SCIENTIFIC AMERICAN

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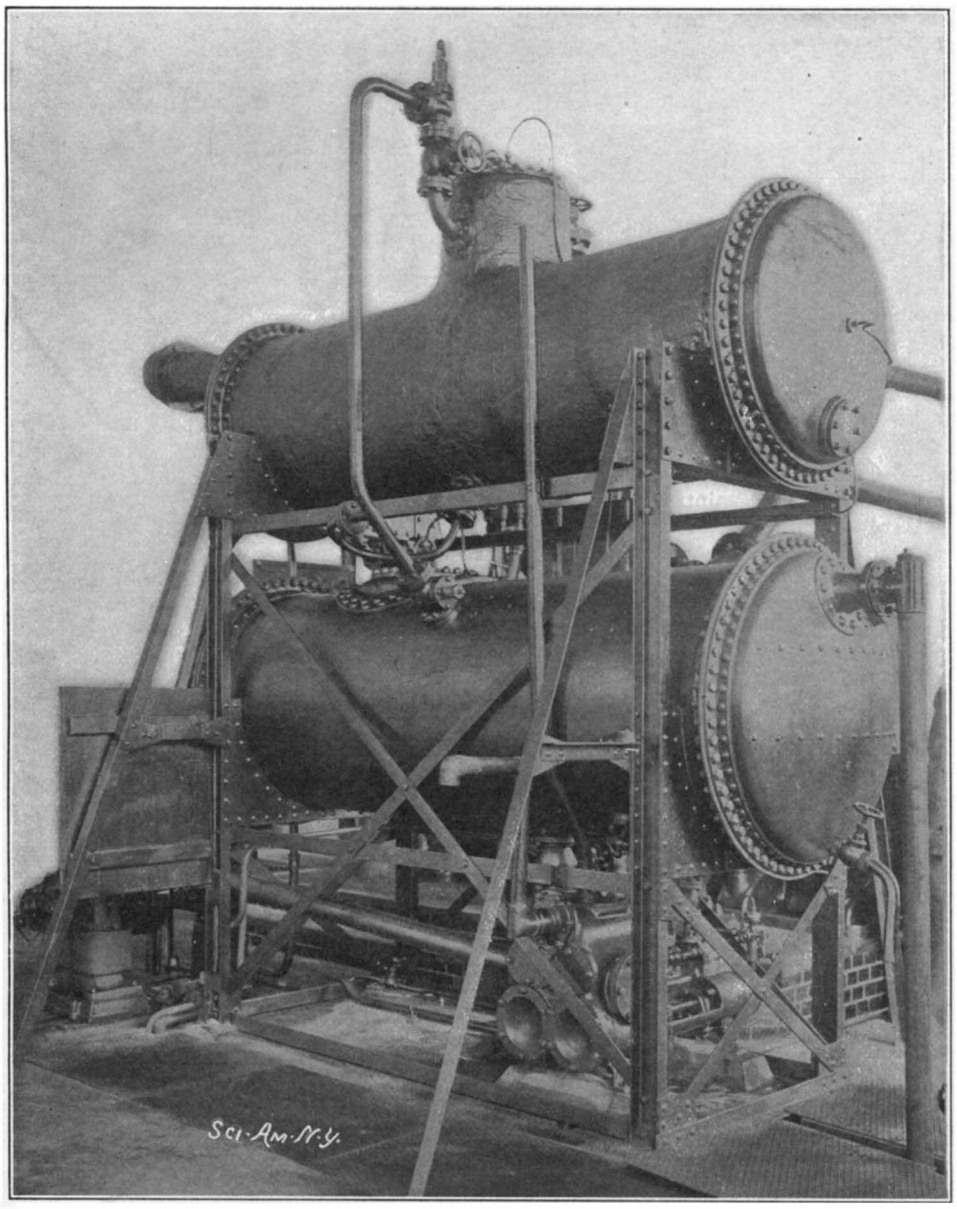
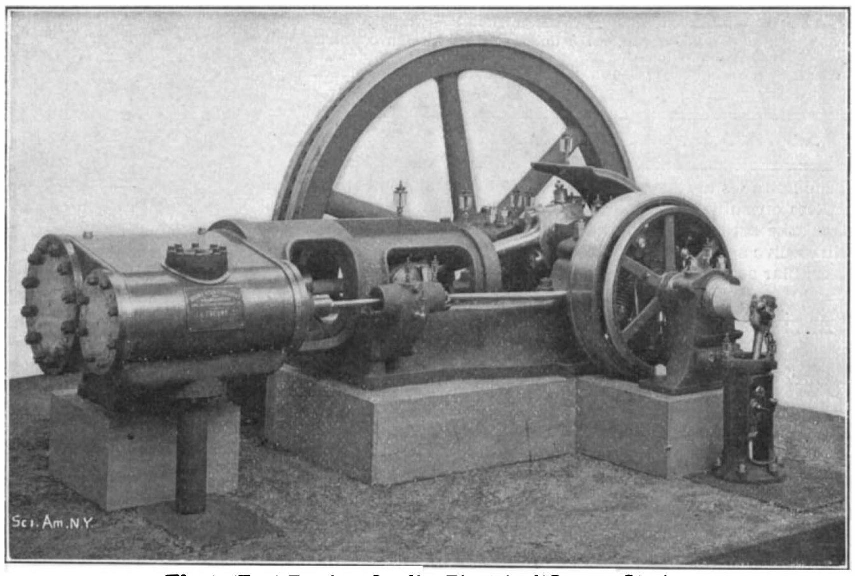
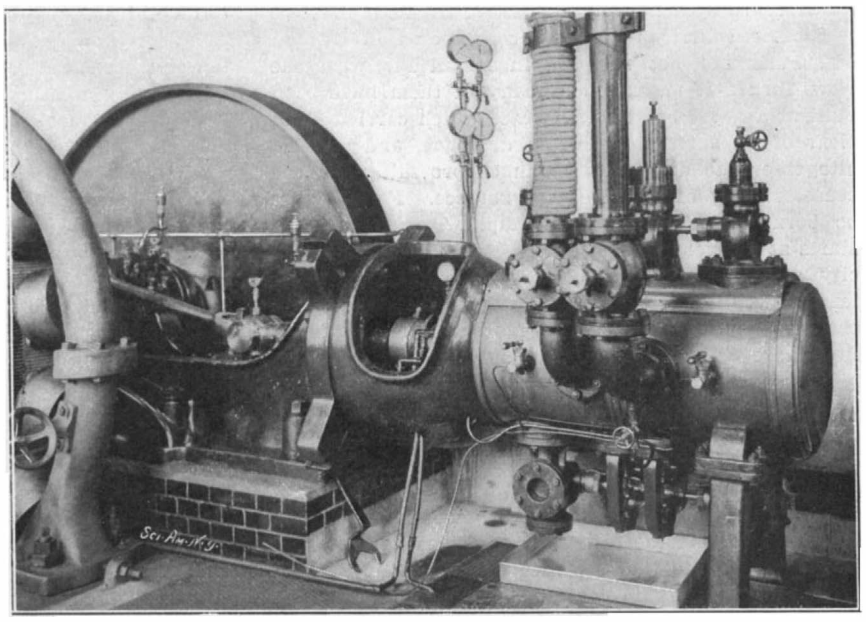


