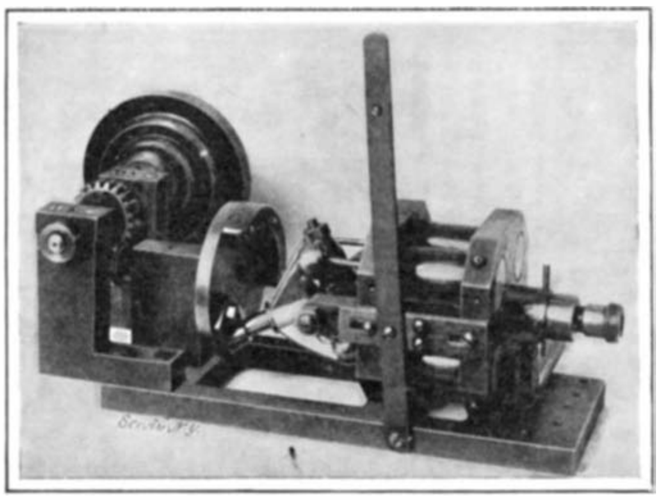
Report on the Sleeping Sickness.

A valuable report concerning the dreaded "sleeping sickness," which infests the East Africa Protectorate, has been prepared by Dr. C. A. Wiggins, principal medical officer at Nairobi. The disease, he finds, is propagated by the tsetse fly; this insect is found in trees or bushes near the lake coast line. The difficulties and dangers of poisoning by this pest during a journey in these parts are exemplified in Dr. Wiggins's account of the passage of the Yala swamp. This is an extensive expanse of huge masses of papyrus, or large tracts of black mud, with stagnant, ill-smelling water, both reaching to the waist. Papyrus, it was observed, does not shelter the flies. In Mageta Island an epidemic had raged, and out of 500 inhabitants not one survived, and the place is now deserted.

A NOVEL GYRATING STEAM ENGINE.

A new form of steam engine, with which a constant thrust is obtained on the driven shaft, is shown in the accompanying illustration. The engine is the invention of Mr. Frederick Egge, of Bridgeport, Conn., and it will be found particularly useful for any service where a powerful, compact, and light-weight engine that can be instantly reversed is desired, such as for hoisting work and for automobiles. As can be seen in the illustration, the engine consists of four horizontal cylinders placed symmetrically around a central tube containing, near its right-hand end, ports opening into the cylinders (one port for each). The piston-rods are fitted with ball and socket joints at both ends. Their outer ends are connected to a sort of spider set at an angle with the transversely-placed disk on which it is mounted. The thrust of the piston rods on the arms of this spider tends to push it off the periphery of the disk, but as the spider is firmly secured to the disk, this is revolved instead, and the spider goes through a gyrating motion as it is successively driven by each of the four pistons. The spider is mounted on and pinned to a short rod having a bearing at its upper end near the periphery of the disk and at its lower end in a block on the extremity of a small central shaft that actuates the rotary valve for supplying live steam to and carrying off the exhaust steam from all four cylinders. The gyrating movement of the spider causes this rod (which has a universal joint near its lower end) to make one turn to every revolution of the disk, and thus the valve also is driven at the same speed as the disk. The valve consists of a sleeve having two sets of ports—one set for running in either direction—as well as a suitable exhaust port. The lever on the side of the engine slides the valve laterally, and instantly reverses the engine. This feature is the result of the constant thrust at an angle of 30 deg. obtained from one or another of the four pistons.

The photograph which we reproduce is that of a working model designed to show the use of the motor as a hoisting engine. It could also be applied to an automobile by direct attachment to the rear axle with a bevel or spur gear drive. An engine of this type can be built of very light weight, and so should be useful in all cases where a portable motor is needed.



A NOVEL GYRATING STEAM ENGINE.

THE NEW BRITISH YARD STANDARD.

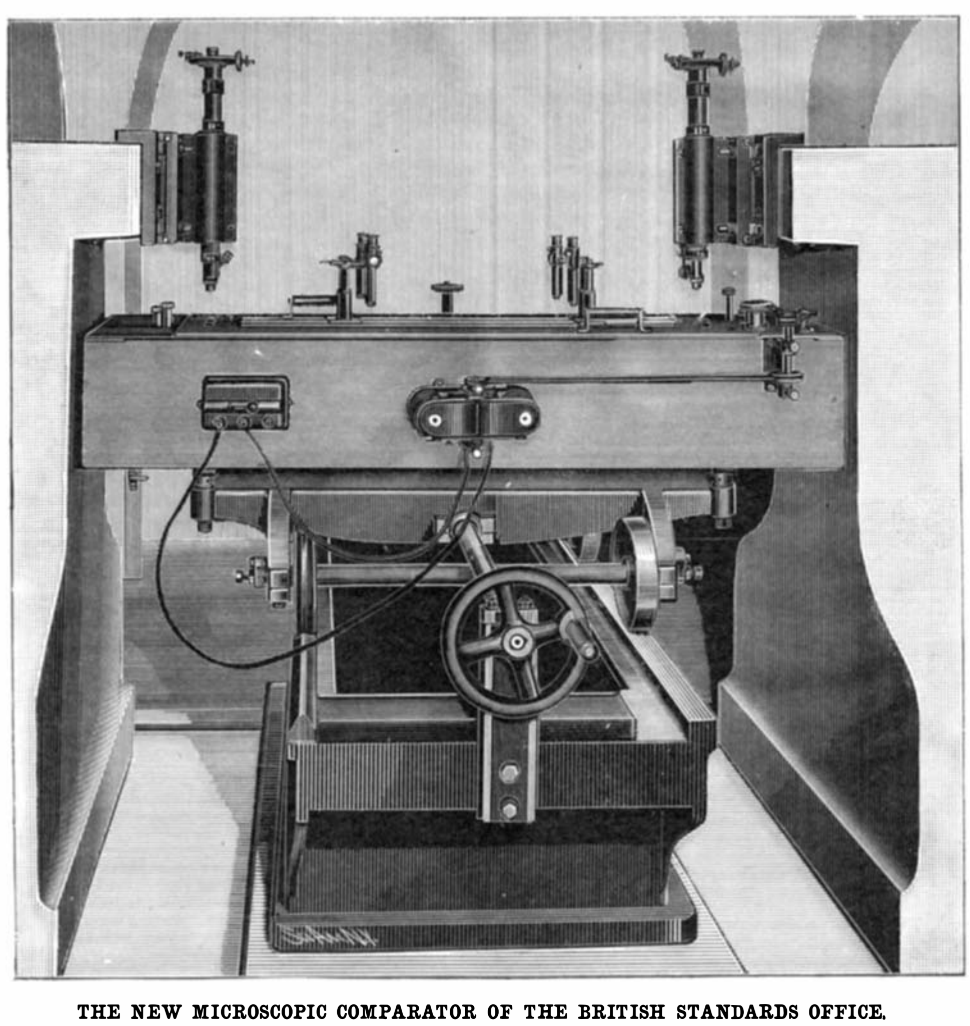
BY HERBERT T. WADE.

During the past year the Standards Department of the British Board of Trade has been engaged in studying and verifying a new yard standard, in which have been incorporated all the refinements made possible by the modern science of metrology. The present imperial standard or legal yard of Great Britain is a bronze or gun-metal bar of rectangular section legalized by Act of Parliament in 1855. The true or legal yard is taken as the distance at 62 deg. F. between two fine lines on the surfaces of two gold plugs that are sunk in wells or holes near the ends so that their surfaces lie in the median or neutral plane of the bar where any effects of flexure are reduced to a minimum. A number of copies of this standard bar were made when it was constructed and one of them, No. 11, was given to the United States government, and is now in the fire-proof vault of the National Bureau of Standards at Washington. It has twice been taken to England for comparison with the British standards, and for many years served as a standard of length for the United States. A study of the various bronze standards, however, showed that they were not absolutely invariable and that their length was likely to be altered some minute but appreciable amount by molecular and other changes taking place in the alloy of which they were formed. In fact, the unsuitableness of bronze for a prototype standard was recognized at the time when the construction of an international standard meter was proposed in 1872, and the commission determined on an alloy of platinum and iridium, not only for the international prototype, but also for the various national standards which were to be similar in size, form and composition. In making these standards, it was necessary to use a material that resembled as closely as possible the original platinum meter of the Archives, but also its composition should be such that it would be free from oxidation and possess as well the requisite strength, elasticity, and other mechanical characteristics. These meter bars when completed represented the most careful and accurate workmanship, so that when the two standards allotted to the United States were received by the government, it was only a brief space of time before they were adopted by executive order as the national fundamental standards of length, from which the yard or common unit was to be derived by using the ratio 3600/3937 specified in the Act of July 28, 1866. Thus the British bronze standard yard was displaced as a standard of length in the United States by the platinum-iridium meter of the International Commission, despite the fact that Anglo-Saxon weights and measures were and are universally employed.

Convinced a few years ago of the necessity of constructing a new copy of the imperial standard yard, the Standards Department of the Board of Trade, under the direction of Mr. H. J. Chaney, superintendent, decided to employ such a material as would best answer the requirement of resistance to oxidation, hardness, density, permanence, elasticity, etc., and select such a form as should be considered best in the light of actual experience with standards of length and the developments of metrological science. These matters had been most thoroughly discussed and investigated at the time of the construction of the international metric standards, when it was realized that such materials as gold, platinum, iron, or even rock-crystal, for various reasons, were quite unsuitable. Accordingly, it was determined to employ an alloy of 90 per cent platinum with 10 per cent iridium. This was possible by the adoption of a peculiar cross section of X shape devised by M. Tresca, of the French committee, whereby sufficient strength and rigidity were obtained without the employment of an undue amount of metal such as would render the cost prohibitive or the bar of unwieldy mass. Furthermore, the platinum-iridium alloy expands but little with an increase in temperature, while its surface can be given a high polish so that the lines marking the standard distance could be engraved directly on its surface. These international standards had not only proved eminently satisfactory in their use at the Bureau of Weights and Measures and in the various national laboratories, but no essential improvements could be suggested, so that the British metrologists concluded that they could do no better than to copy the composition and their form in constructing their new standard yard. Thus they would have a standard whose constants would be known not only independently, but also in terms of the International Prototype Meter. Fortunately, they were able to obtain one of a series of bars made from an ingot of the specified alloy which was cast at the Conservatoire des Arts et Métiers at Paris for the use of the Bureau International des Poids et Mesures. In 1902 this bar was polished and adjusted at the laboratory of the Société Genevoise pour la Construction d'Instruments de Physique at Geneva, and was then sent to the International Bureau of Weights and Measures at Sevres, near Paris, where a meter and a yard were traced on the bar by M. J. Rene Benoit, the director. This was accomplished with the dividing engine of the bureau, and the same general means and methods were employed as were used when the standard meter bars were constructed and graduated. The construction and form of the new standard will be apparent on reference to the accompanying illustration, which shows clearly the X or Tresca section. The rigidity of the bar is manifest from its design, while provision is made whereby the neutral or median plane coincides with the upper surface of central portion or cross bar on which the lines are traced, reducing to a minimum any effects of flexure caused by inequalities of the supports. On this surface parallel with the axis of the bar are traced two fine lines, 0.2 millimeter distant from each other, and across these is another fine line which marks one extremity of the standard length, the latter being measured between two such lines, points being taken which are included between the longitudinal lines, the general appearance when seen under the microscope being as shown in the accompanying engraving. In the new British standard one such transverse line marks the beginning for both the meter and the yard, while at the opposite end of the bar there are similar sets of lines to indicate the limits of each. In short, the new standard is practically a standard meter with a yard marked on it, and thus the British Standards Office now has on a single bar a determination of the value of both of these fundamental units of length as given by the officials of the International Bureau in terms of the international standards, and also, after the conclusion of the present investigation of the bar, its value in terms of the Imperial Standard, which doubtless will be legalized in some form or other. According to the officials of the bureau the new British standard when referred to the International Prototype Meter at 0 degree Centigrade is too long by 2.9 microns or 29 parts in ten million, while the yard marked when referred to the yard standards and equivalents of the Bureau was too long by 0.000226 inch when reduced to 62 deg. F., the British standard temperature. After its determination and study at the Bureau, the new bar was then carried to London, where it has been the subject of a most careful investigation by the officials of the Standards De-

British Iridio-Platinum Yard Standard Showing Cross-Section. The Bar is in the Position it Occupies in the Comparator.

The Standard Turned on Its Side and Showing the Two Defining Lines (Magnified) on the Neutral Surface of the Bar.



THE NEW MICROSCOPIC COMPARATOR OF THE BRITISH STANDARDS OFFICE.

partment, having been compared directly with the national or Imperial Standard in an elaborate series of experiments. The result of the preliminary observations when computed and reduced was that the platinum-iridium standard was too long by 0.000227 inch, but the investigation has not as yet been concluded and this value may be changed. The research, however, brought out many interesting points about the British standards of length and their degree of accuracy. The Imperial Standard yard is legally defined to have its true length when measured at the temperature of Fahrenheit's thermometer, but there was and is no legal standard of the Fahrenheit thermometer, and the original temperature measurements employed in determining the bar were made with mercurial thermometers which vary 0.3 deg. Fahrenheit plus and minus. As the length of any solid such as a bar is continually varying with changes in temperature, it is of course impossible to determine linear values with precision unless the temperature is known with a degree of accuracy corresponding to the other measurements. Consequently, the British observers were forced to follow the example of the International Bureau and modern physicists generally reduce all their readings to the scale of the gas thermometer containing hydrogen. This also involved a careful study of the thermometers, new and old, so that in the present determinations the temperature effects could be considered and corrected for with the greatest possible precision. The comparisons were made at the Standards Office, Old Palace Yard, Westminster, and the old Sheepshanks comparator used when the Imperial Standard was constructed was employed in some of the comparisons, as well as a Troughton and Simms comparator which was built in 1870. But these instruments were considered to be somewhat below the standard demanded by modern metrological science, so accordingly a new comparator was built capable of the greatest accuracy and embodying all refinements that scientific thought could suggest and precise workmanship execute. As the object of a comparator is to determine as accurately as possible the difference in the length of two or more standards, its essential characteristics are two micrometer microscopes mounted on heavy masonry pillars, so as to be free from all vibration, and some suitable mechanical device to permit the scales to be placed successively below the microscopes in the same position. The distance between the two microscopes remains constant during the comparison, and the bars to be compared are placed below them, so that the cross-wires of the microscopes can bisect the fine lines of one of the standards. Then when this standard is replaced by the other under exactly similar conditions, by means of the micrometers the cross-wires can be brought to bisect its lines, and the difference in length be determined. Of course, means must be provided for carrying and moving the standards, for regulating the temperature and keeping it uniform, illuminating the surfaces of the bars, avoiding vibration and other disturbances, and providing for many other conditions demanded in exact measurement. The construction and action of a modern comparator can best be appreciated by reference to the illustration, which shows the new instrument of the British Standards Office, which is essentially the same as the comparator of the Bureau International, and involves the most improved devices. It is mounted on a deep foundation of concrete, which rests on rubble over sand. On the concrete are placed three slate slabs, two of which carry massive blocks of Yorkshire stone, forming the two pedestals for the microscopes, while the third or center slab carries the heavy cast-iron frame on which are the rails for the carriage carrying the scales. To prevent any movements of the observers being communicated to the apparatus, there is an air space surrounding the foundation to a depth of five feet. On the tops of the stone pedestals are bolted heavy cast-iron supports or brackets for the microscopes, whose objectives are about 95 millimeters above the bars. The latter are carried in a trough on a carriage capable of a transverse movement beneath the microscopes, and also so arranged that the height of the bars can be adjusted by micrometer screws which raise or lower the trough. The latter is double-walled, and water kept in circulation by an electrically-driven agitator flows in the intervening space, and causes a constant temperature to be maintained. The bars themselves rest on rollers in the trough, so that they are free to expand or contract with any change in temperature. The micrometers are of the ordinary type, where a system of cross-wires arranged in the focal plane of the objective can be moved by means of an accurately cut screw with a divided head moving in a nut. By means of a linear scale placed in the field of the microscope, the value of the space traversed by the cross-wires during one revolution of the screw is ascertained, and fractions of a revolution can be determined from the graduated head and its vernier. The illumination of the surface of the bars is also important, and the method adopted is to send light from a small incandescent lamp into the microscope tube, and by means of a thin polished plate of glass inclined at an angle of 45 degrees reflect it onto the lines of the bar. With this new instrument it is believed that the highest accuracy can be secured, and that the British Imperial yard can be defined in a more satisfactory manner, as well as be represented by a more permanent and accurate standard.