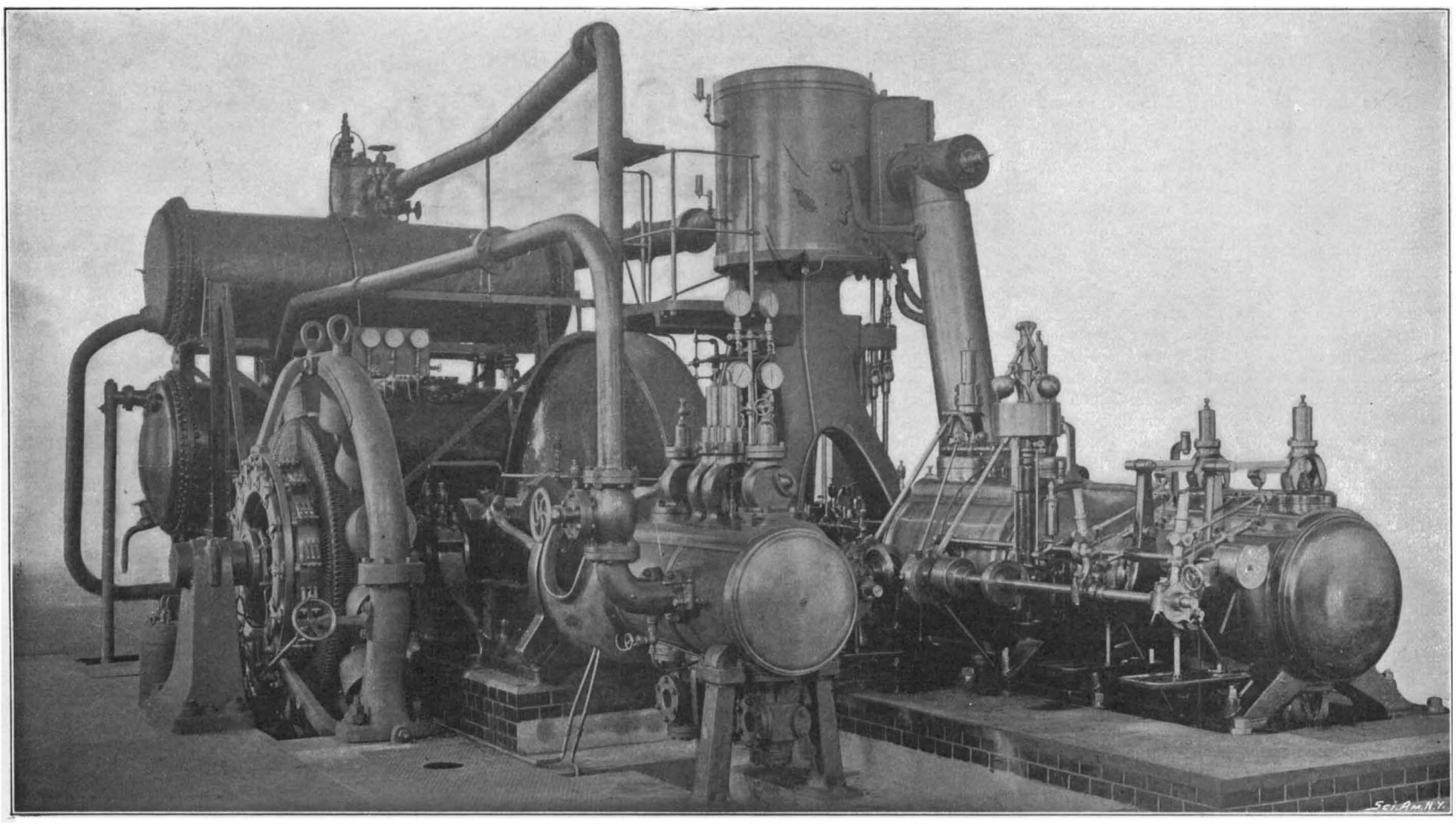
Vaporizer and Condenser.



Waste-Heat Engine, Berlin Electrical Power Station.



Waste-Heat Engine at Technical High School.



The Waste-Heat Auxiliary Engine—Vaporized Sulphur Dioxide Gas Being Used Expansively in a Separate Cylinder.

WASTE-HEAT AUXILIARY ENGINE OF 150 HORSE POWER AT THE TECHNICAL HIGH-SCHOOL, CHARLOTTENBURG, PRUSSIA.—[See page 279.]

Scientific American.

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NEW YORK, SATURDAY, NOVEMBER 2, 1901.

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.

RAPID CONSTRUCTION OF THE RAPID TRANSIT SUBWAY.

Our congratulations are extended to the engineers, the construction company and the contractor of the New York Rapid Transit Subway, on the great skill and unprecedented dispatch with which they are prosecuting a work, which may justly be considered as being at once the largest and most difficult of its kind ever undertaken. Although this is not the first time that an underground system has been built in a metropolitan city under cast-iron conditions as to non-interference with the regular flow of traffic, it must be remembered that the tunnels constructed in London and Paris did not compare in magnitude with the New York system, and that many of them have been built at a depth below the surface which carried them clear of all surface pipes and drainage, and avoided altogether the difficult problem of providing for the ceaseless flow of traffic at the surface. For it must be borne in mind that the Rapid Transit Subway starts at the very busiest center of traffic in the whole city and runs for a considerable part of its total length of 20 miles beneath some of the most important thoroughfares of New York. Moreover, except for a few short stretches, it lies in close proximity to the surface, with little more than the depth of its steel-and-concrete roof intervening between the top of its cars and the wheels of the traffic above. Hence it has been necessary, before a stroke of work could be done upon the actual excavating of the tunnel itself, to provide an elaborate and massive system of falsework to hold the surface of the street temporarily in place. Add to this the fact that over the greater part of the route the contractors have had to make special provision for holding up the massive roadbed of a double-track underground trolley road, to say nothing of a perfect network of gas and water mains, and electric cable conduits, and it becomes evident, even to the lay mind, that the construction of this tunnel was an engineering problem of far greater proportions than can be expressed in mere statements of length and quantities.

In drawing up the contract, the Rapid Transit Commissioners set the date of completion at August 21, 1904, or four and a half years from the date, February 21, 1900, on which the contract was signed. Having in view what we might call the incidental difficulties of construction as mentioned above, to which, by the way, must be added the necessity of diverting and lowering some of the largest elements in the sewerage system of the city, it would not have been surprising if it had become evident, as the work developed, that an extension of time would be necessary. At any rate, it must be confessed that the history of earlier contracts of the kind rendered such a delay a decided probability. It is extremely gratifying, therefore, to learn that the work has been handled with such skill and pushed through with so much energy that to-day the contractors are several months ahead of their time, as will be seen from the following figures: Out of a total estimated earth excavation of 1,700,000 cubic yards, 800,000 cubic yards has been taken out, leaving only a little more than one-half of the total to be removed. Out of 1,300,000 cubic yards of rock, including both rock taken out in open cut and that removed in tunnel excavation, 366,000 cubic yards have been removed, or 28 per cent of the whole. On November 1 of this year $9,700,000 had been expended out of the total contract price of $35,000,000. As the amount paid out for work done is about the fairest way of estimating the rate of progress it may be said that about 28 per cent of the tunnel is completed. The fact that the amount paid out every month for work done is steadily increasing augurs exceedingly well for the early completion of the contract. In August of last year the total monthly payment amounted to $265,000, whereas in August of this year it had risen to $900,000, and there is a probability that it will increase as the months pass by. Bearing this in mind, then, we think that the engineers and contractors are perfectly justified in assuming that the subway will be completed by Christmas of the year 1903. In agreement with this estimate the contract for the power plant names January 1, 1904, as the date on which the whole of the installation of boilers, engines and generators is to be delivered. The power station is to be located at Fifty-ninth Street and the Hudson River, and the contractors, having an eye to the future probable extensions of the subway, have secured a plot of ground which will enable large additions to the plant to be made as required. The power station will be larger than the Metropolitan Street Railway Company's plant of 70,000 aggregate horse power, and larger even than the huge power station of 100,000 horse power which is now nearing completion for the Manhattan Elevated system.

PAINTING OF BIG BRIDGES.

The New York public has had the question of the painting of large bridges brought very forcibly and somewhat painfully to mind, of late, by the extraordinary disclosures of the report of the expert commission appointed by the District Attorney to examine the Brooklyn Bridge. In this connection a few facts regarding the system of painting adopted in the case of the largest and most important bridge in the world, the Forth Bridge in Scotland, will be of interest.

It seems that ever since this structure was opened for traffic, eleven years ago, the work of painting it has gone on without any interruption. A staff of about thirty-five men is employed on the work. They commence painting at the southern end of the structure (which, by the way, comprises two main spans of 1,710 feet and two shore spans of 700 feet), and the work proceeds daily, except on Sundays and in unusually stormy weather, until the northern end of the structure is reached. It takes three years to cover the full length of the bridge, which, in the cantilever portions alone, is about one mile in length. Hence it will be seen that this period of thirty-six months represents the useful life of the paint, since one coating is no sooner completed than the work is begun again. Already the huge structure is receiving its fourth coat. To enable the painters to conveniently reach every part of the structure, the engineer in charge has devised a system of ladders and steam hoists. Where possible, ladders attached to the great struts and ties are made use of, but for reaching the loftiest portions of the cantilevers, which rise to a height of 360 feet above the piers, a series of permanent elevators have been installed. These are operated by means of steam winches which are placed a little below the level of the roadway. In proximity to each elevator there is erected a house in which the paint is mixed. For painting the under side of the roadway permanent wire ropes are stretched along each side of the structure, from which the painters' platforms are suspended in such a way that they can be drawn along the rope very much after the manner of a cableway. Evidences of the thoroughness with which the work is done is seen in the fact that, so far, no portion of the bridge has shown any signs of decay or need for renewal.

This method of painting certainly has its advantages over a system in which the repainting is only done as various parts of the structure seem to call for it; since it precludes the possibility of any detail being overlooked for any considerable period of time. An ideal system would be that which combines a periodic painting of the whole structure with a special coating, in the interim, for such parts as are particularly exposed to the action of the elements or traffic, such, for instance, as, in the case of the Forth Bridge, the first 20 or 30 feet of the steel towers above the salt waters of the Firth of Forth, or in the case of the Brooklyn Bridge, the articulated portions of the structure which are subject to movement and those portions of the floor system in which mud and water are liable to collect and set up a rapid oxidation.

ANNUAL REPORT OF THE BUREAU OF ORDNANCE.

In the annual report of Rear-Admiral O'Neil, Chief of the Bureau of Ordnance, it is stated that increased efficiency for the larger naval guns must be looked for, not in the direction of larger size and weight of the guns themselves, but rather in increasing the weight of the projectile and in improving the smokeless powder; in other words, we must endeavor to increase the striking energy of the shell per ton weight of the gun. The latest types of guns, of both large and small calibers, are so heavy and large, that any further increase of weight or length will seriously hamper the design of warships, by making a too large demand upon displacement. The report states that the ordnance equipment for American naval vessels is up to the highest standard attained in foreign navies for vessels of corresponding date and class. Rear-Admiral O'Neil says that he knows of no guns afloat, or shortly to be put afloat, that will equal in energy those which are being built for the United States navy. It is gratifying to know that the manufacture of guns and other ordnance fittings is well in hand, and that the outfits will probably be completed when the vessels are ready to receive them. During the last fiscal year 143 naval guns were completed, and 256 are at present under construction. We are also pleased to learn that there is a steady improvement in naval smokeless powder, that of to-day being considerably superior to the grade manufactured twelve months ago.

Speaking on the subject of submarine boats, Rear-Admiral O'Neil is of the opinion that this type is receiving undue prominence; an opinion in which we heartily concur. He states that if these craft are to have any permanent value, it will be as an adjunct to a system of coast defense. They are, as yet, purely in the experimental stage, and he believes that they will never take the place of ships of the regular type, or render a reduction in the fleets of the world possible. We are pleased to learn from the report that the latest armor contracts are extremely advantageous to the government, the price being lower than that paid abroad, and the armor the best that can be procured.

Interesting light is thrown upon the present controversy which is raging in naval circles over the designs for our new battleships and cruisers. We had thought that the point at issue was that of the double versus the single turret; but Rear-Admiral O'Neil, who is president of the Board, states that the issue is as to the relative merits of the new 7-inch gun as against the 8-inch and 6-inch guns, he himself being a strong advocate of the lighter piece. The arguments in favor of the 7-inch gun were given in our issue of August 10, 1901, when firing diagrams, showing the concentration and total energy of the gun fire obtained with two types of ship, one carrying the 7-inch gun and the other the 8-inch and 6-inch guns, were given. We hope in a later issue to take up this question in fuller detail.

IMPORTANT APPLICATION OF ELECTRIC POWER IN RAILROADING.

President James J. Hill, of the Great Northern Railway, is preparing to operate a 66-mile section of that railroad through the Cascade Mountains with electricity instead of steam. If the project proves successful it is proposed to operate an entire division from tidewater at Everett to Wenatchee on the Columbia River, a distance of 141 miles, with electric motors. This accomplishment, railroad men believe, will be but the beginning of the equipment of the entire main line with electricity. The plan of substituting electricity for steam, which has been forced upon Mr. Hill by his long tunnel and peculiar conditions, was first proposed to the railway world, as applied to long distance, by Henry Villard nearly ten years ago. Mr. Villard was at that time in control of the Northern Pacific Railroad and had become greatly impressed with the possibilities of electricity through his association in a business way with Thomas A. Edison. Early in 1892 Mr. Villard gave instructions for George W. Dickinson, then assistant general superintendent of the Northern Pacific at Tacoma, and one or two high officers of the engineering department, to meet him in New York, whence they were taken to the works of the General Electric Company for a conference with Mr. Edison and other electrical engineers regarding the feasibility of introducing electricity on the Northern Pacific. To these officers Mr. Villard unfolded a plan which he had partially matured for operating first a broad-gage electric railroad between Milwaukee and Chicago. He had under consideration either the building of an entirely new line between those cities or the substitution of electricity on that portion of the Wisconsin Central which was then controlled by the Northern Pacific. Mr. Villard figured that the line could be placed in operation by the summer of 1893 and could thus be used by thousands of visitors to the Columbian Exposition at Chicago. The consummation of this plan was prevented by the gradual tightening of the money market which preceded the stringency of 1893, and in consequence of the receivership which followed, the Northern Pacific passed out of Mr. Villard's hands.

The investigations on the same subject by the Great Northern cover a period of over three years and have been under the direction of J. N. Hill, the eldest son of President J. J. Hill. The matter was first brought to the elder Hill's attention by the reports of his civil engineers to the effect that it might be found impracticable to operate trains through his two-mile Cascade tunnel by means of coal-burning locomotives, on account of its extreme length and the fact that there would be no means of effectively ventilating the tunnel when finished without going to the expense of installing and permanently operating compressed-air motors. The investigations which followed have convinced the officers of the road that a great saving can be made by operating trains by water power converted into electricity. This fact is shown by the extension of the original plans to a long section of the railroad through the mountains as recently announced by President Hill. His present plans as announced contemplate the application of electricity to that portion of the road extending from Leavenworth on the east side of the Cascades to Skykomish on the west side, 66 miles. It is understood that if the electric motors prove as successful as anticipated, the electric system will be further extended so as to include the mountain division, from Everett on Puget Sound to Wenatchee, 141 miles. This would be the beginning of an electrization which might eventually include the entire mileage of the system.

The section of the road chosen for the first application of the experiment is the most difficult and expensive portion of the road to operate on the entire system. It runs through the wild and rugged Cascade where the grades are very heavy, and where every winter there are numerous slides of earth and rock which come down the steep mountain sides to cover the track and endanger the operation of trains. One of the most important causes of the Great Northern's desire to secure cheaper motive power is the fact that its tributary coal supply is very limited. In the matter of cheap fuel the Great Northern is being operated at a tremendous disadvantage as compared with the Northern Pacific or the Oregon Railway and Navigation Company, its Washington rivals. The Northern Pacific owns the largest coal mines in the State at Roslyn, thereby securing its fuel at a cost not exceeding $1 to $3.25 per ton. The advantage of the Oregon Railway and Navigation lies in its gravity route down the Columbia River from the Rocky Mountains. On the other hand, the coal used by the Great Northern costs about $2.75 per ton for the ordinary product, while for the Crow's Nest Pass coal, which is used on all trains through the tunnel, the cost is much greater.

For about thirty miles of the mountain climb on the Cascade division each loaded train requires the assistance of one or two helping engines. The coal consumption of this division is something enormous, amounting to upward of 2500 tons a day, or nearly a million tons a year. With a difference of $1.50 per ton in favor of the Northern Pacific, it will be readily seen that the older road has in the matter of coal supply alone a great advantage over its newer rival. As the water for the generation of the electric power for the operation of trains under the new system will be taken from one or more of the numerous rivers heading in the Cascade Mountains near the Great Northern lines, the innovation contemplated will reduce the coal bills of the division very greatly, if not eventually doing away with them entirely.

The details of President Hill's plan are now being worked out, and it is understood that active work toward the installation of the electric power will be commenced next spring. The successful long distance transmission of electric power generated at Snoqualmie Falls, forty miles from Tacoma, has been a powerful object lesson to the Great Northern.

The street railway systems of both Tacoma and Seattle, together with the electric lighting system of Tacoma and the vast machinery of the great Tacoma smelter, are all being operated successfully and economically with Snoqualmie power. A. W. C.

THE HEAVENS IN NOVEMBER.

BY HENRY NORRIS RUSSELL, PH.D.

Two astronomical events of great interest occur during the present month, but, unfortunately, one of them lies outside the range of our observation. This is the annular eclipse of the sun, which takes place on the 11th. It is noteworthy for the very long duration of the annular phase, which is, at maximum, a little over eleven minutes. The moon is so much farther away than usual that she hides only about 6-7ths of the sun's surface, even when she is directly in front of him, so that there will be plenty of light left to see by, even in the middle of the eclipse. The annular phase is visible along a belt of country about 200 miles wide, extending from Sicily past Cairo, over Arabia, Ceylon and Siam to the neighborhood of Manila. A partial eclipse is visible generally in eastern Europe, Asia, and northern Africa.

More interesting to us is the remarkable series of planetary conjunctions which happen later in the month, when the three brightest planets will be close together in the evening sky.

Jupiter has for months been slowly overtaking Saturn, and, just before he reaches him, Venus, whose eastward motion is much swifter, catches up with them both. She passes Jupiter on the night of the 17th, and Saturn on that of the 18th. The two are about a degree apart, while she is three degrees south of them, so that all three planets are crowded into a space no larger than the belt of Orion. The group which they form will be by far the most conspicuous thing in the evening sky, and will remain in sight for two hours and a half after sunset.