THE MAMMOTH CUNARD LINERS.

It is many years since there was the same amount of interest attached to the building of a new liner for transatlantic service as is shown in the two turbine-driven Cunarders which are now under construction, one at Swan & Hunter's yard on the Tyne, and the other at the John Brown Company's works, Clydesdale.

This interest is due to the extreme size, the high speed aimed at, and the novel character of the motive power. To find a parallel to the interest in these vessels we have to go back to the year 1889, when the Inman and International Company brought out the first twin-screw ships to be seen in the Atlantic service, the "City of New York" and "City of Paris." Furthermore, it is realized by the general public that these new Cunarders represent the determination of Great Britain to win back the Atlantic record, which was lost several years ago to the "Kaiser Wilhelm der Grosse," and which has subsequently been easily retained by those other fine German ships, the "Deutschland" and the "Kaiser Wilhelm II."

It is known that the new Cunarders are to be the largest ships ever built; but it is not generally realized how very much larger these ships are to be than any of the huge liners which now excite our wonder by their great proportions. The increased dimensions are shown in the accompanying table, which includes the largest of the ocean liners that have been built of late years; and on comparing the Cunarders with the largest of the existing fast passenger ships, the "Kaiser Wilhelm II.," we find that she is longer by 94 feet than that vessel; that she has 7½ feet more molded depth; that she has 16 feet more beam; that her designed horse-power is nearly twice as great; that her displacement is 13,000 tons more; and her sea speed will be 1½ knots greater. Furthermore, in view of the fact that turbine engines invariably develop a horse-power greatly in excess of the contract, it is possible that on her trial she may make 26 knots an hour, or 2½ knots more than the record speed of the "Kaiser Wilhelm II."

THE BIG STEAMSHIPS OF THE WORLD.

	Length over all in feet	Beam, feet.	Depth, feet.	Displacement.	Horse-Power.	Speed.
Great Eastern	692	83	57½	27,000	8,000	14.25
Lucania	625	65	42	19,000	30,000	22.01
Oceanic	704	68	49	28,500	28,000	19.50
Deutschland	686	67	42	23,000	37,500	23.5
Baltic	725	75	49	40,000	18,000	16.25
Kaiser Wilhelm II.	706	72	52½	30,000	40,000	23.5
Turbine Cunarders	800	88	60	43,000	75,000	25

It was not the original intention to make these vessels of such extreme proportions. They grew to the dimensions ultimately adopted, as the result of the elaborate studies that were made, both at the towing tank and at the designing board. The first tentative plan called for a vessel 700 feet in length. This grew to 720 feet, and finally to the present overall length of 800 feet. The beam is 88 feet measured over the skin plating, or 87 feet 6 inches to the outside of the frames; the plating, by the way, being 1½ inches in thickness, which, on the lap, will bring it to a total thickness of 3 inches on each side. The plated depth is 60 feet, which may be compared with the 42 and 49 feet molded depth of such ships as the "Deutschland" and "Oceanic," the plating being, in this vessel, carried up one deck higher. This increase is rendered necessary by considerations of the longitudinal girder strength of the ship as a whole, and is one of the means by which the necessary shearing strength is obtained. The extreme draft is 36 feet; but this, of course, can only be availed of when the new Ambrose Channel into New York harbor shall have been fully dredged out. The government has promised sufficient depth in this channel, by the time the Cunarders are ready, to enable them to come and go, drawing 33½ feet of water. On the latter draft they will displace a little over 40,000 tons, and on the full draft of 36 feet they will displace about 43,000 tons. Of the dimensions given above, the beam is the most striking, and these ships are the first to exceed in beam that accepted standard of measurement for modern steamships, the "Great Eastern."

The drawing on our front page contains the first authentic information regarding their interior structure. The double bottom, which is the most important structural element in the hull, will be 5 feet 6 inches in depth between the outer and inner shells. There will be a dead rise of 18 inches from the keel to the bilge, and the frames will decrease from 5 feet 6 inches at the keel to about 4 feet in depth where the curve of the bilge straightens into the sides. There will be about twenty longitudinal frames consisting of heavy built-up I-beam sections, extending, some of them, the full length of the ship. Our sectional view is taken at about the midship section, and it passes through one of the boiler compartments. The great width of the ship enables the Scotch boilers, which will be of the largest size, to be placed four abreast, and still leave room for large coal bunkers in the wings. There are eight decks in all. First, the Orlop deck, just above the boiler rooms, on which, in this particular part of the ship, there will be space for carrying the regular ship's stores; the deck above, known as the Lower deck, will be devoted largely to third-class passengers. A feature that will add considerably to the comfort of these passengers will be the subdivision of the space into separate staterooms. The waterline will be at the level of this deck, which will be lighted with portholes, and thus provide a large number of outside staterooms for the third-class passengers. The Main deck will be given up to first-class staterooms. The Upper deck, also, will be devoted to first-class accommodation, and on this deck will be the great dining saloon, which will extend the full width of the ship, providing a single room over 80 feet in width by 125 or more feet in length, and capable of seating over 500 people. In the center will be a large overhead well, which will extend through two decks and be crowned with a dome of cathedral glass. The fifth, or Shelter deck, completes the molded portion of the vessel, and is 60 feet above the keel. The three decks above this, known as the Bridge deck, Promenade deck, and Boat deck, are devoted to first-class passenger accommodation, and they have, on each side of the central tiers of staterooms, a broad promenade open to the weather.

How greatly these ships will exceed all others in the nature of the passenger accommodations is shown by the fact that the first-class staterooms are to be 50 per cent larger than the customary size. The total height of the ship, from the keel to the boat deck, is about 90 feet, or the height of say an eight-story building. In the presence of such dimensions, the problem of what might be called "vertical travel" becomes a serious one. On shore we have overcome it by the adoption of the elevator; and with the growth in size and steadiness of the giant passenger ships, the time has now come when the passenger elevator can be applied with perfect safety to these floating hotels. The Cunard Company was the first to incorporate the elevator in the plans for its new ships; and it may interest the readers of the SCIENTIFIC AMERICAN to know that the first practical suggestion of the use of the marine elevator was made in 1902 by a member of the staff of our paper to Mr. Vernon H. Brown, the general manager of the company in America, who thought so well of it, that he forwarded the suggestion to the Liverpool office with his approval of it as a practical improvement. The suggestion was adopted, and at once incorporated in the plans of the ship. There can be no question of the great convenience that will be afforded by a passenger elevator on board large steamships, and it is pretty certain to be generally adopted.

The motive power will consist of four turbines, each of a designed indicated horse-power of 18,000, which latter, by the way, is about the total horse-power of the "City of Paris" and the "City of New York," above referred to. All four turbines will be placed upon the same platform; but while the propellers of the inside pair will be located just forward of the rudder in the usual position, the propellers of the outside pair of turbines will be located forward of the inner pair, the great beam of the ship admitting of this arrangement. Although the contract horse-power is about 71,000, the boiler power is sufficient for 75,000 horse-power, and 75,000 horse-power with reciprocating engines would, according to the tank test, give a speed of 25 knots an hour. Mr. Hunter, of the firm of Swan & Hunter, where one of these ships is being built, has supplemented the tests of the tank models, constructed on a quarter-inch scale, by building a working model on a ¾-inch scale, which is 50 feet in length. He has equipped this model with turbines and four propellers, and has been making a large number of tests with propellers of every conceivable practicable type. The results of these experiments, of course, are not available outside the company, but it is sufficient to say that they are very promising for the complete success of the great ships themselves. As regards the speed of the vessels, they must show an average of 24½ knots an hour on actual voyages. Judging from the way in which the steam turbines in the British cruiser "Amethyst" ran ahead of the anticipated results, we shall not be surprised to see these vessels exceed an average speed of 25 miles an hour from port to port under favorable conditions.

Correspondence.

The Lunar Rainbow.

To the Editor of the SCIENTIFIC AMERICAN:

The article in your issue of July 8, 1905, "A Lunar Rainbow," calls to my mind a similar phenomenon witnessed by the writer several years ago, only this was on a perfectly cloudless night. It occurred about 9 o'clock P. M. I was coming over a hill, to the west of which was a deep valley. A thick bank of fog lay over the valley, and as I descended into the valley I saw the bow perfectly defined. The colors were very faint, but the whole arch was perfect. How long it was visible I could not say. W. W. RANDALL.

Sea View, Mass., July 12, 1905.

The Reasoning Powers of Animals.

To the Editor of the SCIENTIFIC AMERICAN:

I have with much interest noted the discussions in your columns as to whether animals can reason. Two letters to this effect, published June 3 and July 1, apparently attempt to establish an affirmative theory that animals actually do reason, giving as they do the story of the cat which has learned to open a door by its latch and even knob. Let me say in the name of psychology that these cats did in no way show reasoning power, but on the contrary it was an act of dumb imitation, prompted by dire necessity on the part of the animals to get inside or outside, and indeed they had ample opportunity to learn under the circumstances.

While I do not discredit the reasoning power of elephants or beavers, however limited it may be, it does not demand expert observation to decide positively that at least animals of the feline genus and some other carnivorous ones, as for instance the bear, are wholly destitute of reason. Why? In Central Park the reason is engraved in not only hard cement, but also in the nose of a cinnamon bear. This animal is fenced in, but he can easily see freedom outside, and he has long ago made up his mind to secure his freedom by walking outside of this cruel inclosure. Seeing that the broad side of the fence would bar him, the bear made for the front corner; but seeing this corner impregnable, he naturally turned toward the other unexplored corner quite undaunted. Of course, he is again disappointed, but since the first disappointment was forgotten by the shock of the second, he hopefully again returns to the said first corner, and so on, hour after hour, days, weeks, and year after year. Lions, tigers, leopards, etc., do exactly as does this bear; but I will say of this particular bear, that although he has worn deep holes in the cement floor in both corners of alternate hope and despair, his nose has become worn by his systematic swing of the head in spurning these really hopeless corners of escape. There is as yet no clear impression on the mind of this bear that his long search for freedom is really hopeless. But this undaunted bear can be convinced, as by cutting off his view of freedom without, and it would also teach us a lesson—that the difference between simple intuition and reasoning is enormously great.

What little reason exists in animals is so feeble, that the slightest intuitive activity on their part will easily hypnotize their reasoning powers. Imitation, as proved by the monkey or the parrot, and still more so by small children—just because they have a larger brain area—may become so extensive that almost all the product of reasoning minds may be faithfully memorized and imitated, although the minds engaged never themselves ever reason except to a negligible degree. ALBERT F. SHORE,

Member Am. Assoc. for Advancement of Science.

Brooklyn, July 7, 1905.

The Current Supplement.

Carl Lautenschlaeger's article on Theatrical Engineering, Past and Present, is concluded in the current SUPPLEMENT, No. 1542. Dr. A. P. Coleman writes on "Theories of World Building." Lord Blythswood's liquid-air plant for experiments at low temperatures is very fully discussed by the English correspondent of the SCIENTIFIC AMERICAN. The Berlin correspondent of the SCIENTIFIC AMERICAN writes on an electrical long-distance water-level indicator which has been used with success in Austria. A very excellent *résumé* of agricultural electro-chemistry is presented. The action of metals in the colloidal state on the evolution of infectious diseases is made the subject of a well-written article. An interesting lecture was recently delivered before the Cleveland Institution of Engineering (England) by Mr. Robert Whipple, in which various forms of thermometers and pyrometers, with some of their industrial applications, were described. Mr. Whipple's paper is published in full. Saghalien, the island which has just been captured by the Japanese, is fully described. Clive Holland writes on pictures with romantic histories. An abstract of the communication made by J. Butler Burke on his *radiobes*, apparently living bodies produced from day to day by radium, is published. The Rev. Reginald A. Gatty writes on "The Home of the Pigmies."

ARTIFICIAL FOUNTAIN AND GEYSER SPRINGS.*

BY MYRON L. FULLER.

Where springs issue in cool, transparent pools, or as streams of clear water from the rock, little can be added to their attractiveness by artificial means. In many places, however, the water of the springs seeps out slowly through the soil, the point of emergence being marked simply by a wet, grassy, or boggy place. In such cases the springs may often be transformed

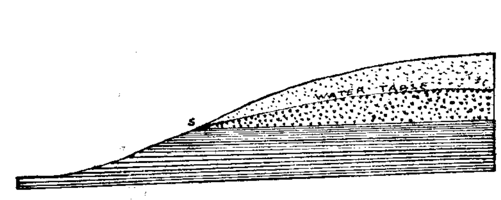


Fig. 1.—HILLSIDE SPRING WITH WATERS UNCONFINED AND WITHOUT HEAD.

into attractive spots by the construction of artistic basins, rocky arbors, rustic spring houses, and other similar means. One of the most useful methods of treatment is the construction of a so-called "fountain spring," while the most interesting, in many ways, and the most puzzling to many, is the "geyser spring." Both are of simple construction and inexpensive. Under the hands of a competent landscape gardener they can be made to form an attractive addition to parks and

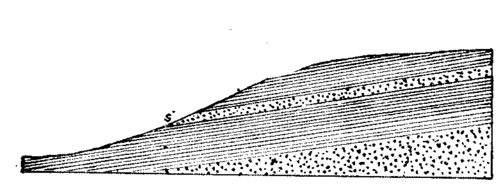


Fig. 2.—HILLSIDE SPRING WITH WATER BETWEEN IMPERVIOUS BEDS AND UNDER PRESSURE.

estates where the conditions are favorable, and where no water works system exists.

The common surface springs may be grouped according to their occurrence in two classes: Hillside springs and springs on flat or level land, both of which may or may not be under pressure or head. Where there is no pressure, the water cannot be made to rise naturally above its point of emergence, but when under head it will, if confined, rise more or less above the point at which it issues. Fig. 1 represents a hillside spring unconfined and without head, while Fig. 2 shows a similar spring, the water of which is confined between two impervious layers and under more or less pressure.

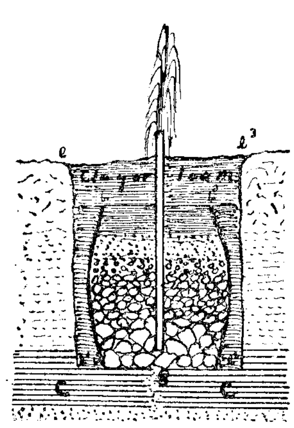


Fig. 3.—METHOD OF CONSTRUCTION OF "FOUNTAIN SPRINGS."