Though these three heavenly bodies seem so near together, their real distances from us are, of course, vastly different. Venus is very much the nearest, being but 74,000,000 miles distant. Jupiter is more than seven times as far away, his distance being 540,000,000 miles. Finally, Saturn is almost 1,000,000,000 miles from us—as far beyond Jupiter as Jupiter is beyond Venus.

It is to her nearness, both to us and the sun, that Venus owes her great brightness, for she is but one-eleventh as large as Jupiter, and, were she at his distance, she would not be as bright as the pole-star.

If she were as far off as Saturn, she would be invisible to the naked eye. It would be a mistake, however, to conclude from this statement that Venus, as she actually is, would be invisible from Saturn, for, in her present position, she receives from the sun about two hundred times as much light as she would if removed to Saturn's distance, and is correspondingly brighter. She would, in fact, appear considerably brighter to an observer on Saturn than Saturn himself does to us.

On the other hand, if Jupiter were in Venus' place, he would show, at favorable times, as a crescent about one-quarter the size of the moon, and would give us a pretty fair sort of moonlight. We may well be thankful, however, that such is not the case, for the attraction of so great a planet, so near us, might so change the earth's orbit as to bring us uncomfortably near the sun, or to send us so far from him that we should all be frozen.

Such a conjunction as the one which we now have the privilege of viewing is a rare occurrence. Jupiter revolves about the sun in twelve years, and Saturn in thirty. Twelve years hence, Jupiter will be in the same part of the sky as at present, but Saturn will have gone nearly half way round, and will still be ahead of Jupiter. It will take the latter twenty years in all to catch up with Saturn again, in which time he makes one and two-thirds revolutions to Saturn's two-thirds. So it will not be till 1921 that we will see Jupiter and Saturn close together again, and such conjunctions will recur every twenty years. But the two planets, when closest, may be in any part of the zodiac. Now, since Venus never goes more than about 45 deg. away from the sun, if they are more than that distance from him, they cannot be near Venus. If they are to be visible in the evening they must be east of the sun, and at least 15 deg. from him. This narrows down the region within which a conjunction like the present one is possible to about 30 deg., or one-twelfth of the whole circumference. It follows that, on the average, one conjunction of Jupiter and Saturn out of twelve will be such that an event like the present *may possibly* happen. But when such a conjunction occurs, Venus may not be in such a part of her orbit that she *actually does* come into conjunction with the others. There is only one chance in five or six that she will be. Therefore, on the average, only one out of sixty or seventy conjunctions of Jupiter and Saturn will be marked by the presence of Venus also. That is, such a display as occurs this month will happen, in the long run, once in about twelve hundred years. The actual intervals between two such conjunctions are very variable, some being much longer than the average, and some much shorter.

Jupiter and Saturn are closest on the 27th, when their distance is less than the moon's diameter. They will be very near one another throughout the last week of November.

There is a possibility that the lost Leonid meteor shower may turn up on or about the 13th of this month, but the chances seem to be much against it.

THE HEAVENS.

At 9 P. M. on the 15th, Gemini has just risen in the northeast, and Orion in the east. Auriga is above Gemini, and Taurus over Orion. Eridanus and Cetus fill up the southeast. Andromeda is directly overhead, with Cassiopeia on the north, Perseus on the east, Aries on the southeast, and Pegasus on the southwest. Aquarius and Capricornus are below and to the west of Pegasus, and Fomalhaut is the only conspicuous star lower down. Cygnus, Aquila and Lyra lie near the Milky Way in the west. Ursa Major is on the horizon below the pole, and Draco is above and to the right.

THE PLANETS.

Mercury is in conjunction with the sun on the 4th, and is invisible till the middle of the month. On the 20th he reaches his greatest western elongation, and is well seen as a morning star, rising nearly two hours before the sun.

Venus is evening star in Sagittarius, and increases in brightness throughout the month. Her conjunctions with Jupiter and Saturn have already been described. Mars is evening star, too faint and near the sun to be easily seen. Jupiter and Saturn are evening stars in Sagittarius. Uranus is too near the sun to be seen. Neptune is in Gemini, well placed for telescopic observation.

THE MOON.

Last quarter occurs on the night of the 2d, new moon on that of the 10th, first quarter on the morning of the 19th, and full moon on the evening of the 25th. The moon is nearest us on the 25th, and most remote on the 11th. She passes Mercury on the night of the 9th, Uranus and Mars on the 13th, Venus on the forenoon, and Jupiter and Saturn on the afternoon of the 15th, and Neptune on the 27th. The moon, Venus, Jupiter and Saturn, all in close proximity, will afford a fine spectacle on the evening of the 15th.

SCIENCE NOTES.

Prof. William T. Richards, of Harvard University, has received a call to the newly established research professorship of chemistry in the University of Göttingen. It is especially gratifying to note that one of the greatest universities in Germany should offer the chair to an American.

About 250,000 pairs of glasses will be purchased by the State committee in Maryland for use in polling booths. Politicians have found that both in the city and country districts a large number of voters of the poorer classes can read sufficiently well to ballot, but their sight is so defective that in the dimly lighted booths they are unable to read the long list of contestants on the ballot. Capable men will be provided at every polling place to adjust the glasses for the voters.

A cheap and rapid method for concentrating the enormous quantities of blood collecting in abattoirs is described by its inventor in the Technische Rundschau. The blood is injected in a finely pulverized state into an oven-shaped chamber, open at the top, and brought into contact with a current of hot air ascending from below. All the water is evaporated in this manner, and the blood powder is carried to the receiving chamber. According to the inventor, the powder thus obtained is tasteless and contains 74.8 per cent of digestible albumen.

The committee has not yet decided whether M. Santos-Dumont is entitled to the prize of 100,000 francs or not. No decision will be made before November 1, as the competition remains open until October 31, so that if in the meantime another competitor should appear and fulfill the conditions he would share in the prize. The persons who are prominently identified with aeronautical matters are of the opinion that M. Santos-Dumont has really won the prize, and M. Deutsch is convinced that the commission will award it to the young Brazilian.

Carrier pigeons have been put to novel use by a physician of Rockland, Me. On one occasion he was called to an island some twenty miles distant to attend a patient who was seriously ill. To reach this island he was obliged to make a dangerous trip. Before he returned to the mainland he gave the family of his patient six homing pigeons which were to be used as messengers to inform him of the patient's condition. A pigeon was dispatched as often as necessary, carrying assurances to the physician of the patient's steady progress toward recovery.

A series of observations by the late Prof. A. von Kerner has been published on the variations in the time of the opening and closing of flowers. He states that the fact that some flowers remain open for a longer period in summer than in spring is not due to the direct influence of an increase in the light, but to a rise in temperature due to the absorption of light. With many flowers the opening is not the result of growth, but of changes in turgidity due to transpiration. In *Hemerocallis flava* and *Hibiscus trionum* the flowers remain open only for a single day in the summer, while in autumn they open for two or three days in succession.—Oesterr. Bot. Zeitschr.

A new explosive, which is safe from detonation, has been invented by M. Fiedler, of Moscow, Russia. His explosive comprises a fluid and a solid, and the two have to be mixed before they will explode. The former is composed of nitrol-benzol 80 parts and turpentine 20 parts. The solid consists of potassium chlorate 70 parts and permanganate of potash 30 parts. To form the explosive 20 parts of the liquid are added to 80 parts of the solid. The former is packed in soldered tins, and the latter in packets waterproofed with chromic glue. A very salient feature of this explosive is that even when mixed, should it become ignited by contact with flame, the substance will burn away quietly.

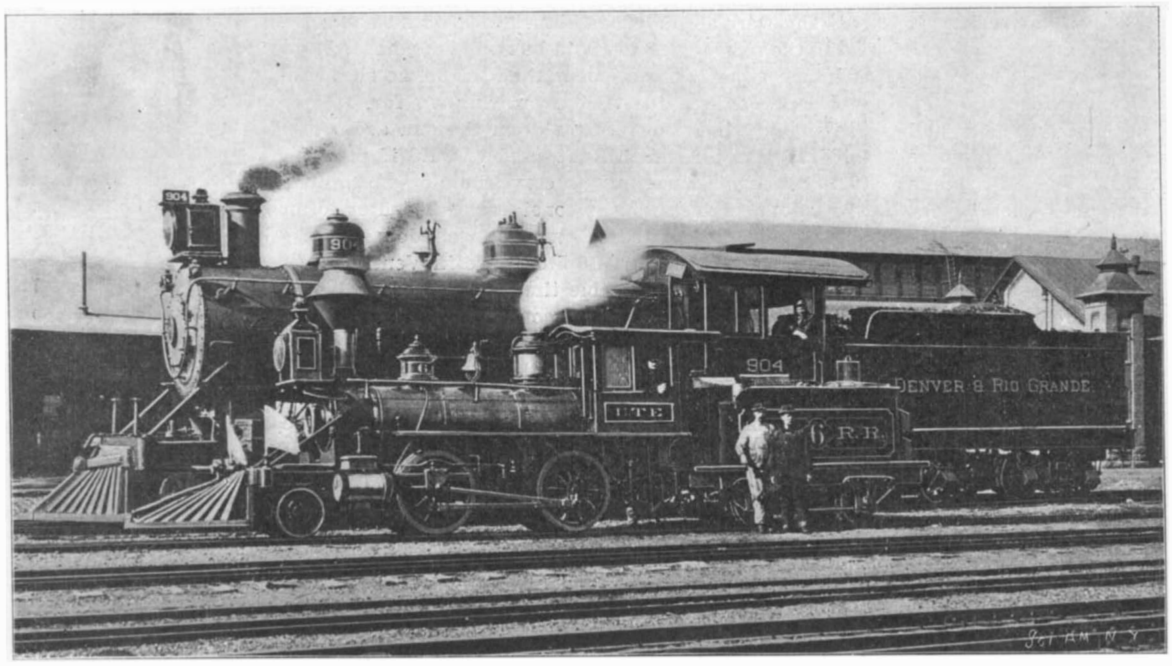
An English aeronautical engineer, Mr. T. Hugh Bastin, of London, is to make an attempt for the Deutsch prize. This aeronaut in his invention has emulated the movements of birds while in flight, thus following in the footsteps of Langley, Hargraves, and Lilienthal. He practically utilizes huge wings for driving his vessel through the air. The wings are immense framework structures, sufficiently rigid and strengthened to overcome atmospheric resistance, with a covering of silk. These wings or fans have two movements at right angles to the direction of flight, precisely the same as a bird, with the same results. The front of the machine is pointed, so that it can readily cleave its way through the air. In flying the aeronaut avails himself of the oscillating movements of nature.

THIRTY YEARS' GROWTH OF THE LOCOMOTIVE.

The accompanying photograph shows a phase of railroad development in this country in the demand for additional locomotive power as traffic has increased. In 1871 the smaller engine was ordered for the Denver & Rio Grande Railroad Company, and built according to the specifications of the railroad officials. It was utilized to haul both freight and passenger trains, and, at the time, was the average size locomotive in service in the West. Its companion represents one of the latest placed in service on the same system, and, as will be noted, it is a mechanical giant beside the other.

The great difference in the locomotives will be appreciated by a comparison of their dimensions. While the larger has cylinders 22 by 28 inches, those of the smaller engine are 9 by 16 inches; while the driving-wheel base of the latter is but 6 feet 2½ inches, as compared with 14 feet 8 inches on that of the former. It has a pony truck and four coupled driving wheels, while the diameter of its boiler is but 34½ inches, 40 inches less than that of the other; its tank is a pail compared with the equipment of the modern engine, for it carries but 450 gallons, whereas the capacity of the other is 6,000 gallons. The diminutive locomotive was constructed when the track of the Denver & Rio Grande Railroad was but 3 feet gage, and it is now utilized on small feeders of the system to haul light loads. The smaller engine and tender are no longer over all than the engine of its successor, while the smokestack is not as high as the top of the other's boiler.

No. 6, however, has been kept in good condition, and is in daily service, despite the fact that it weighs but twelve and one-half tons. The new type weighs ninety-two tons. Both engines were built at the same works, and the little fellow was considered in its day to be an up-to-date and first-class locomotive in every respect.



Locomotives of 1871 and 1901 on the Denver & Rio Grande Railroad. Respective weights, 12½ and 92 tons.

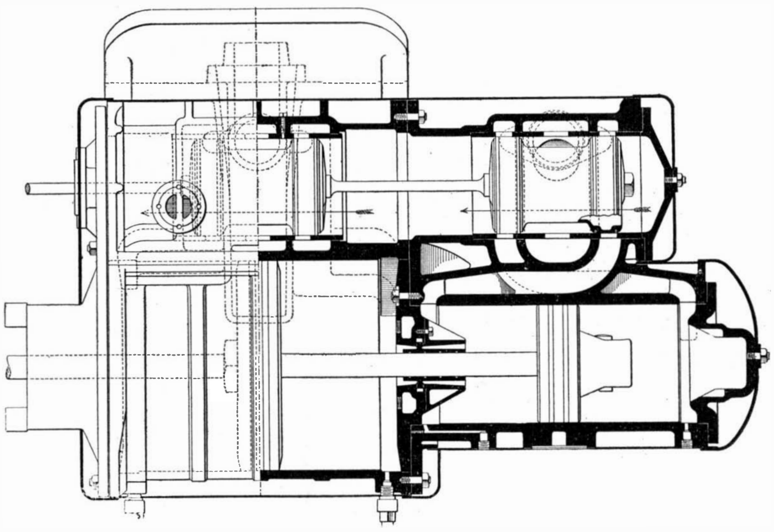
THIRTY YEARS' GROWTH OF THE LOCOMOTIVE.

TANDEM COMPOUND LOCOMOTIVE FOR THE NORTHERN PACIFIC RAILWAY.

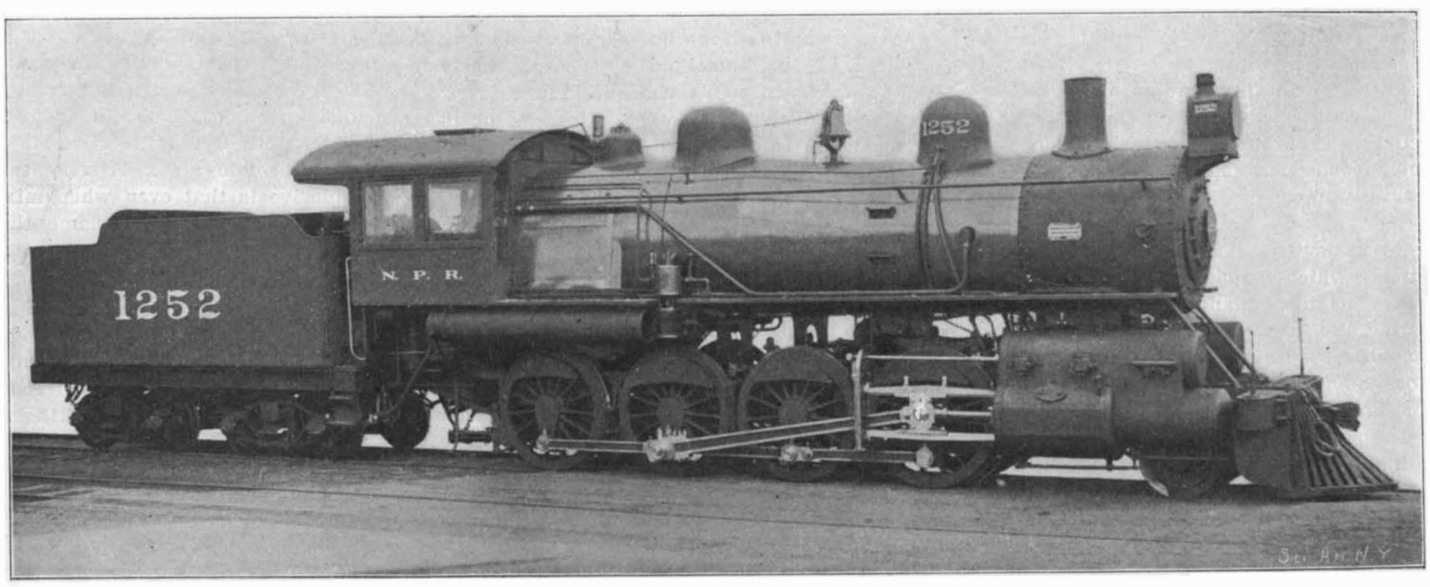
The accompanying photograph and line drawing show the general appearance and details of the tandem cylinder of an experimental four-cylinder tandem compound locomotive, which was built by the Schenectady Locomotive Works for the Northern Pacific Railway. After a year of service the new type has proved so satisfactory that the Schenectady firm is building twenty-six more locomotives of the same type for the Northern Pacific and forty for the Atchison, Topeka and Santa Fé Railroad.