The latter only will rise if confined, but a fountain or a geyser spring can be constructed from either if sufficient fall can be had near the spring. Like the hillside springs, those occurring on level land can also be classed according to the amount of head, which will vary from just enough to bring the water to the surface to enough to make it boil strongly from the ground. To test the amount of head, it is necessary to confine the flow, which can be done in the manner outlined below for the construction of fountain springs.

Construction of Fountain Springs.—The term fountain spring is used to designate a spring which is made

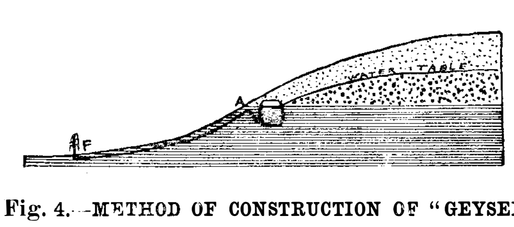


Fig. 4.—METHOD OF CONSTRUCTION OF "GEYSER SPRINGS.

to rise through a pipe to a point above the surface. It may flow gently into a trough by the roadside or in the barnyard, into the sink in the kitchen, or it may, if the head is considerable, be made to throw a jet into the air, as in an ordinary fountain.

The aim in the construction of such a spring is to confine the water, and force it to rise instead of flowing out uselessly upon the ground, as in natural springs. To do this, a circular excavation should be made about the spring, the earth being removed to a depth of three to five feet, preferably until a clay or clayey sand is encountered. The excavation when completed should have the outline indicated by $e\ e^1\ e^2\ e^3$ in Fig. 3.

A bottomless barrel, $b\ b^1\ b^2\ b^3$, may then be inserted, and a pipe placed in the center with its bottom nearly level with the lower edge. Around the pipe inside the barrel are packed stones, three or four inches in diameter at the start, and gradually decreasing in size until a thickness of two feet is reached. About six inches of sand should then be inserted, to be followed by the same thickness of clay, or as clayey sand or loam as can be found. This should fill the remainder of the barrel, and should be worked in around the edges on the outside until all avenue of escape of the water, except through the projecting pipe, is cut off. The ground should then be leveled over and thoroughly tamped down.

The result of this treatment is that the water of the spring, deprived of its ordinary outlet, is forced to rise through the pipe. The height to which it will rise and the force with which it will flow depends upon its head, which is in turn dependent upon the elevation of its source. There are many instances where the water is raised into roadside troughs, and its possibilities in connection with farm and household supplies are considerable. A few owners of important springs, as at the No-che-mo Springs, Reed City, Mich., have by this or similar processes succeeded in obtaining streams which throw jets several feet in the air, making fountains of considerable beauty.

Construction of Geyser Springs.—By a geyser spring is meant one so piped that it will at certain intervals throw a jet to a greater or less height into the air, after which the water subsides and ceases flowing until the lapse of another interval, after which it again flows. To successfully construct a geyser spring, it is necessary to find a spring at some elevation above the point at which the flow is desired and but a short distance away. A spring on a steep hillside, not more than 50 feet away from the desired point of flow, and 15 to 20 feet higher, presents the most favorable conditions. It does not matter in this instance whether or not the water is under pressure at the spring.

The spring will nearly always emerge just above an impervious layer, as at *A* in Fig. 4. A little back from this point dig a small pit about four or five feet deep, and insert a barrel with the upper edge about six inches above the top of the impervious layer. Holes should be bored in the sides to admit the water just above the clay, this part of the barrel being surrounded by fine gravel, to keep the holes from clogging and to prevent clay and sand from entering the barrel. A pipe should be connected with the bottom of the barrel by a tight joint, and should lead upward sharply until about six inches below the top of the clay, or a foot below the top of the barrel, when it should be bent gradually and carried downward, at a depth sufficiently below the surface to prevent freezing, to the desired site of the fountain, when it should be bent again into a vertical position and brought to the surface. The pipe is in fact a simple siphon.

Starting with an empty barrel, the water gradually accumulates until a height equal to that of the upper bend of the siphon is reached, at which moment a flow is inaugurated, issuing at the fountain at *F*. The flow will continue until the water is exhausted from the barrel, when it will stop, only to commence again when the level of the top of the siphon is again reached. One precaution, however, is to be observed in regard to the making of the siphon; namely, the capacity of the pipe should be greater than the capacity of the spring, otherwise the flow once inaugurated will be continuous.

The height to which the water will be thrown depends primarily upon the altitude of the spring above the fountain; the higher the spring is, the higher will be the jet. A decrease in the size of the jet will also within certain limits increase the height to which it will rise.

* Published by permission of the Directors of the United States Geological Survey.

The Maiorana Telephone.

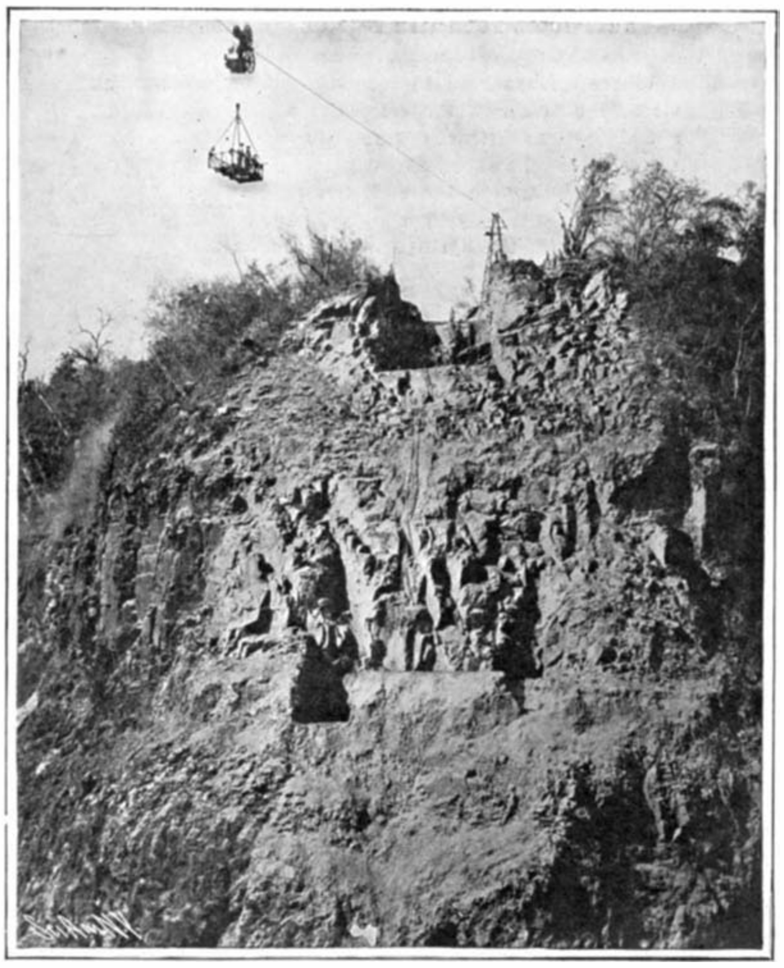
Prof. Quirino Maiorana has been engaged for some time in perfecting his hydraulic telephone, and according to a notice appearing in Industria, has succeeded in transmitting speech distinctly from Rome to London. The successful results of this experiment have been confirmed recently, when the London General Post Office was able to understand clearly whatever conversation was transmitted from Rome. The success of this experiment is the more remarkable as the telephone line Rome-Paris-London, apart from its length, includes submarine cables in the channel, so that this achievement can be said to be the most important telephone transmission ever obtained up to now.

COMPLETION OF VICTORIA FALLS BRIDGE.

BY THE SCIENTIFIC AMERICAN LONDON CORRESPONDENT.

In many ways the Victoria Falls bridge, over the Zambesi gorge in Central Africa, is an interesting piece of engineering work. In the first place, the structure can claim the distinction of being the highest bridge in the world. Again, the waters of the gorge which it spans have never been fathomed, and no one knows their depth. But the feat is deserving of more than ordinary notice, not so much on account of its engineering difficulties, but rather because the work has been carried out in the very heart of the Dark Continent. It was only fifty years ago that the gorge and the famous falls at their head were discovered by David Livingstone. Now it is not only possible to reach the Falls by rail, but to cross the Zambesi by the iron road, and proceed northward for another one hundred miles by the same train. The completion of the bridge means that another link—and the most important probably—has been forged in the great scheme proposed and started by Cecil Rhodes, namely, the Cape-to-Cairo railroad.

Before proceeding to a description of the bridge itself, a few facts about the railroad will not be inappropriate. The total distance by railroad from Cape Town to the Falls is 1,631 miles. Travelers from London are now carried right up to the Falls in twenty-one days, whereas prior to the opening of the line their transportation was a matter of months. At the Falls themselves there is a hotel where accommodation is provided for eighty guests. True, it is only a temporary building, but it will shortly be replaced by a permanent one. That tourists are now making their way to this spot in Central Africa to see for themselves the eighth wonder of the world, as the Victoria Falls have been rightly termed, is made clear after a chat with the present hotel proprietor. Last Christmas there were considerably over a hundred persons staying at the hotel, many of whom had to sleep in tents and temporary annexes, so crowded was the building itself. A large number of Americans visiting the Cape make the journey by railroad to the Falls, spending, as a rule, several days exploring the gorge and beautiful islands just above the great waterfall.

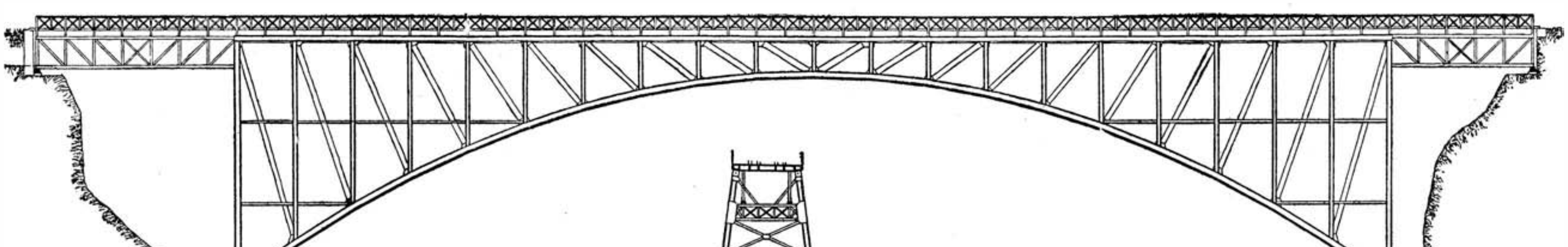


EXCAVATING FOR THE ABUTMENTS OF THE VICTORIA FALLS BRIDGE.

As to the Falls themselves, no attempt will be made here to describe them, with the exception of saying that they are the largest in the world, being about a mile in width and boasting of a depth of from 400 to 420 feet. After the waters of the Zambesi have plunged over the Falls, they continue their course for several miles in a comparatively narrow gorge, and it is this latter which has been bridged to carry the track of the Cape-to-Cairo railroad.

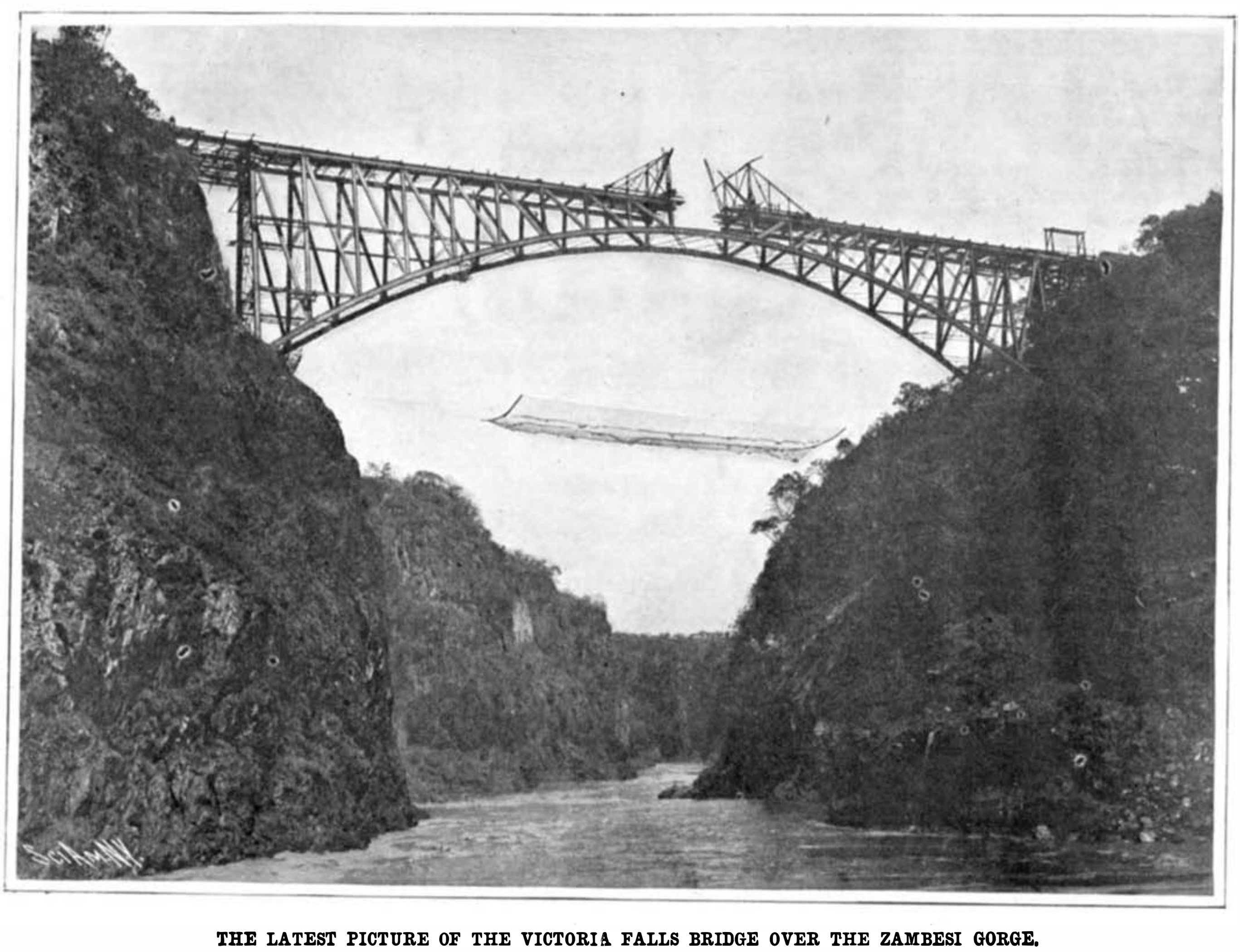
A word here may be said as to the site. It is a little way below the Falls themselves, on the borders of what is termed the "Rain Forest." During the rainy season the great volume of water dashing over the mighty chasm sends up five more or less distinct columns of spray to a height of 3,000 feet, which descends like heavy rain for an extensive area, whose limit is variable and is governed by the force and direction of the wind. This area is called the Rain Forest, and it is just within its full water confines that the bridge is located. It was Cecil Rhodes's wish that it should be so. He is said to have uttered the words: "Build the bridge where the spray from the Falls shall shower upon the trains as they pass." He also expressed the wish that a view of the great cataract may be obtained from the windows of the railroad carriages. The engineers have fulfilled the great man's wishes, and before these lines appear Rhodes's idea of the trains being drenched with spray from the Victoria Falls will have passed out of the region of poetic fancy to that of actual fact.