The compound locomotive has not made the rapid progress in this country that it has in some parts of Europe, particularly in France, where the fastest train in the old world is hauled by four-cylinder compounds. Nevertheless, the really good designs of compound locomotives that have been turned out by our builders have fully justified the claims of fuel and steam economy which are commonly made for the compound locomotive, as such. Simplicity of parts and convenience of manipulation have always been characteristics of the American locomotive, and the desire to maintain these features, no doubt, has led our makers to prefer the two-cylinder type of compound to that which uses three or four cylinders. There is an objection to the two-cylinder type, however, arising from the fact that in the larger locomotives, which are now in such increasing demand, the diameter of the low-pressure cylinder becomes so great that its casing projects beyond the loading line permissible by the platforms and tunnels of our railroad systems. Hence we are driven to the necessity of using four cylinders of less diameter. In the well-known Vauclain type, two cylinders, one high and one low pressure, are placed on each side of the smokebox, the high-pressure being above the low-pressure, and the two piston rods connecting to a common crosshead. In Great Britain a type of four-cylinder compound has lately been put in service, in which the four cylinders are placed abreast of each other, two being outside and two inside connected, and all coupled to the forward driving wheels and axle. In France the two inside-connected cylinders drive the forward axle and the two outside-connected cylinders drive the rear axle of the four-coupled driving wheels.

The Northern Pacific engine carries two pairs of high and low pressure cylinders on the outside of the frames and in tandem, the high-pressure cylinder being placed in front of the low-pressure and on the same axial line, a common piston rod carrying the two pistons. There is only one pair of saddle castings and the cylinders are cast separately, the high-pressure cylinders being mounted upon the front of the low-pressure cylinders. Both cylinders are fitted with piston valves with a continuous passage between them. This passage forms the receiver. The valves are made hollow, the high-pressure valves being arranged for inside admission and the low-pressure valves for outside admission. This arrangement, coupled with the crossing of the steam ports of the high-pressure cylinder, has enabled the designer to use a single valve stem. Relief valves are used on the high and low pressure cylinders. On the low-pressure they are attached to the steam chest and act as a bypass when the engine is drifting. The general dimensions of the engine are as follows: Diameter of high-pressure cylinder, 15 inches; of low-pressure, 28 inches; and stroke, 34 inches; the greatest travel of the slide valves is 6 inches, the outside lap is ⅞ of an inch and the inside clearance is ¼ of an inch in the case of the high-pressure and ⅜ of an inch in the low-pressure. The diameter of the driving wheels outside of the tire is 63 inches; the boiler is of the expanded-wagon-top type, with wide fireboxes; the outside diameter of the first ring is 66½ inches. The length of the firebox is 100 1-16 inches and the width is 75¼ inches, and the depth of the front is 70¾ inches and at the back 59¾ inches. There are 338 2-inch tubes, each measuring 16 feet in length over the tube sheets. The heating surface in the tubes is 2,815 square feet; in the water-tubes, 26.46 square feet; in the firebox, 155.64 square feet, making a total heating surface of 2,997 square feet. The grate area is 52.29 square feet. The boiler pressure is 225 pounds to the square inch. The tender, which weighs empty 47,000 pounds, has a water capacity of 5,500 gallons and a coal capacity of 10 tons. The weight of the locomotive, on the drivers, is 175,000 pounds, and the weight of the locomotive in working order is 198,000 pounds.



SECTION THROUGH CYLINDERS AND STEAM CHEST.



Cylinders, 15 inches and 28 inches by 34-inch stroke; boiler pressure, 225 pounds to the square inch; heating surface, 2,997 square feet; weight of locomotive, 198,000 pounds.

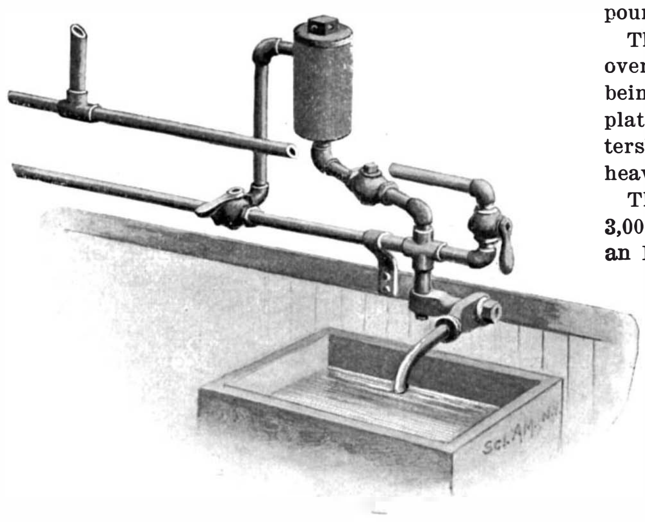
TANDEM COMPOUND LOCOMOTIVE FOR THE NORTHERN PACIFIC RAILROAD

Monument to James Bowman Lindsay.

At Dundee, a granite monument was recently unveiled to the memory of James Bowman Lindsay, an investigator and inventor whose experiments in connection with wireless telegraphy and other scientific advances fifty years ago, ought not to be forgotten. Sir William Preece, in unveiling the monument, remarked that Bowman Lindsay was long before his time. He was a prophet who would compare with any prophet, for in 1834 he wrote that houses and towns would in a short time be lighted by electricity instead of gas, and heated by it instead of coal, and machinery would be worked by it instead of by steam. Sir William Preece recollected that while he was attached to the electrical department of the Electric Telegraphs Company there came from Dundee to London a gentleman with a proposal to dispense with wires and communicate across water. He was attached to Mr. Lindsay, and he made all the arrangements and conducted all the experiments to illustrate his system in London. Unfortunately there was really no necessity for the invention in those days. An invention to be of use must come at the proper time. There must be the want for it, otherwise it died. This accounted for the fact that the system of wireless telegraphy, which was now associated with the name of Lindsay, had been neglected.

A SOAP-DELIVERY ATTACHMENT FOR WATER PIPES.

A simple invention, patented by Charles R. Walker,



A SOAP-DELIVERY ATTACHMENT FOR WATER PIPES.

of Jamestown, N. D., provides a means whereby soap or water mixed with soap can be delivered at a kitchen sink. The inventor employs a double T or four-way coupling, which is connected with a hot-water supply pipe and with a cold-water supply pipe by means of its two horizontal arms. With the upper vertical arm of the T a pipe leading from a soap receptacle is connected. The soap receptacle is likewise connected by a pipe with the hot-water supply pipe, the pipe at its junction with the hot-water line being provided with a three-way valve. The lower vertical arm of the four-way T is connected with a pipe having a nipple and a discharge faucet adjustable relatively to the lower vertical arm of the T. All of the pipes are valved. By a proper manipulation of the valves it is possible to permit cold water, hot water, hot and cold water, hot water and soap, cold water and soap, or hot and cold water and soap to flow through the faucet.

A CALIFORNIA MARINE RAILWAY.

BY ENOS BROWN.

The first marine railway yet installed upon the Pacific coast has just been completed at Oakland, Cal. It is one of the Crandall type and is used in a ship-yard for hauling vessels out of the estuary, when repairs below water-line are required. It has been in use for several months, and has proved expeditious and efficient. The railway itself consists of a platform 255 by 76 feet, resting upon trucks running upon four tracks, which themselves rest upon three tiers of pine timbers. The rails are flat, the inside 1⅜ by 10 inches and the pair outside 1⅜ by 5 inches in dimensions. There are seventeen standards on each side of the cradle, the bilge blocks, sliding on rails, being worked by a small winch on top of the standards. Patent relieving bilge blocks, which are released by a small wrench, are used. The total length of track is 700 feet, ending in 30 feet of water and inclining at an angle of 1 in 22.

Four chains 570 feet long are employed in hauling the cradle. Each link is 8 inches long and made of 2 1-16 iron. The power for raising and lowering the marine tramway is supplied by duplicate engines, working on a main shaft 12 inches in diameter. The engines have a stroke of 18 inches, with cylinders 14 inches in diameter. Together they are of 240 horse power, and they are geared up to 2,000 horse power. The foundations are of massive concrete resting upon piles driven to a great depth, and in large numbers. Steam is supplied by the boilers of the shipyard. The entire iron work of the engines is of the most solid and massive character, the main gears being 11 feet in diameter with a 14-inch face, the two weighing 24,000 pounds. They work at an average of 160 revolutions.

The endless chains for hauling up the platform pass over a gypsy, cast-steel, sprocket wheel, each link being caught as the wheel revolves. The speed of the platform is controlled by brakes acting upon the countershaft. These are used only when descending with heavy loads.

The railway is capable of hauling out a vessel of 3,000 tons' displacement. The largest yet handled was an English bark weighing 1,500 tons with 300 tons of load, making a total weight of 1,800 tons. This vessel was lifted in 20 minutes.

The terminus of the railway is 10 feet below the channel of the stream. The vessel to be docked is brought between two massive blocks of piles, which mark the situation of the cradle when under water. With the keel resting upon the center blocks the bilge blocks are worked up to the sides and the ship is secured.

It is claimed that this method of docking vessels is superior to the drydock, or the ordinary ways, inasmuch as the frame is subjected to less strain and much time is saved. An advantage is also secured in the easy operation of the machine.