The bridge as it stands to-day represents a year's labor. It has been shipped from England, and erected on its remote site in this comparatively short space of time. It was only twelve months ago that the last section of the railroad reached the Falls. Until then nothing could practically be done. The gorge where the bridge has been built is some 650 feet in width and about 420 feet deep to the water level. The method adopted in building the bridge was as follows: It was built out simultaneously from each bank on the cantilever principle until it met in the center. To accomplish this, it was necessary of course to carry a large quantity of material to the other side of the stream. To get this across the river, an electric



Span of main arch	500 ft. 0 in.
Rise at crown	90 " 0 "
Depth of main arch at bearings	105 " 0 "
Depth of main arch at crown	15 " 0 "
Width between main arches at top	27 " 6 "
Width between centers of bearings	53 " 9 "
Batter of main arches	1 in 8
The main arch is divided into 20 bays of	25 ft. 0 in
Spans of end spans......87 ft. 6 in. and	62 " 6 "
Widths between centers of girders.	20 " 0 "
Depth of main girders	12 " 6 "
The end spans are divided into bays of	12 " 6 "
Clear width of roadway	30 " 0 "
The curve of the main arch is parabolic	
Camber of main arch at 60° F.	9 "

ELEVATIONS OF THE VICTORIA FALLS BRIDGE.



THE LATEST PICTURE OF THE VICTORIA FALLS BRIDGE OVER THE ZAMBESI GORGE.

Total length of bridge, 650 feet; height over low-water level, 450 feet.

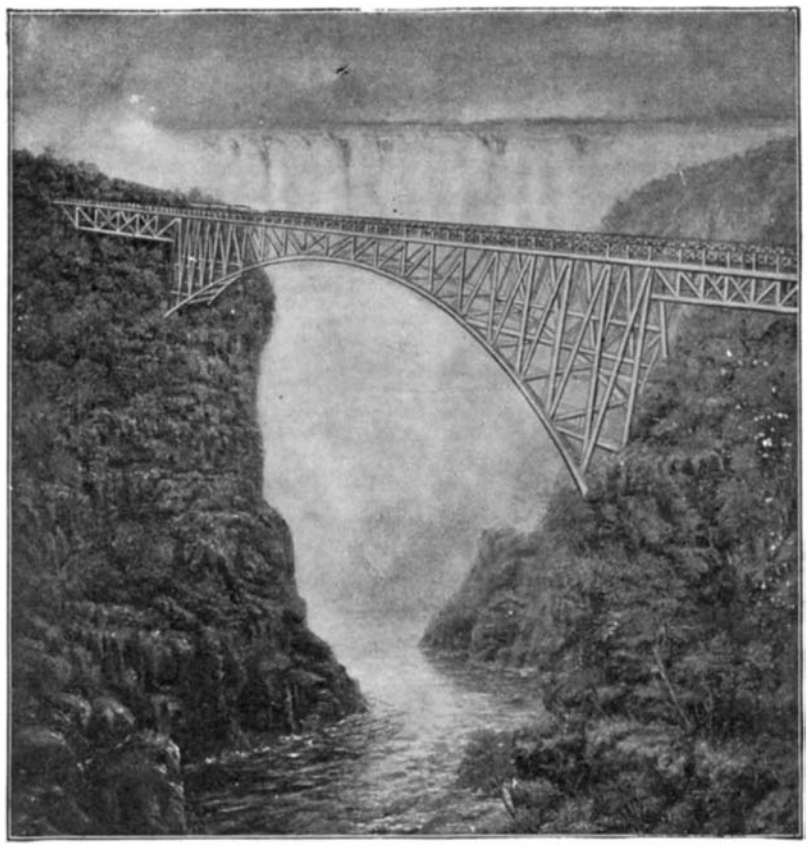
cableway was thrown across the gorge. Communication was first established between the two banks by firing a rocket across. To the rocket was attached a line, by means of which a stronger rope was drawn across, and again a stronger one, until a 2¾-inch diameter steel-wire rope was thrown over the site. A box kite was first tried as a means of carrying a string across, but the rush of air at this spot always drove the kite in the opposite direction to that which it was intended to travel.

The 2¾-inch steel-wire rope referred to was supported at one end by a fixed tower, 36½ feet high, and at the other by a swinging post, 79 feet in length. To prevent this latter being pulled over by the cable into the gorge, a counter-weight of about sixty tons was attached to it. On the cable ran an electric machine, from which was suspended a cage, which carried men and material across. The whole was controlled by the motorman from the platform of his machine, who could raise and lower his car at will. When it is remembered that the gap between the supports of the cable measured 870 feet, and the aggregate amount of material that had to be transported across amounted to many thousands of tons, it will be seen that the cableway played no mean part in the undertaking. In addition to carrying the weight of one half of the bridge across the gorge, all the material and rolling stock required for the construction of over fifty miles of railroad were also safely conveyed across the stream by the electric cable. The car and its machinery weighed about five tons, and the maximum weight of load it carried was ten tons. When the cable was first erected, many distinguished visitors to the Falls took a journey across in the suspended carriage, including Princess Victoria of Schleswig-Holstein and Lord and Lady Roberts. The journey occupied about four minutes. The railroad company also allowed passengers to cross the stream by the cable, charging $2.50 for the trip.

The bridge, which is a combination of girder and arch, has a total length of 650 feet, and consists of three spans, 87 feet 6 inches and 62 feet 6 inches in length respectively. As already stated, it was erected from each side simultaneously. On account of the weight of the structure, about 2,000 tons, it was necessary to tie back the weight to each bank in some way until a junction was made, as the bridge then, of course, would carry its own weight. The manner in which this was done may be said to constitute one of the most interesting features of the whole undertaking. Two bore holes were sunk on each bank, 30 feet deep and 30 feet apart, and the two extremities joined together by boring through the rock. Wire ropes suspending the weight of each half of the bridge were passed down one hole, along the passage connecting the two, and out at the other, so that the weight was sustained by this solid mass of rock; and to make assurance doubly sure, a weight of 500 tons of rails was piled also on the top of the rock. It was estimated that when the two halves of the bridge were on the point of meeting in the center, there was a pull of 400 tons on each of the four corners, and as the bridge was built out toward the center, additional ropes were added to withstand the increased stress.

The curve of the main arch is parabolic, and is divided into twenty bays, each 25 feet long, and has a 9-inch camber at 60 deg. Fahr. The two side spans are divided into equal bays of 12 feet 6 inches. The bridge has a clear width of roadway of 30 feet, sufficient for a double set of rails. A close inspection of some of our photographs will reveal the presence of a huge net, which was thrown across the chasm on two steel cables, and was erected, so the contractors declared, "to catch the boys and tools should they inadvertently drop into it." In addition to a staff of about twenty-five European erectors, a hundred Kaffir boys were engaged upon the work.

Before the scheme was put in hand, there were not a few complaints in the public press, declaring that the erection of a bridge at the Falls would mar the beauty of the surroundings. To ascertain the general feeling of the visitors on the site chosen, a book was kept at the engineers' camp, and a very large majority of the opinions are favorable to it, many visitors being converted from hostility to approval on seeing the facts of the case—in fact, one guest goes so far as to say the following: "The Falls in their present position cannot possibly detract from the beauty of the bridge." It is not without interest here to note that the South African Company, which owns the land on both banks of the river, has decided to reserve a large area of the forest, extending for some six miles on each side of the Zambesi, as a public park, to be preserved forever in its natural beauty.



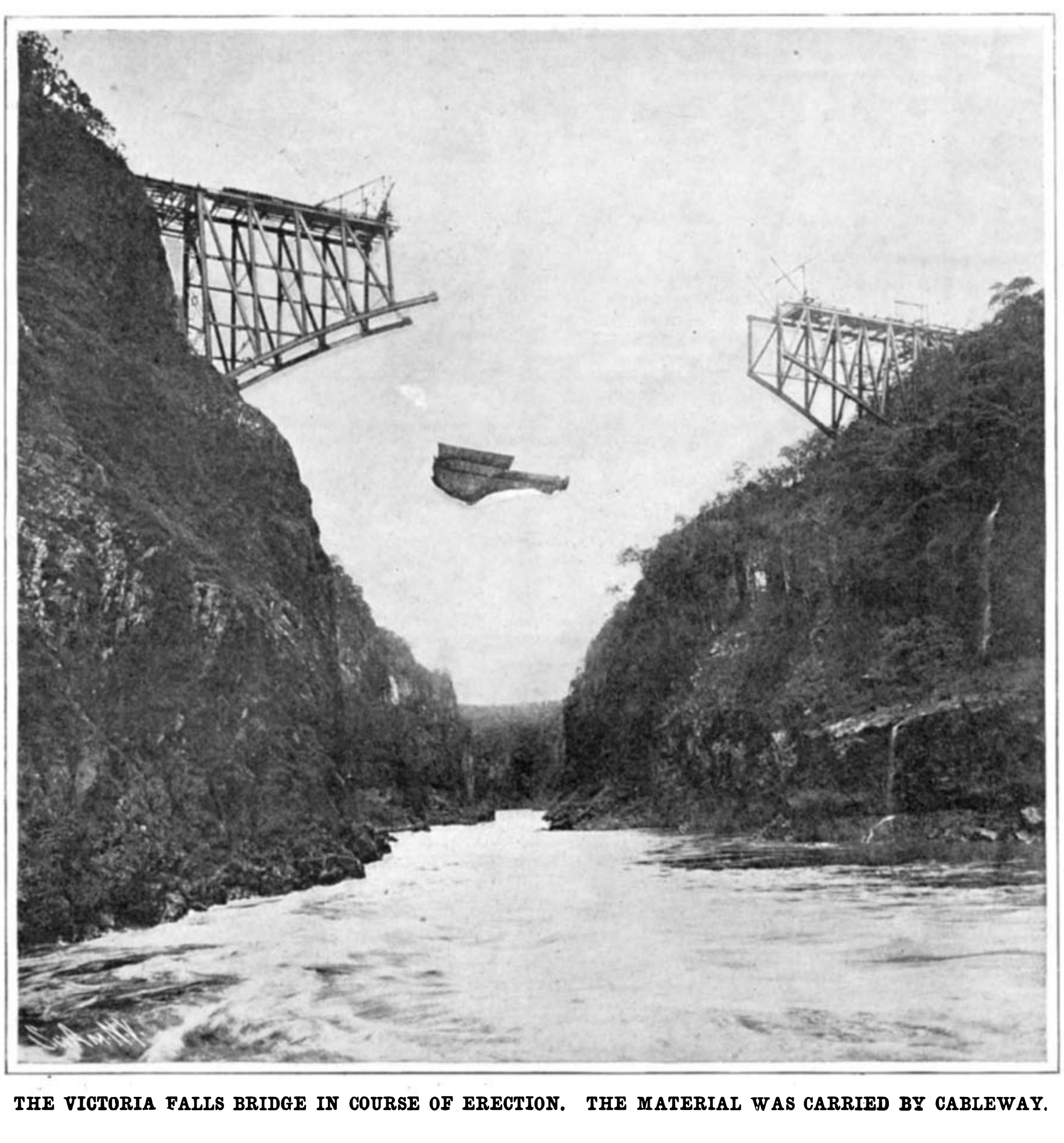
THE ZAMBESI RAILROAD BRIDGE COMPLETED

The contractors for the bridge were the Cleveland Bridge and Engineering Company, of Darlington, England. The whole of the plant was erected in their yards, and exhaustive tests were made with it before it was sent out. It was shipped at Middlesborough, on the River Tees, to Beira, a port on the east coast of Africa, a little south of the mouth of the Zambesi, and here transshipped to the railroad, which runs through flat, swampy country, until it rises about 4,000 feet above sea level at Umtali, and thence through Matabeleland to Salisbury and Bulawayo, and from the latter place to the Falls, a total distance of close upon 8,000 miles. The engineers for the work were Sir Douglas Fox & Partners and Sir Charles Metcalfe, Bart. One of the members of this firm, Mr. G. A. Hobson, M. I. C. E., the designer of the structure, and to whom the writer is indebted for much assistance in the preparation of this article, has left London to inspect and pass the bridge.

A New Hardening Compound.

A Hungarian professor and chemist of the Brunn University claims to have rediscovered the secret of the ancient Greeks by which they were able to render mortar imperishable. The reason for the remarkable preservation and hard texture of this sealing material of the Acropolis, which is as good to-day as it was when first laid centuries ago, has always puzzled scientists and archæologists. This Hungarian some twenty-five years ago procured a piece of this flint-like mortar and ever since has been engaged upon ascertaining the secret of its manufacture. He has invented a chemical compound liquid in character and yellowish in color, to which he has given the name "zorene." The claims of this inventor are that by the application of this compound the density of nearly every description of stone, including granite, is doubled and is rendered absolutely impervious to water; it imparts to all metals the quality of resisting rust, and is a great, powerful germicide. These properties are not transient, but everlasting. Several practical tests to demonstrate the powers of the solution have been given in London. In the first instance, a piece of ordinary slag of a brittle nature after immersion in the liquid resisted a heavy blow from a hammer which before treatment had crushed the slag to powder. The same effect resulted when an ordinary brick was similarly treated. A block of Red Jarrow wood was then immersed in the solution and then placed in a bath of water for several hours. When withdrawn from the water, the wood was carefully weighed upon a delicate scale and found not to have absorbed a particle of water, testifying to the water-resisting qualities of this discovery. Two pieces of steel were then placed in the bath and after treatment were submitted to a severe ammonia test equivalent to an exposure to the outer atmosphere for five years. No trace of rust was observed on the metal. The professor has an ordinary steel table knife which was immersed in the compound six months ago and which has been exposed to the open air ever since; there is no trace of rust upon it. The professor will shortly give a lecture upon the subject before one of the scientific societies in London, and will carry out several demonstrations to substantiate the claims of his discovery.

An experiment with vacuum tubes of several kinds by Herr Hess showed that external friction of the tube, such as rubbing with the free hand, stimulates conductivity within.



THE VICTORIA FALLS BRIDGE IN COURSE OF ERECTION. THE MATERIAL WAS CARRIED BY CABLEWAY.

ATMOSPHERIC FRICTION AS AN OBSTACLE IN LOCOMOTION.

BY DR. A. F. ZAHM, CATHOLIC UNIVERSITY OF AMERICA, WASHINGTON.

To plan a hull rationally, whether for air or water, one must know the pressure and friction at every point of its surface. Summing these for all parts of the body gives independently its head resistance and skin friction. In other words, the factors are to be studied separately, and then their aggregate made a minimum. In marine science this method has been used to advantage, but not so in the design of air-going hulls. Till recently it was supposed, even by eminent experimenters, that bodies of good form cleave the atmosphere without sensible friction. The writer, however, found that in air, as in water, friction is a chief element of resistance, and therefore endeavored to determine its laws accurately in his aerodynamic laboratory.

To measure the tangential force of free air flowing swiftly over even surfaces, various skin-friction planes were suspended inside a wind tunnel, by means of two fine steel wires. The tunnel itself, standing on the floor of the laboratory, measures 40 feet long by 6 feet square, and has a 5-foot suction fan at one end to generate the wind, and two cheese-cloth screens at the other end to straighten the inflowing air. The current steadily displaces the plane endwise an amount which is carefully measured, and serves to compute the wind force. As shown in one of the illustrations, the tunnel is sometimes narrowed, so as to increase the speed.