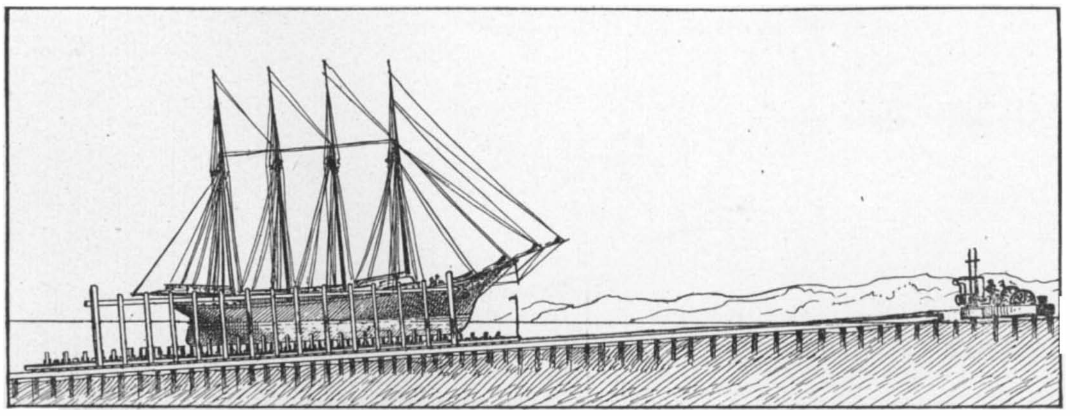
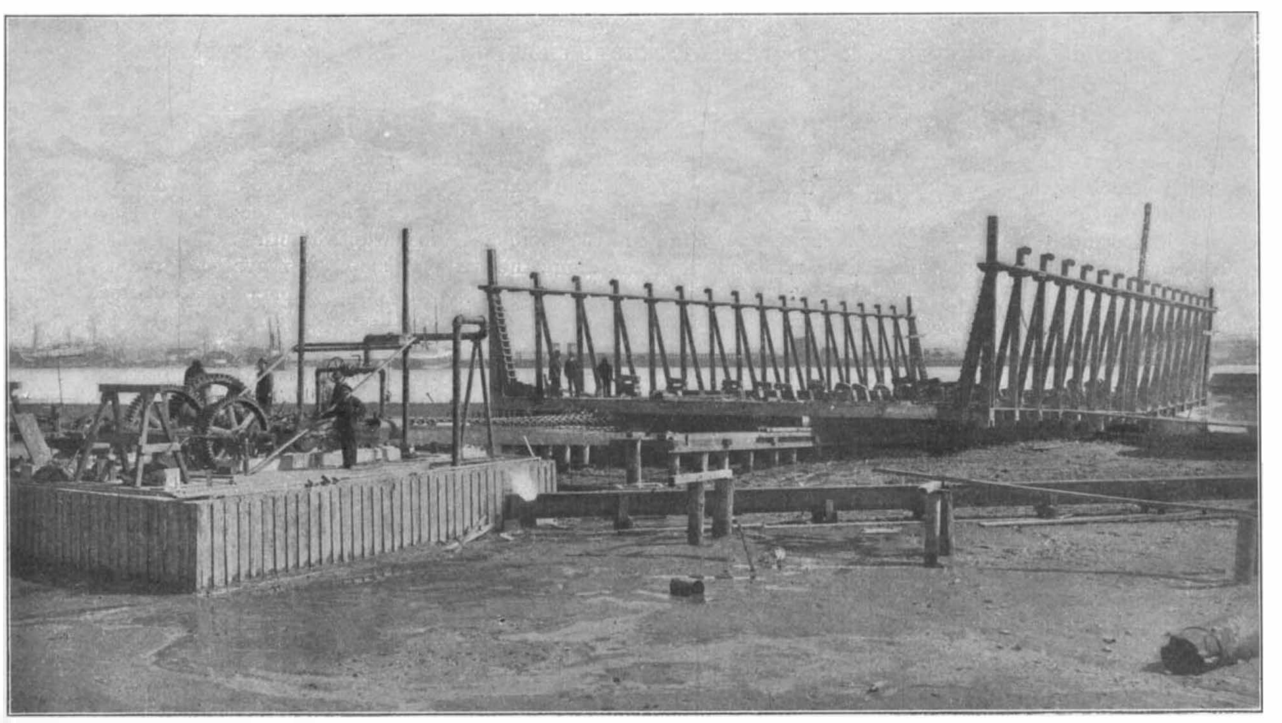


Diagram Showing Vessel Floated Into Cradle and Being Hauled Out by Stationary Engines on Shore.



The Hauling Engines and the Cradle.

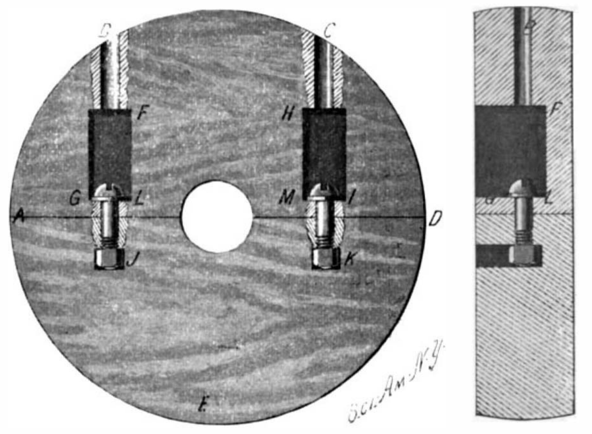
A CALIFORNIA MARINE RAILWAY.

HOW TO MAKE A SIMPLE SPLIT PULLEY.

Sir Charles B. Elliott, general manager of the Cape Government Railways (South Africa), recently paid a visit to this country and called upon the editor of the SCIENTIFIC AMERICAN, and he described an easily constructed split pulley which he had built, and he has given us the following description:

Take two pieces of hard wood and saw them into two semicircular disks, *A B C D* and *A E D*. The diameter, *A D*, may be 15 inches or any other diameter that may be required. The thickness of the wood may be 3 inches, or any other suitable thickness.

Make two rectangular holes about 3 x 1 inches in the upper disk, *F G* and *H I*. These holes should be just large enough for a 3-inch bolt to slip in easily. In the lower disk, *A D E*, cut two holes, *J*, *K*, about 1 x 1 inch, just large enough for the nut of a 3-inch bolt to slip in, so that when the bolt is screwed into it the nut will not turn round. Bore a ½-inch hole between *F G* and *J*, and another between *H I* and *K*, so that a 3-inch bolt may be inserted in *F G* and screwed into the nut at *J*. Bore a hole from *B* to *F*, large enough for a narrow screwdriver to be inserted, so as to screw the bolt into the nut. For this purpose the square edges under the head of the bolt should be filed or turned down, and the head of the bolt should have a slit sawed into it with a hack-saw, to receive the screwdriver. An iron washer, *L*, should be inserted under the head of the bolt. A similar hole



AN EASILY CONSTRUCTED SPLIT PULLEY.

should be bored at *C*, and another bolt screwed into the nut at *K*, with a washer, *M*, under the head of the bolt.

Before finally bolting the two disks together, it is well to place either a piece of veneer or a piece of thin pasteboard between the two disks. When they are firmly bolted together a hole should be bored in the center, the exact diameter of the countershaft on which the pulley is to run. The two disks may now be separated, the veneer or pasteboard removed, and the two disks should again be firmly bolted together on a mandrel the exact size of the countershaft, placed between the lathe centers, and be turned up to the exact dimensions required, rounding off the edges, and finishing with sandpaper. A side view of the finished pulley is represented in the engraving. The disks may be again separated and bolted onto the countershaft.

If the pulley is required to have two or more steps, four instead of two bolts may be used; and these will be sufficiently strong to hold the pulley firmly to the countershaft.

Nature of Lightning.

K. R. Koch (Physikal. Zeitschr.) has found that lightning conductors whose connections have become imperfect through rusting or otherwise, act, nevertheless, in quite an efficient manner in the case of a thunderstorm. This is, in his opinion, due to the oscillating character of lightning discharges. Electromagnetic waves are produced, which act upon the imperfect connections as upon a coherer, restoring their conductivity for a more or less long period. Lightning has hitherto been considered a continuous discharge, which often becomes apparently oscillatory by quick repetition. The author employs a rapidly revolving camera in order to test this question, but does not arrive at any definite conclusion, as the flashes photographed were all too distant.

One of the largest American manufacturers of street and railroad cars is to build a factory in England.

PROGRESS OF CONSTRUCTION OF THE RAPID TRANSIT TUNNEL.