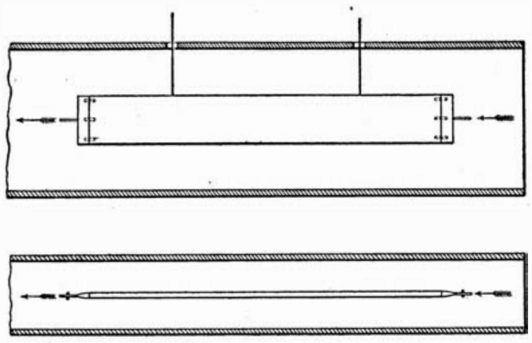
The planes employed were similar to those commonly used to determine the skin friction of water. They were smooth varnished pine boards about two feet wide, one inch thick, and having sharp ends, each end seven inches long, and they were steadied by appropriate guides. The planes varied in length from two feet to sixteen, all having identical prow and stern.

The main object was to determine the friction for various lengths of surface, at various velocities of wind, and to express the relations so found in the form of laws. To that end the total wind force on each plane was observed in a current at ten different speeds, from 5 to 40 feet a second. Subtracting the latter from the former, gave the friction on the straight sides of each board. These data revealed the laws sought for. Plotting the results, it was found that the friction varies with the length of surface as the power 0.93, and the velocity of wind as the power 1.85. The entire friction, F pounds, on a surface one foot wide and l feet long, is given by the numerical equation:

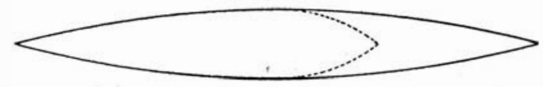
$$F = 0.00000778\ l^{0.93}\ v^{1.85}$$

in which v is the wind speed in feet per second. Of course, this value of F must be doubled for a material plane, since it has two sides. From the equation a table for engineers' use was computed, giving, at a glance, the skin friction for surfaces of various length, moving at all ordinary velocities of locomotion.

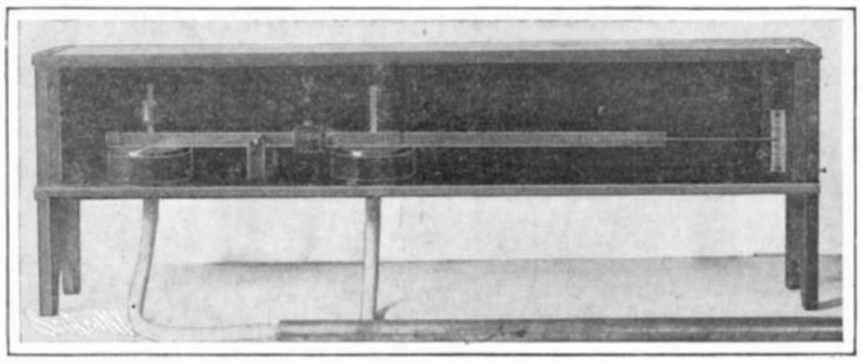
This much accomplished, some further experiments were made, to observe the effect of quality of surface on the tangential resistance. Practically the same friction was observed, whether the board was coated with dry varnish or wet, sticky varnish, or sprinkled with water, or covered with calendered or uncalendered paper, or glazed cambric, sheet zinc, or old English drafting paper, which feels rough to the touch. But when the plane was covered with coarse buckram, having sixteen meshes to the inch, the friction, at ten feet a second, was ten to fifteen per cent greater than for the smooth surface, and the friction increased approximately as the square of the speed.



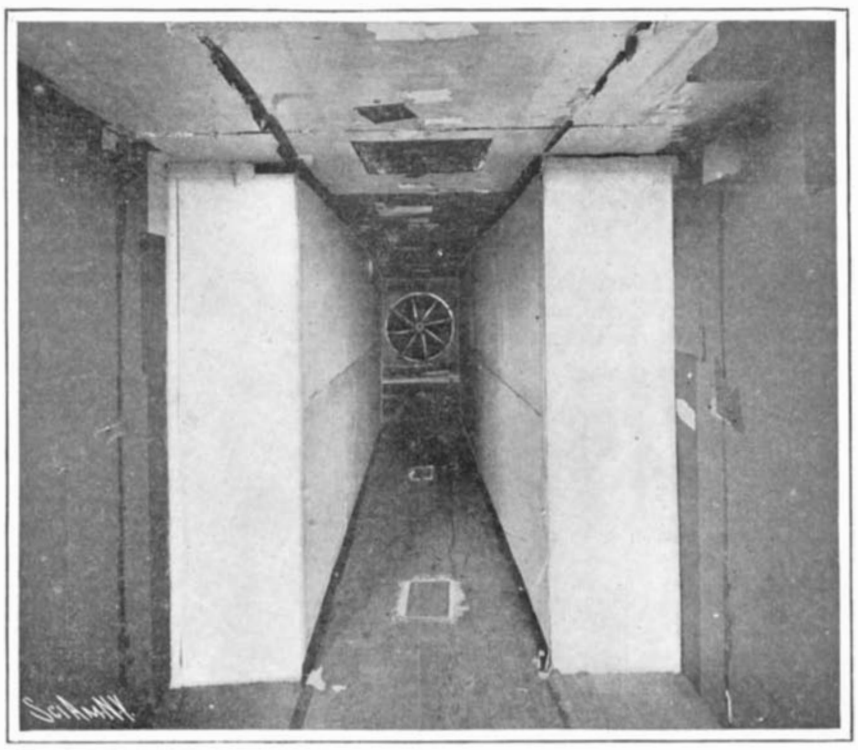
Section Through Tunnel, Showing Form and Method of Suspension of Skin-Friction Planes.



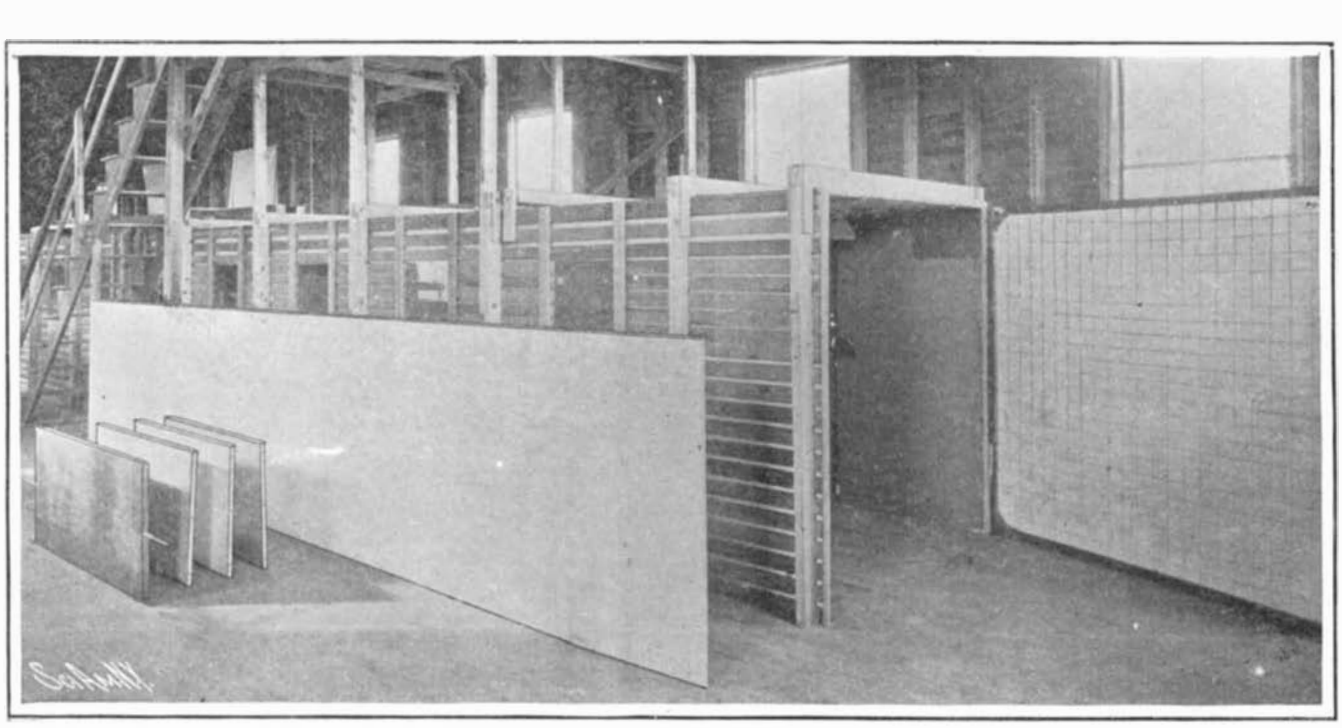
Symmetrical Spindle Showing Length for Minimum Skin Friction.



The Pressure-Tube Anemometer



Interior of Tunnel Constructed so as to Increase the Resistance.



Exterior of Wind Tunnel, Showing the Screen Removed and the Skin Friction Planes in the Foreground.

ATMOSPHERIC FRICTION AS AN OBSTACLE IN LOCOMOTION.

The fact that such a variety of materials exhibit practically the same friction seems to indicate that this is a shearing force between the swiftly-gliding air and the comparatively stationary film adhering to the surface, or embedded in its pores. If, as seems to be true, there is much slipping, this means that the internal resistance of the air is less at the surface than at a sensible distance away. As the shearing strength of a gas is due to the interlacing of its molecules, owing to their rapid motion normal to the shearing plane, it may be that the diminution of shearing resistance near a boundary surface is due to the dampening, within the film, of the component of molecular translation normal to the surface.

To summarize the results attained thus far, it may be said that within the ascribed limits of size and wind speed:

(1.) The total resistance of all bodies of fixed shape and aspect is expressed by an equation of the form

$$R = a\ v^{n}$$

R being the resistance, v the wind speed, a, n, numerical constants.

(2.) For smooth planes of constant length and variable speed, the tangential resistance may be written:

$$R = a\ v^{1.85}.$$

(3.) For smooth planes of variable length l, and constant width and speed, the friction is

$$R = l^{0.93}$$

(4.) All even surfaces have approximately the same coefficient of skin friction.

(5.) Uneven surfaces have a greater coefficient of skin friction, and the resistance increases approximately as the square of the velocity.

On comparing the above results with those obtained by Froude for water, it is found that the equations are very similar. The exponents are nearly the same for a variety of materials, and the coefficients are to each other roughly as the densities of air and water. This fact is of considerable practical interest. For it is well known that the head resistances of any two fluids are directly as their densities; and hence, if their friction coefficients also bear nearly that ratio, the total resistances must be approximately as their densities. Thus the data obtained from water-resistance measurements may be used with fair accuracy to estimate the air resistance on various-shaped models. However, this must be said with reserve, as it is but roughly true, and not for all material surfaces.

The laws of skin friction may be applied with advantage to many practical questions in transportation. They show, for example, that every surface of constant major section has some length for which the resistance is a minimum, and beyond which it increases with the length. The symmetrical spindle outlined in one of the views illustrates this. Its resistance is a minimum when the length is about twelve calibers, or nearly seven times the major diameter. Beyond this length the friction exceeds the true head resistance. A still better form consists of a two-caliber bow, shown dotted in the figure, combined with a twelve-caliber stern, making the length about five times the major diameter. Similar results are found for posts having the form of a two-edged sword.

Take another illustration. It has been taught that the power needed to just support a thin plane gliding through air diminishes with the velocity, because the angle of flight decreases indefinitely with the speed, and the resistance was supposed to do the same. The fact is that after a certain moderate velocity the resistance of a gliding plane, and still more so the propelling power, increase with the velocity. For instance, a thin foot-square gliding plane weighing one pound soars with the least expenditure of power at a speed of about 40 miles an hour, and at 80 miles an hour the power required is more than twice as much.

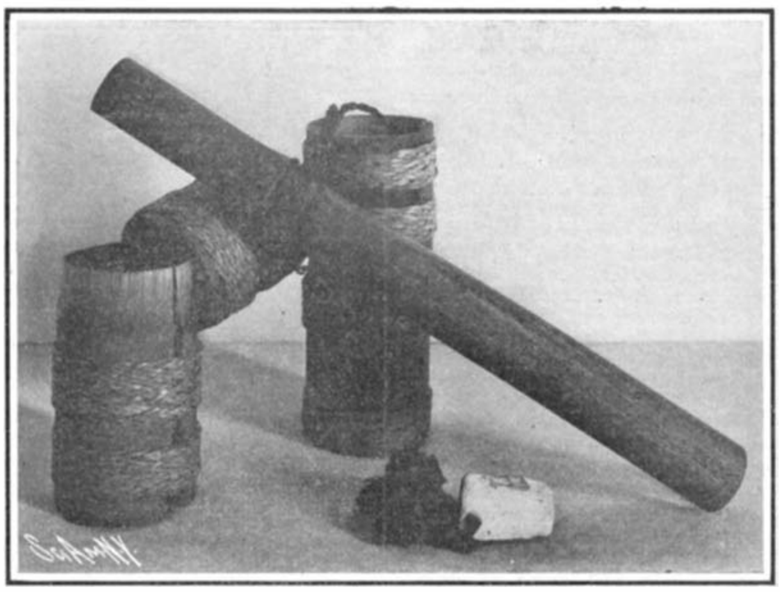
Again, the friction on a long railway train may equal or exceed the true head resistance, while on a short train or single car, the friction is comparatively inconsiderable. Now, though the head resistance may be very greatly reduced by sharpening the front and rear, the skin friction cannot be reduced appreciably by any treatment. Hence, it is apparent that the total air resistance of a long train or hull cannot be reduced very largely by any treatment, whereas the resistance of a single coach, like a street car or automobile, may be reduced several per cent by use of suitable prow and stern.

In conclusion, it may be said that both theory and experiment show that the atmospheric friction about equals the head resistance on symmetrical hulls of easiest shape, on double-edge sword shapes of least resistance, and on soaring planes gliding at the most economical angle of flight.

THE MORO FIRE MAKER.

BY C. H. CLAUDY.

The match has been said to be the greatest civilizer of the world, but it has not yet completed its work. There are still tribes of barbarous and semi-barbarous people who use nature's means for producing fire, either by friction with or without apparatus, or the contact of two substances which produce a spark, as flint and steel.



MORO FIRE MAKER. BAMBOO TO BE STRUCK WITH CHINA AND TINDER.

The Moros, of great interest to us on account of our experience with them in the East, use a method distinctive from other savage races, and of interest not only for its uniqueness, but as showing the effect of environment on invention.

This apparatus consists, as shown in the accompanying photograph, of a bamboo stick, a bit of china, and tinder. The cylindrical cases, which are also shown, are part of the device as it is used, one being a case for tobacco, and the other a case for the china and tinder. The whole, connected with cords, is worn at the belt. To use the apparatus, the native takes the bamboo firmly in his left hand, and in his right holds the bit of china by the finger and thumb, and on the thumb side pinches a bit of tinder. The edge of the china is then struck sharply down and along the bamboo, producing a bright and long spark, which catches in the tinder and ignites it. Very little practice is required to enable even a novice to light a fire by this means. Obviously, when the apparatus was first devised, no china was available, and doubtless some sharp stone took its place. Now, however, bits of broken china, such as are found in cheap eating houses, are regarded as best for the purpose, and universally used.

The thoughtful reader will at once draw an analogy between this means of fire making and the flint and steel of our own ancestors. In the eastern tropics, however, bamboo is the commonest of woods, and so was doubtless observed many times to make a bright spark when struck where flint, in contact with metal, was seen once. In consequence, after the first bright thinker had devised this way of using the spark, the method held its popularity and obtains to this day, although the flint and steel is so much simpler, easier, and more portable.

The philosophy of the device will at once be apparent. The sharp edge of the china scrapes off a bit of bamboo—not much, because the wood is hard and the outside has quite a glaze—but enough to be made incandescent by the friction of the stroke. The tinder catches this spark, and the desired flame is the result.

The photograph was made from the object in the possession of Mr. W. W. Dinwiddie, of Washington, D. C.

A Japanese observatory has been built at Chemulpo, and was opened in March, 1905.

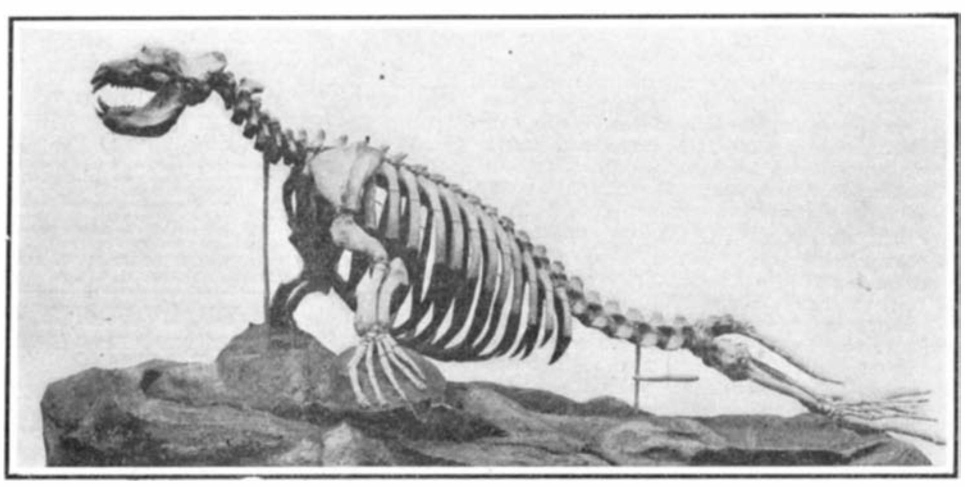
MOUNTING A MONSTER SEA ELEPHANT.

BY HAROLD J. SHEPSTONE.

A new and interesting attraction at the Berlin Zoological Garden is a mounted specimen of a monster sea elephant. It can claim the distinction of being the largest sea elephant that has ever been killed, while the mounting of the giant animal is undoubtedly a clever piece of taxidermic work.

It was found some eighteen months ago by whalers off the coast of the Falkland Islands. They promptly surrounded the monster, and subsequently slaughtered it—no easy task—and the hide with the raw skeleton was purchased at a high price by Mr. J. F. G. Umlauff, the proprietor of the famous Umlauff Museum in Hamburg.

He at once commenced the difficult task of mounting the giant sea mammal. It took him six months to complete the work, which cannot be regarded as an excessive amount of time. A laborious piece of work was the removing of the fatty matter from the skin, which was entirely permeated by blubber canals. Before the animal was finally dressed a model was made, and there being a distinct lack of pictorial representations of the sea elephant, the artist had very little material to guide him.



Skeleton of the Giant Sea Elephant.

From the tip of its tail to the tip of its tusk the specimen measures 21 feet.

THE GREAT SEA ELEPHANT. A REMARKABLE PIECE OF TAXIDERMIC WORK.

Some idea of the size of the monster may be gaged from the fact that from the tip of its tail to the tip of its tusk it has a total measurement of nearly 21 feet. Such an animal, when alive, would weigh 10,000 pounds, or nearly 4½ tons. The circumference of the body at its widest part is some 18 feet. The skull alone measures 2 feet 3 inches long and 1 foot 3 inches high. The sea elephant, or seal elephant, is in many ways an interesting creature. So far as size goes, he can give points to the walrus, but he is certainly not so ferocious looking. Except for the curious nose (whence his Greek name) he is just a big black seal fairly agile in the sea and clumsy ashore, like all his kind. He is about the bulk of a hippopotamus, although more hirsute and with a less extensive opening of the jaws. He holds among seals the unique position of being common to both hemispheres, although from the ardor with which he has been hunted, very few specimens exist now north of the equator. Just now, however, the sea elephant is enjoying a respite, and is consequently increasing in numbers rapidly, particularly in the southern seas. He forms practically the only population of many an otherwise lonely series of barren rocks in the Antarctic Ocean. His food consists chiefly, if not entirely, of cuttlefish. Formerly the animal was hunted by whalers upon all the islands of the Antarctic Ocean, notably Kerguelen's Land and the South Shetland, where they abounded in immense herds. The creatures were slaughtered for their hides and blubber.

The animal has derived the title elephant from the fact that it possesses a kind of trunk, or proboscis. This characteristic is only found, however, in the old males. It extends quite a foot beyond the angle of the mouth. In other respects, also, the males are distinguished from the females, more especially by their size. The female, on the average, attains only half of the length attained by the males, and only one-third the weight of the latter. Old males also lose the hair from the nether part of the neck, the skin thickening in this part and getting barky and cracked, deep intersected furrows dividing it into irregular patches. The tusks of the males reach a length of four to five inches, their external part being smooth and conical, while the part imbedded in the flesh is furrowed and slightly curved. The tusks of the males are solid; at the lower end only a slight cavity appears, while in the female they are shorter, and, moreover, almost hollow up to the point. Sailors and seal-hunters are fond of using these hollow teeth of the females for pipe-bowls, quills from the wings of pelicans supplying suitable stems for the pipes. The monster sea elephant seen in our picture has been mounted with penguins beside it. As already stated, it is the size of this sea mammal that has attracted attention. Even old, experienced whalers declare they have never met a larger specimen.

The first marine engineering in the modern sense was the adaptation of the steam engine as already in familiar use on shore to a modification of the centuries old method of mercantile propulsion, the oar. Some attempts were actually made to adapt the steam engine to a series of oars, which would have meant something like a mechanical trireme; but of course the trained mechanical sense soon saw that the collection of the oars in a revolving wheel was the correct solution. As oars had been used on both sides, so it was natural at first that the paddle wheels should be on both sides; a center wheel was also tried, but it is interesting to remark that practically about the same time that the sidewheels were used on the seaboard, the first marine engine was the shore engine modified to suit the circumstances, and thus on the seaboard the engine was designed and worked with what we now consider an exceedingly low pressure. On the western rivers, where the change has been made in the location of the wheel, there was also the additional change of dispensing with the condenser and using very much higher pressures. It was doubtless due to this fact—that the first non-condensing engines really carried a very high pressure—that the term "high pressure," in the early days meant non-condensing. The reason for the difference is of course very clear; the western rivers are very shallow and it was necessary to make the machinery as light as possible; on the seaboard and the rivers of that section there was deep water and the vessels could carry heavy machinery.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**

MUNN & CO.

Marine Iron Works. Chicago. Catalogue free.

Inquiry No. 7044.—For makers of engines for changing farm wagons and top buggies into traction vehicles.

For mining engines. J. S. Mundy, Newark, N. J.

Inquiry No. 7045.—For firms in the United States manufacturing apparatus for the dry distillation of wood, for producing alcohol, charcoal and other products.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 7046.—Wanted, manufacturers of gold brilliant sign letters stamped from copper plate, concave, finised inside with gold leaf, used on inside of glass or show windows.

2d-hand machinery. Walsh's Sons & Co., Newark, N.J.

Inquiry No. 7047.—Wanted, a meter for measuring gasoline gas.

Perforated Metals, Harrington & King Perforating Co., Chicago.

Inquiry No. 7048.—For manufacturers of a weight motor or blower to be used in connection with gasoline lighting system.

Handle & Spoke Mchy. Ober Mfg. Co., 10 Bell St., Chagrin Falls, O.

Inquiry No. 7049.—For makers of small, wooden boxes.

Adding, multiplying and dividing machine, all in one. Felt & Tarrant Mfg. Co., Chicago.

Inquiry No. 7050.—For information in regard to the manufacture of paper bottles.

Sawmill machinery and outfits manufactured by the Lane Mfg. Co.. Box 13, Montpelier, Vt.

Inquiry No. 7051.—For makers of small, wooden articles turned out of wood.

Boyd's City Dispatch, city, furnish lists of manufacturers, jobbers, etc. Send for catalogue.

Inquiry No. 7052.—For dealers in magnetic sand ore containing gold.

I sell patents. To buy them on anything, or having one to sell, write Chas. A. Scott, 719 Mutual Life Building, Buffalo, N. Y.

Inquiry No. 7053.—For importers or manufacturers of the "La Luciole" French electric sign, illuminated.

The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Machine Company, Foot of East 138th Street, New York.

Inquiry No. 7054.—For makers of small commutators.

Gut strings for Lawn Tennis, Musical Instruments, and other purposes made by P. F. Turner, 46th Street and Packers Avenue, Chicago, Ill.

Inquiry No. 7055.—For dealers in pure oils and ingredients for use in making flavoring extracts.

WANTED. — Agency for South Africa of any new article or patent. Write with particulars. F. Smith, Cuthberts Bldgs., Woodstock, Cape Town, S. Africa.

Inquiry No. 7056.—Wanted, firms who underwrite stocks and bonds.

Sheet metal, any kind, cut, formed any shape. Die-making, wire forming, embossing, lettering, stamping, punching. Metal Stamping Co., Niagara Falls, N. Y.

Inquiry No. 7057.—For manufacturers of a certain Metropolitan lever handle loco. injector.

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, wood fiber machinery and tools. Quadriga Manufacturing Company, 18 South Canal Street, Chicago.

Inquiry No. 7058.—For the manufacturers of the collapsible foil metal tubes.

Space with power, heat, light and machinery, if desired, in a large New England manufacturing concern, having more room than is necessary for their business. Address Box No. 407, Providence, R. I.

Inquiry No. 7059.—For makers of small, gray iron castings.

Absolute privacy for inventors and experimenting A well-equipped private laboratory can be rented on moderate terms from the Electrical Testing Laboratories, 548 East 80th St., New York. Write to-day.

Inquiry No. 7060.—For parties engaged in cleaning dynamo belts, which have been oil soaked.

MOUNTAIN AND LAKE RESORTS.

Is the name of a beautifully illustrated publication of one hundred and twenty-eight pages just issued by the LACKAWANNA RAILROAD. The book contains a list of more than four hundred hotels and boarding houses among the various mountain and lake resorts reached by that road in New York, New Jersey and Pennsylvania. It suggests where to go, how to go, what it will cost and what can be seen and done when you get there. In addition there is a delightful love story entitled "A Paper Proposal," illustrated by well-known artists.

The book will be sent on receipt of ten cents in stamps addressed to T. W. LEE, General Passenger Agent, New York City.

Inquiry No. 7061.—For makers of turbine water wheels, from 2 to 10 h. p.

Inquiry No. 7062.—For a machine for making open ditches.

Inquiry No. 7063.—For a machine for preparing manila and sisal for binder twine.

Inquiry No. 7064.—For the makers of the patent clasp which is attached to suspenders.

Inquiry No. 7065.—For manufacturers of glass.

Inquiry No. 7066.—For makers of umbrella ribs and handles, and steel rods.

Inquiry No. 7067.—For manufacturers of furnishing fixtures for a toy shop.

Inquiry No. 7068.—For manufacturers of peroxide of iron, venetian red, corcus mortis, powdered pipe clay, chalk, oxalic acid.

Inquiry No. 7069.—Wanted, address of firms who underwrite stocks and bonds.

Inquiry No. 7070.—For the names of firms that make perfectly puncture-proof bicycle tires.

Inquiry No. 7071.—For manufacturers of machinery used in making bricks.

Inquiry No. 7072.—For manufacturers of plants for distilling turpentine, wood alcohol, creosote, etc., from rich pine stumps.

Inquiry No. 7073.—For manufacturers of the "Peerless Combination Sharpener."

Inquiry No. 7074.—For manufacturer of an article called "Flat Lap."

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

TELEPHONE-SWITCHBOARD. — E. DARNELL, Carrollton, Mo. The inventor provides a compact switchboard in which the spring-jacks, plugs, and cords are all dispensed with with their incidental objections, and the movable parts to be adjusted are assembled within limits of an easily-reached and conveniently-managed switch, whereby the reaching movements are reduced in number, and so restricted in extent of reach as to greatly economize time, and whereby, also, enunciation between subscribers is rendered secret, so that operators can hear nothing after subscribers are put into communication with each other, and whereby disconnection between subscribers is placed under their own control.

Of General Interest.

ERASER.—H. H. HALL, Treichlers, Pa. The object had in view by the inventor is to combine in one device a sharpened blade and an erasive block of rubber, with the combination device affording advantages novel and useful over other erasers. One of the points of novelty resides in the shoulder and lug devices holding a blade at unfolded adjustment for effective use of its sharpened edge to a flange with its upturned edge, forming a guard for a sharpened edge of the blade when the latter is adjusted to folded position.

DAYLIGHT DEVELOPING APPARATUS.—A. O. GRAF and D. GRAF, New York, N. Y. In the present patent the invention has reference to photography; and the object is to provide a new and improved daylight developing apparatus arranged to allow convenient and quick developing, washing and fixing of exposed photographic plates in broad daylight without resorting to the use of a dark room.

PACKAGE-HANDLING DEVICE.—W. R. DENNIS, Denver, Col. In this instance the invention refers to improvements in devices for handling shelf goods of all descriptions usually sold in stores, the object being to provide a simple and novel device by means of which packages may be readily removed from the shelves or the like or placed thereon without danger of breaking or otherwise damaging the packages.

EASEL.—A. R. COBB, Shorthills, N. J. The present invention pertains particularly to improvements in artists' sketching-easels, the object had in view by the inventor being the provision of an easel of strong yet light construction that may be compactly folded when not in use or for convenience in carrying about.

TOY BUREAU.—A. D. CONVERSE, Winchendon, Mass. A purpose of this improvement is to provide a construction whereby the mirror and its frame may be placed for shipment or storage in a compartment at the back of the body of the bureau and held in a protected position, the top of the bureau body being at such time flush throughout, and to so locate the said compartment that when the mirror is stored therein it will not interfere with the action of the drawers.

DEVICE FOR HOLDING VALVES.—C. O. COLE, Bellingham, Wash. The invention relates to a device for holding valves and preventing their displacement when subjected to jarring or other motions. The principal object is to provide for holding valves as stated and at the same time permit them to be opened and closed without the necessity of loosening or tightening any of the parts or using separate tools of any kind.

Machines and Mechanical Devices.

MACHINE FOR CURLING HAT-BRIMS.—W. W. KEYS and D. A. FERGUSON, Yonkers, N. Y. The inventors provide an economic device for curling brims by steam and so construct a feed device for the curling-shackle that it retains the curl in the brim and may be released at any time from action on the brim, permitting the ready withdrawal of the brim from the shackle, and furthermore so construct the shackle that the steam will be equally distributed at the top and bottom of the curl in the brim which is produced by the shackle.

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 the paper.

INDEX OF INVENTIONS

For which Letters Patent of the United States were Issued for the Week Ending July 11, 1905

AND EACH BEARING THAT DATE

[See note at end of list about copies of these patents.]

Abrading sheet, G. Gorton 794,496
Abrading surface, G. Gorton 794,495
Abrading surfaces, machine for making, G. Gorton 794,174
Adding and subtracting machine, A. F. Hansen 794,353
Advertising machine, automatic, Kingscote & Williams 794,232
Air brake connection joint, S. Feust 794,350
Air brake for railways, automatic, S. H. Heginbottom 794,222
Air moistening, C. A. Erbsloh 794,166
Aluminium compounds, making, L. R. Keogh 794,413
Ammunition box, H. W. Daly 794,663
Amusement device, W. T. Smythe 794,431
Amusement device, F. D. Knapp 794,511
Antirattler and thill pin lock, combined, L. J. Dillon 794,283
Audiphone, portable, E. W. Schneider 794,686
Automobile, M. J. Davin 794,666
Automobile body, convertible, H. F. Vogel. 794,650
Automobile brake, J. Unser 794,382
Baking pan, J. S. Frey 794,292
Bale ties, machine for forming wire, E. A. Frantz 794,602
Baler frame, hay, J. H. Pitkin 794,379
Bar and joint bit, combination, C. W. Phillips 794,681
Bath apparatus, electrothermal, F. W. Weeks 794,208
Battery grid, storage, M. Heisser 794,501
Bearing box, conical, J. D. Alsup 794,154
Bed bottom support, C. L. Harrell 794,171
Bed, Davenport, R. Coopersmith 794,299
Bed, lounge, or the like, J. W. Petavel 794,378
Beds, elastic support for spring, F. A. Zielke 794,270
Beet topping machine, A. H. Kramer 794,514
Belt, conveyer, T. Robins, Jr. 794,381
Belt, moisture carrying, G. Goldman 794,402
Bending roll, J. J. Boax 794,392
Binder, J. L. McMillan 794,536
Binder for papers, pamphlets, etc., B. F. Methven 794,529
Binder, loose leaf, E. T. Ford 794,290
Binder, loose leaf, R. W. Richards 794,682
Binder, temporary, R. F. Hight 794,223
Bit. See Bar and joint bit.
Blackboard, D. W. Allen 794,653
Blank trimming machine, J. H. Haskins 794,221
Block signal system, automatic, J. Lanz. 794,519
Blood and the product thereof, treating, J. Herbabny 794,623
Blowpipe, G. H. Brown 794,449
Boiler furnace, J. Siebel 794,556
Boot or shoe polishing machine, Oliver & Ohlgart 794,540
Bottle, S. J. Hyman 794,302
Bottle stopper, W. T. Abbott 794,478
Bottle, testing, C. Wagner 794,572
Bottle washer, C. Murbach 794,533
Box partition, G. Klenk 794,627
Box trimming machine self feed, J. E. Erickson 794,286
Bracelet or belt, automatically adjustable, J. J. Sommer 794,193
Brake beam, J. Green 794,404
Brooch pin fastening, P. A. Viersen 794,571
Brooder, G. H. Lee 794,520
Broom, C. T. Adair 794,332
Brush, fountain, W. L. Payn 794,638
Bucket, clam shell, G. H. Williams 794,330
Buckle, R. A. Brown 794,699
Building construction, T. O'Shea 794,246
Bung, N. A. Smith 794,258
Burglar alarm, F. C. & V. H. Kline 794,360
Button and loop clasp, M. M. Downer 794,455
Button, cuff or collar, M. F. Oebbecke 794,636
Cabinet, credit, S. L. Henry 794,405
Cabinet, kitchen, H. Clark 794,589
Cam finishing machine, G. Meyer 794,530
Cans to tipping or soldering machines, means for feeding, F. G. Dickerson 794,493
Car draft beam, railway, W. F. Richards 794,252
Car dumping mechanism, A. Becker 794,274
Car frame, railway, G. Gibbs, reissue 12,368
Car, gravity dumping, Boyle & Ustick 794,485
Car handling apparatus, L. F. Card 794,587
Car, metal, C. M. Carnahan 794,280
Car wheel and making same, W. B. Brayton 794,277
Carbureter, H. J. E. Hennebutte 794,502
Cart, log, R. J. Williams 794,576
Cartridge packet, E. G. Parkhurst 794,680
Carving machine, W. B. Hughes 794,182
Carving machine, automatic, M. De Tamble. 794,282
Casing spear, E. B. Noble 794,308
Catalytic substance and making same, R. Knietsch 794,512
Cataract cylinder and dash pot, M. A. Replogle 794,312
Center gage, J. W. Fessler 794,170
Chair, D. Mackey 794,461
Check strap, E. Morrey 794,531
Chuck, Bergman & Elmer 794,582
Churn, W. B. Chalfant 794,490
Cigars, combined guiding and lighting device for, J. J. Shickluna 794,321
Circuit breaker, J. B. Laing 794,518
Clasp. See Button and loop clasp.
Clock movement, H. S. Prentiss 794,380
Cloth drying machine, J. S. Johnston 794,228
Cloth, laying, A. O. Morse 794,307
Clover buncher, S. K. Dennis 794,164
Clutch mechanism, Ford-Smith & Coventry. 794,291
Clutch mechanism, friction, M. Campbell. 794,393
Coal cutting machine engine, J. G. Patterson 794,248
Coal piling apparatus, S. D. Warriner 794,574
Coin distributer, C. H. Hall 794,620
Coke oven, E. Coppee 794,662
Collar, L. M. Wilkinson 794,477
Collar and leash, dog, C. D. Stahlknecht. 794,563
Collar, hameless horse, C. P. Randolph 794,311
Controlling mechanism, G. E. Turner 794,203
Conveyer, J. D. Buchanan 794,342
Conveyer, portable, G. E. Gannon 794,604
Cooker, steam, J. W. Bauman 794,335
Copper mattes, white metal, and blister copper in a single furnace, producing, R. Baggaley 794,272
Copy holder, S. N. McCloud 794,419
Corn popper, W. S. Coffman 794,344
Corn shocker, G. W. Hollister 794,300
Corn snapping and husking machine, E. M. Jetson 794,504
Corset, W. F. Brooks 794,698
Crane, overhead traveling, C. L. Taylor 794,200
Crate, V. E. Windell 794,439
Crate, bottle shipping, C. W. Smith 794,558
Crushing apparatus, M. Dickerson 794,703
Cultivator, W. Hull 794,408
Cultivator, cotton, H. Barditzky 794,696
Curd agitator, E. L. McKinnon 794,421
Curtain pole and curtain fastener, J. F. Koepp 794,414
Curtain stretcher pin, P. J. McGinnis 794,420
Cushion stuffing machine, O. Roop 794,467
Cuspidor, B. C. Crouse 794,347
Cutlery, table, C. K. Decherd 794,591
Cutting off machine, J. J. Boax 794,389
Damper, sheet metal, F. T. Myers 794,534
Dashboard, adjustable, H. Gottschalk 794,249
Decoy ducks or the like, manufacturing, Rimpler & Self 794,643
Disk, furrow opening, H. C. Ham 794,621
Display rack, L. Feldmann, Jr. 794,456
Display stand and truck, combined, A. E. Beall 794,273
Display stand, revolving, D. H. Manwiller. 794,418
Door catch, W. C. Kinard 794,626
Door construction, W. B. Gervais 794,295
Door hanger, H. Lobel 794,524
Door holder, A. J. Boland 794,657
Door mat, flexible metal, Karnaghan & Prescott 794,304
Door, screen, B. S. D. S. Martin 794,369
Door securer, M. Farrell 794,400
Door sill, air tight, C. J. Petit 794,424
Doubling and twisting machine, D. Schmutz. 794,427
Draft deflector, J. Dellinger 794,163
Draft equalizer, A. M. Kindwall 794,231
Drainer, utensil, W. R. Green 794,617
Drawing table, T. King 794,359
Dressing comb, T. M. Noyes 794,244
Drill motor, electric, E. E. Drake 794,398
Driving mechanism, W. J. Bell 794,211
Drum, E. Boulanger 794,658
Drying apparatus, G. Stiff 794,564
Dust, water, and mud guard, combined, J. I. Maguire 794,239
Dye, new azo, A. Thauss 794,568
Dyeing, B. Richard 794,314
Dyeing machine, R. P. Smith 794,560
Ear muff, H. Smith 794,559
Elastic tired wheel, E. Keup 794,230
Electric circuit closer, M. Guett 794,220
Electric furnace, C. L. Saunders 794,255
Electric machine, dynamo, Balachowsky & Caire 794,210
Electric motor, B. G. Lamme 794,362
Electric motor and controlling means therefor, B. G. Lamme 794,363

HOW TO MAKE AN ELECTRICAL Furnace for Amateur's Use.—The utilization of 110 volt electric circuits for small furnace work. By N. Monroe Hopkins. This valuable article is accompanied by detailed working drawings on a large scale, and the furnace can be made by any amateur who is versed in the use of tools. This article is contained in SCIENTIFIC AMERICAN SUPPLEMENT, No. 1182. Price 10 cents. For sale by MUNN & CO., 361 Broadway, New York City, or by any bookseller or newsdealer.

Electric motor controller, F. Wright....... 794,442
Electric switch, W. E. Dow............... 794,218
Electrical controller, R. P. Jackson........ 794,358
Electrical meters, construction of, O. T. Blathy 794,656
Electrode, medical battery, K. L. V. Curry. 794,161
Elevator, M. Fullenlove 794,293
Elevator gate, automatic, J. H. Morris.... 794,306
Elevator winding machine, M. Turnbull... 794,264
Elliptic spring, J. J. Flanagan............ 794,289
Embroidering machine, R. Zahn............ 794,331
End gate, Holt & Hudson................. 794,355
End gate, wagon bed, W. F. Wagner..... 794,328
Engines. See Internal combustion engine.
Engine starting means, gas, W. J. Bell.... 794,275
Engines, means for balancing compound, E. P. Clapp 794,281
Engraved plates when printing therefrom, wiper for cleaning the surfaces of, F. E. Blaisdell 794,213
Envelop, S. J. Mathews 794,527
Excavating apparatus, W. J. Newman..... 794,243
Excavating machine, A. N. Cross.......... 794,346
Excavating machine, C. C. Jacobs......... 794,410
Excavating machine, L. W. & H. W. Hoadley 794,624
Explosive composition, H. Boyd 794,583
Fare register, W. G. Kirchhoff....794,508, 794,509
Farm implement, W. Daly................ 794,396
Fastening, J. Bagnall 794,695
Feet, device for relief of club or flat, W. M. Scholl 794,256
Fence tie, F. W. Reed.................. 794,250
Fertilizer distributer, C. Johnson 794,505
Fiber material, apparatus for feeding strips of short, R. Kron 794,516
File, letter or bill, T. P. Loblaw.......... 794,237
File, paper, J. N. Talbott................ 794,648
Filter, drum, E. Fullner.................. 794,173
Filtering apparatus, J. S. Milne........... 794,631
Fire apparatus, B. B. Briggs.....794,278, 794,486
Fire escape apparatus, self saving, F. Stabe. 794,562
Fireproof ceiling and floor, J. Weber...... 794,438
Fireproof structure, F. L. Saino........... 794,316
Fish catching apparatus, M. Ward........ 794,573
Fish hook, V. Gebhardt 794,352
Flagstaff, P. H. & F. F. Downes.......... 794,668
Flat iron heater, A. V. Maniachi.......... 794,417
Flax breaking machine, G. H. Ellis....... 794,284
Floor grinding and polishing machine, G. Lyon 794,305
Floor or wall covering, wood, W. Gutwasser 794,672
Flue cutter and expander, S. W. Blevins... 794,337
Fluid gage, M. Martin, 794,675, 794,676, 794,678, 794,679
Fluid operated gage, M. Martin........... 794,677
Fly exterminator, Park & Jones........... 794,637
Food, article of, A. A. Faust............. 794,287
Fuel burner, T. W. Phillips, Jr............ 794,545
Fuel from seaweeds, manufacturing, D. M. Balch 794,481
Fungicide and making same, F. J. Smith.. 794,644
Furnace charging apparatus, R. Baggaley.. 794,386
Furnace charging device, J. J. Boax....... 794,391
Furnace grate, A. Wilkinson.............. 794,575
Fusee, W. E. Matthew 794,371
Gage or similar tool, C. J. W. Hayes...... 794,500
Garbage crematory, portable, I. D. Smead. 794,471
Garment fastener, M. E. Kintz........... 794,183
Garment holder, F. J. Hamilton.......... 794,176
Garment supporter, F. Ferguson, reissue... 12,372
Gas burner, A. H. Humphrey............ 794,225
Gas burner for singeing machines, H. H. Skevington, et al........... 794,429
Gas generating apparatus, L. Guenot, Fils.. 794,498
Gas generator, acetylene, T. Lindenberg... 794,236
Gas purifying apparatus, centrifugal, E. Theisen 794,201
Gate, H. H. Gorton 794,403
Gear, speed changing, T. W. Jenny....... 794,227
Gear, speed changing and transmission, I. H. Pleukharp, reissue 12,369
Gearing, transmission, E. Hill............ 794,224
Glass fastener, plate, W. R. Bickford..... 794,447
Glass machine, L. P. Holston............ 794,179
Governor, F. G. Hobart 794,178
Grain drill, O. Schutt 794,191
Grass cutter, F. A. Nelson.............. 794,422
Grinding machine, L. F. Brening......... 794,159
Grinding mechanism, J. Nazel 794,375
Gun sighting apparatus, E. Ternstrom..... 794,649
Gyroscope, H. Anschutz-Kaempfe 794,654
Hame fastener, E. G. Bennett............ 794,336
Hams, bacon, or the like, machine for branding and polishing, R. Wirth..... 794,440
Harness, wire ribbed, W. Dann........... 794,453
Harrow and sulky, combined, D. H. Brown. 794,339
Harvester, corn, W. T. Poff............. 794,547
Harvester, cotton, J. S. Watson.......... 794,265
Harvester guard, J. Lutin 794,238
Harvesting machine thill attachment, J. W. Latimer 794,235
Hay and stock rack, C. L. Clark.......... 794,491
Heat control, automatic electric, J. I. Ayer. 794,580
Heater. See Flat iron heater.
Heating apparatus, M. Rapp 794,550
Heating system, hot water, H. A. Bolze... 794,157
Hedge trimmer, E. J. Nolting............ 794,538
Hinge, Davis & Brown 794,454
Hoist and carrier, J. F. & G. J. Kropp.... 794,517
Hose coupling, J. D. O'Brien............ 794,539
Hose reel bracket, G. Erxleben........... 794,399
Hub and bearing, wheel, H. M. Butler.... 794,489
Hydrometer, Beck & Smith 794,697
Incubator, G. H. Lee 794,521
Inhaler, A. H. Ramey 794,641
Ink well, F. C. Luethy.................. 794,366
Insulating block for electric light canopies, I. J. Parker 794,309
Insulator bracket for telephone poles, etc., K. G. Springen 794,645
Internal combustion engine, J. W. Seal.... 794,192
Internal combustion motor, C. C. Riotte... 794,683
Ironing machine, H. A. Utley............ 794,383
Joint, D. D. Palmer 794,247
Journal box, T. H. Symington............ 794,259
Journal box dust guard, railway, T. H. Symington 794,260, 794,261
Journal box lid, J. S. Patten............ 794,542
Key opening can, C. Jovignot............ 794,229
Kneading apparatus, dough, J. Nazel..... 794,376
Knitting machine pattern mechanism, F. B. Wildman 794,474
Knitting machine pattern mechanism, Wildman & Loomis 794,475
Knitting machines, thread changing mechanism for circular, E. A. Hirner........ 794,407
Lamp, electric arc, M. A. Stogsdill....... 794,565
Lamp, electric display, H. J. Gille....... 794,296
Lamp, flash, G. H. Saunders............ 794,189
Lamp socket, incandescent electric, L. C. Gollatz 794,458
Lamps, mantle holder for incandescent, T. Brabson 794,158
Lamps, manufacturing incandescent electric, H. Casassa 794,588
Lantern, W. S. Hamm............794,297, 794,298
Ledger sheet and monthly statement filing holder, A. Inglis-Donnell 794,303
Level, A. P. Hall 794,175
Level and plumb, E. R. Brodton.......... 794,659
Lifting jack, pneumatic, F. E. Ten Eyck.. 794,262
Line holder, L. B. Tompkins............. 794,570
Linotype machine, R. J. Foster.......... 794,670
Locomotive boiler, J. F. Sweeney......... 794,566
Loom attendance, apparatus for facilitating, F. G. Cobb 794,701
Loom filling tension device, A. L. Scarboro. 794,685
Loom shuttle, C. B. Webster, reissue...... 12,371
Loom weft replenishing mechanism, F. O'Donnel 794,377
Loom weft replenishing mechanism, E. D. Thayer, reissue 12,370
Looms and the appliances used therein, production of heddles for use in, T. E. Dean 794,590
Lubricator, W. B. Featherstone........... 794,167
Magnetic separator, electrostatic, H. M. Sutton, et al........... 794,647
Mail bag delivery device, P. J. A. Schnoor. 794,554
Malt house and malting apparatus, W. P. Rice 794,313
Mandrel or arbor, expanding, C. J. Jones.. 794,411
Mandrel swing for bending dies, J. J. Boax. 794,390
Mantles, heating to incandescense refractory, J. Herczeg 794,406
Manure spreader, L. Kniffen 794,513
Marker, personal wear, J. B. Spencer...... 794,561
Match safe, B. F. Fulgham.............. 794,603
Measuring device, tailor's, G. B. Kaiser... 794,506
Measuring instrument, electrical, F. Conrad. 794,395
Measuring, protecting, and display means for fabrics, A. E. Standen........... 794,689
Meat products, curing, W. Eppinger...... 794,285

Mechanical motor, E. Putnam 794,549
Metal, expanded, J. Kahn 794,412
Metalliferous materials, purifying and nodulizing, T. C. King 794,673
Metallurgical furnace, G. H. Benjamin 794,212
Mine ventilation, F. C. Weber 794,384
Molding machine, C. Herman 794,177
Mosaic work, H. A. Litz 794,523
Muffler, P. J. & G. J. Ihrig 794,226
Music holder, J. Hoffman 794,503
Musical instrument, P. Wuest, Jr. 794,443
Musical instrument valve, pneumatic, F. de Kleist 794,674
Nail trimmer, H. La Casse 794,234
Nitrocellulose or similar substances, making compounds of, D. Bachrach 794,581
Nozzle, locomotive exhaust, J. K. Booth ... 794,214
Nut and pipe wrench, K. Peterson 794,249
Nut lock, D. A. Frick 794,172
Nut lock, H. E. Clapper 794,450
Oils, chemically modifying, E. Meusel 794,373
Ordnance and firearm, Young & Sheriff 794,652
Ore and gathering gold or precious metal diffused in the employed mercury, treating, G. M. Rice 794,552
Ore concentrator, H. Scovell, et al 794,555
Packing hydraulic, G. J. Bryen 794,341
Pail, milking, P. H. Sanger 794,254
Pan. See Baking pan.
Paper cutting machines, counting machine for, M. McCallum 794,374
Paper feeding device, M. B. Ferguson 794,401
Paper hanger's pedestal, J. R. Brown 794,585
Papers, pads, tickets, cards, etc., holder for, A. A. Low 794,415
Peach splitting and pitting machine, S. J. Dunkley 794,598
Penholder or pencil finger guard, W. A. Whitehouse 794,329
Phonograph record cylinder, E. N. Dickerson 794,592
Photograph machines, loading device for automatic, G. N. Pifer 794,639
Pianissimo device, W. & C. Kreter 794,515
Piano action bracket, J. Davenport 794,665
Piano frame, H. Hornbeck 794,356
Piano or organ pedal lever mounting, L. Lemieux 794,522
Piano plate, J. Davenport 794,664
Piling, metal sheet, H. Wittekind 794,268
Pillow sham holder, A. Guth 794,619
Pin, C. F. Markham 794,368
Pipe clean out fitting, soil, Dozier & Stallings 794,165
Pipe coupling, swivel, A. J. Hageman 794,499
Pipe wrench, H. B. Best 794,482
Plane, G. Dechant 794,667
Planers, etc., truing guide surfaces of, S. McMillen 794,537
Plow, E. R. Lesher 794,364
Plow disk bearing, W. G. Danielsen 794,452
Poison vault, W. S. Small 794,323
Pompadour comb, H. A. Austin 794,479
Portable house, W. M. Ducker 794,595
Pot lid holder or wall pocket wire, G. P. Bosbrink 794,436
Potato cutter, H. H. Tomlinson 794,327
Press, M. Sklovsky 794,430
Printer's quoin, L. L. Rogers 794,188
Printing mechanism, adding machine, C. Wales 794,205
Printing, photomechanical, H. L. Reckard. 794,551
Printing press, L. A. Brod 794,487
Printing press web supplying device, H. A. W. Wood 794,578
Projectile, J. Shearman 794,468
Propellor, vessel, J. Saunders, Jr. 794,317
Protecting box or casing, H. W. Clark 794,661
Protractor, W. L. Thomas 794,569
Pulp from sawdust, mechanical preparation of wood, H. C. Pfeifer 794,187
Pump, W. J. Pennock 794,186
Pump valve, B. C. Woodford 794,209
Pump, variable stroke, G. W. Sinclair 794,257
Pumps, wearing ring for centrifugal, E. Meden 794,184, 794,185
Pumping jack, G. Pitcher 794,546
Punching device, sheet metal, J. Wilderman 794,476
Radiator, corrugated, W. E. Roys 794,315
Rail joint, J. Hubbard 794,180
Rail joint, T. & L. Slingland 794,322
Rail joint and bond, combined, B. Wolhaupter 794,441
Rail, third, E. R. Brodton 794,660
Railway signaling, electric circuits for, H. W. Spang .... 794,194 to 794,196
Railway switch, automatic electric, W. D. Woolley 794,269
Railway tie and rail fastening, Brown & Lauman 794,279
Railway traffic controlling apparatus, T. H. Patenall 794,423
Rand pressing die, J. & J. A. Barbour 794,445
Razor holder and sharpener, B. A. Robeson. 794,253
Refrigerator, G. A. Masters 794,462
Refrigerator, A. H. Merrill 794,630
Regenerator, water sealed, G. Walzel 794,207
Regulator. See Voltage regulator.
Rein guard, T. E. Schumpert 794,319
Restraining device, J. Gaiter 794,457
Reversing and speed changing mechanism, R. Symmonds, Jr. 794,567
Rollers, making, S. Crump 794,492
Rolling disk wheels or similar articles, apparatus for, A. de Fontaine 794,171
Roofing material, R. R. Walker 794,206
Rule and square, combined, J. Irving, Jr. ... 794,409
Sample case box or tray, W. H. Clements.. 794,451
Sand blast apparatus, W. R. King 794,507
Sanitary shield, H. E. Hudson 794,181
Sash holder, J. B. P. Michaud 794,241
Sash lock, ventilating, W. A. Nichols 794,463
Saw swage, J. H. Brown 794,340
Screen, F. C. Wright 794,385
Self lubricating wheel, S. G. Porter 794,640
Separator, D. C. Ruth 794,425
Sewed signature, D. G. Smyth 794,688
Sewing machine attachment, J. T. Bearden. 794,655
Sewing machine binder, H. P. Steward 794,690
Shaft support, H. Morton 794,532
Sharpening and repairing machine, drill, J. J. Brossoit 794,584
Sheet metal, means for removing superfluous metallic coating from, Fellows & Hopkins 794,704, 794,705
Sheet metal, removing superflous metallic coating from. Fellows & Hopkins, 794,168, 794,169
Shoe, J. McBrearty 794,535
Show case, C. A. Sullivan 794,646
Signaling and electropneumatic train control system, electric, J. A. Whyte 794,266
Signaling apparatus, G. C. Graham 794,616
Signals, electric apparatus for producing sound, C. H. O'Brien 794,245
Sink cover, A. Beauchemin 794,388
Sleeve protector, H. Gardner 794,294
Smoke preventing means, H. H. Hughes ... 794,357
Socket joint, W. Burke 794,488
Soldering end seams of cans, machine for, G. H. Stewart 794,692
Soldering side seams of cans, machine for, G. H. Stewart 794,691
Sound record locating device, N. C. Durand. 794,599
Sound reproducer, T. H. Macdonald 794,416
Speed mechanism, variable, J. Parker 794,464
Spindle bobbin clutch, rotatable, W. E. Allen 794,694
Spindle bobbin driving means, rotatable, F. H. Thompson 794,693
Spinning bobbins, apparatus for making, Peck & Hird 794,543
Spinning or twisting apparatus, ring, W. T. Carroll 794,700
Spring construction, W. Ott 794,541
Spring wheel, C. M. Tipton 794,202
Stairways, grated step for traveling, D. M. & T. R. Quay 794,465
Station indicator, J. B. & J. L. Henderson. 794,622
Stave jointer, O. A. Sowers 794,432
Steel trap, D. Rupp 794,684
Stereotype plate casting and finishing machine, B. F. Curtis 794,162
Stone building block, artificial, H. Kline.. 794,510
Stool, store, O. E. Bolling 794,276
Storage battery, electric, Meister & Junker. 794,240
Store service apparatus, J. J. Crist 794,216
Stovepipe thimble, R. T. Holton 794,301
Strainer and separator, J. G. Anson 794,271
Strainer, starch or jelly, L. A. Mangold.. 794,525
Stringer instrument with vibrating resonance board suspended within the resonance box, C. F. J. Appelberg 794,333
Suppositorial bougie, S. L. Kistler 794,233

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Tachometer, G. Saaler 794,426
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Taping machine, F. A. Sandstrom 794,553
Target, Ford & Whitney 794,601
Telegraphic transmitting apparatus, tape controlled, D. Murray 794,242
Telegraphy and transmission across space, wireless, A. Artom 794,334
Telegraphy, wireless, W. S. Hogg 794,459
Telephone lock-out mechanism, Matheny & Hastings 794,370
Telephone switchboard, M. C. Burt 794,343
Telephone system, W. W. Dean, 794,348, 794,349, 794,702
Thermal cut out, T. Varney 794,435
Thermostat, J. D. Gould 794,497
Threshing and straw cutting machine, C. J. Smith 794,687
Ticket case, R. D'Orn 794,397
Ticket collecting apparatus, H. L. Des Anges 794,217
Ticket, railway cash fare receipt passage, W. C. Pope 794,548
Tie. See Fence tie.
Timber transferring machine, G. M. Hinkley 794,354
Timber treating apparatus, P. H. Gerhard. 794,605
Tire, pneumatic, W. F. Stearns 794,197
Tire, pneumatic, D. J. May 794,372
Tires, machine for manufacturing pneumatic wheel, A. E. Vincent 794,473
Tongs, Dunham & Robinson 794,597
Tool, combination, J. H. Priestley 794,310
Tool, pneumatic, J. C. Campbell 794,586
Toy, educational, H. Robinson 794,466
Trace carrier, J. Kiernan 794,625
Track brake, N. E. Knutzen 794,460
Track switch, overhead, E. Mari 794,367
Tram stops, air valve for safety, H. G. Sedgwick 794,320
Truck, E. J. Simon 794,428
Tubing making machine, C. Thibodeau ... 794,433
Tunnel erecting apparatus, E. W. Moir .. 794,635
Tunneling shield, E. D. Wright 794,579
Tunneling shield, E. W. Moir ... 794,632 to 794,634
Turbine, R. H. Goldsborough, 794,606 to 794,608, 794,610 to 794,615
Turbine and means for governing same, R. H. Goldsborough 794,609
Twisting and waxing machine, thread, A. H. Forsythe 794,669
Type lines, producing justified, O. Mergenthaler 794,629
Typewriter table, G. W. Donning 794,594
Typewriting machine, F. X. Wagner 794,437
Typewriting machine, E. L. Foster 794,494
Typographic machine, Mergenthaler & Lawrenz 794,628
Universal joint mechanism, L. P. Valiquet 794,434
Unloading mechanism, C. R. Maples 794,526
Valise and tent, combined, A. C. M. Finlay 794,351
Valve, J. C. Wills 794,267
Valve, automatic regulating, C. H. Caspar. 794,394
Valve gear, W. P. Reynolds 794,642
Valve, pressure reducing and regulating, G. S. Willits 794,651
Valve, pressure regulating, F. C. Few 794,288
Valve, steam engine, T. Dugan 794,596
Vapor burner, C. C. Todd 794,263
Vaporizer, E. W. Ballentine 794,387
Vehicle top, A. M. Beebe 794,446
Vending machine, coin controlled, J. L. Simmons 794,557
Vending machine coin detector, C. Bigelow 794,483
Vertical boiler, T. Suzuki 794,199
Veterinary apparatus, S. T. Bailey 794,480
Voltage regulator, P. M. Lincoln 794,365
Wagon brake coupling, J. E. Smart 794,324
Water screen and filter, S. Stout, et al 794,325
Water tube boiler, G. Y. Bonus 794,338
Watering fountain, stock, J. H. Thornburg 794,326
Web rolls, handling of, H. A. W. Wood ... 794,577
Weed cutter, E. M. Lambson 794,361
Weed exterminator, M. Schmitt 794,318
Weed turner, W. M. Ellsworth 794,600
Weighing apparatus, W. S. & C. I. Corby. 794,215
Wheel. See Car wheel.
Wheel, J. W. Meixell 794,528
Wheel guard, vehicle, B. E. Thompson 794,472
Window box, knockdown, A. Assorati 794,444
Window screen, W. E. Sherwood .. 794,469, 794,470
Window ventilator, H. O. Reese 794,251
Wire receptacle, woven, C. S. Baron 794,156
Wrench, B. S. Boggs 794,448
Yoke attachment, neck, L. T. Gucker 794,618
Zinc from ores, removing or recovering, W. Stewart 794,198
Zither bowing device, J. von Peichl 794,544

DESIGNS.

Automobile body, O. E. Barthel 37,491
Badge, C. C. Fearing 37,478
Bodkin, E. S. Simons 37,483
Book mark, E. A. Ekstromer 37,484
Button rim, G. E. Schweig 37,479
Carriage body, C. E. Duryea 37,490
Coin actuated machine casing, A. A. Caille, 37,488, 37,489
Condiment holder, E. C. Hurlbert 37,482
Fabric, textile, J. W. Kemp 37,492, 37,493
Mount, E. S. Cheney 37,481
Sign, cigar dealer's, O. Wurscher 37,486
Sign, jeweler's, O. Wurscher 37,485
Statuette, R. F. Outcault 37,480
Vibrating machines, stand for automatic, M. Borsodi 37,487

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"Bestuvall," for sardines, R. Coleman & Co. 12,269
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"Golden Crown," for talking machine records, Englewood Co. 12,271
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