In spite of the long and exceedingly trying summer weather, the work of constructing the Rapid Transit Tunnel has been pushed forward with greater activity than at any other period since the work was opened in March of the year 1900. At the present time there are 8,000 men employed on the work, and up to date $9,700,000 has been expended. This represents over a quarter of the contract price for the work of $35,000,000.

The force of men is at work in day and night shifts, and at the present time the total monthly cost of the construction averages nearly $1,000,000. If there should be no unforeseen obstructions and delays, the railroad will probably be completed and in operation by Christmas of 1903 or early in the year 1904. The line of the tunnel has been opened over two hundred blocks, while on about thirty blocks the tunnel is practically completed.

The accompanying progress plan of the work shows the location of the road. Commencing at City Hall Park there is a single-track loop, which swings over to the west in front of the City Hall, and curves around to a junction with the main four-track line, near the Hall of Records. Southward from the station a two-track tunnel will be built below Park Row and Broadway to Whitehall Street, where it will descend and pass beneath the East River to Joralemon Street, Brooklyn. From Joralemon Street it will pass to the City Hall of the Borough, and be extended to the Flatbush Avenue station of the Long Island Railroad. From the City Hall, Manhattan, northward there will be a four-track tunnel, which will extend beneath Center and Elm Streets to Lafayette Place; from which it will diverge diagonally northeast to Fourth Avenue, and up Fourth Avenue to Forty-second Street. Here it will swing to the left, following Forty-second Street to Broadway, when it will turn to the north again and follow Broadway to 104th Street. At 104th Street it will split into two branches, the easterly branch diverging as a two-track structure, and passing diagonally beneath the northwest corner of Central Park to Lenox Avenue, which it will follow to 141st Street. Here it will swing to the right and pass beneath the Harlem River. From the river it will be carried, chiefly as an elevated structure, to Bronx Park. The westerly branch will extend up Broadway as a three-track structure from 104th Street to 145th Street, and from 145th Street to the terminus at Bailey Avenue it will be a two-track structure.

The work of excavation is advancing so rapidly that already orders have been given for the necessary steam and electrical plant for the power station, and John B. McDonald, the contractor, and Chief Engineer William Barclay Parsons, with others, have left for London and Paris to inspect the underground systems in those cities and determine upon the best system of traction to employ on the tunnel. We presume that this trip will include a visit to Budapest, and a thorough investigation of the Ganz system, for which the contractors of the underground railroads in London have lately claimed an economy of 30 per cent as compared with the ordinary direct-current system as used on the Metropolitan railways in this city.

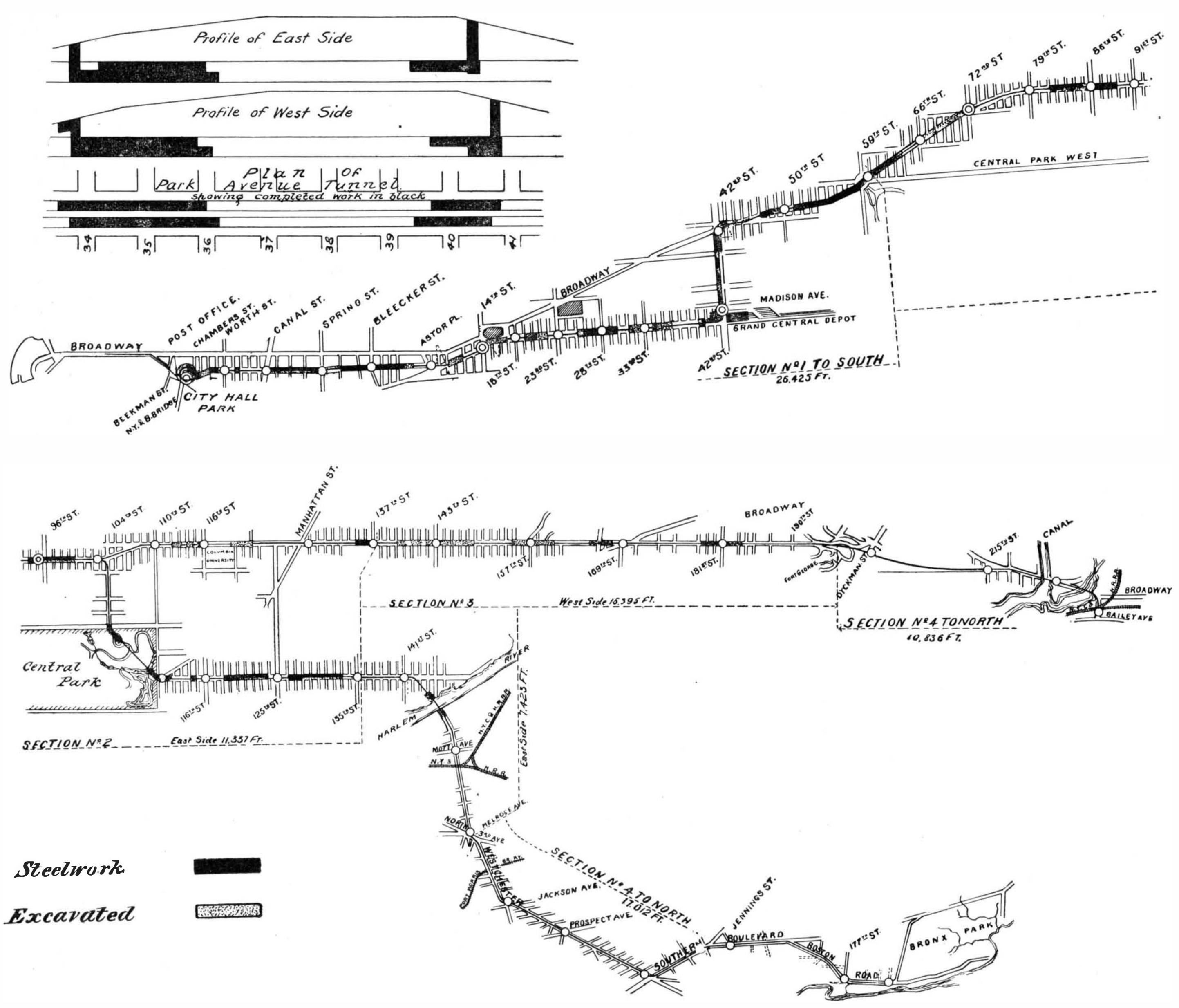
Work on the loop at City Hall Park is well advanced. A considerable part of the concrete arched tunnel has been built and about 70 feet of this completed tunnel has been filled in, and the original surface restored. From Chambers to Duane Street two tracks out of the four have been entirely excavated, and from Duane Street to Pearl Street the full four-track width is excavated and roofed in and the steel in place. From Leonard to Franklin Street ground has been broken and excavation is well under way. From Howard Street to Grand Street excavation has been commenced, and from Grand to Spring Street the width of two tracks has been excavated and the steel framework of the tunnel is in place. From Spring Street to Prince Street the width of two tracks has been excavated along the western side of the tunnel, and from Prince Street to Bleecker Street excavation is completed, the steel, walls and roof are in place, and the concrete arches have been turned. From Bleecker Street to Fourth Street all of the excavation and steel work has been executed for about a total of half the distance. The tunnel through Lafayette Place is about half excavated and a third of the steel is in place. From 10th Street to 12th Street all the excavation has been done, and the steel and concrete work is about half completed. Through Union Square from 14th to 17th Street the tunnel is entirely through rock, which here is met near the surface. The surface tracks of the Metropolitan Street Railway Company have been moved over to the eastward until they are clear of the easterly line of the tunnel. Excavation has been carried out to grade along the westerly side, and the rock is gradually being blasted back to the easterly line. From 19th Street to 22d Street three-quarters of the excavation is completed and half of the steel work has been erected. From 25th to 26th Street excavation has been carried on for about half the block, and is practically completed; on the west side of the tunnel from 26th to 30th Street, the tunnel is excavated and about three-quarters of the steel work completed. From 31st to 33d Street excavation has been completed for the full width of the four tracks.

An exceedingly interesting portion of the work is that which extends below the level of the Fourth Avenue tunnel. At this point the four-track tunnel divides into two two-track tunnels, each running below and somewhat to the side of the Fourth Avenue tunnel. Two shafts have been sunk at 34th Street and excavation has been completed in each tunnel for a distance of two blocks and a half. Between 40th and 41st Streets two shafts have been sunk and a top-heading has been driven for a distance of a block and a half, the full section of the tunnel being excavated for three-quarters of a block in the easterly tunnel.

On 42d Street, between Fourth Avenue and Broadway, the work has been carried forward with considerable activity. At the turn from Fourth Avenue and 42d Street, at the location of the 42d Street station, a large excavation has been made. There is another excavation at 42d Street and Madison Avenue for two blocks, which includes the width of two tracks. Between Fifth and Sixth Avenues the excavation is about complete for the width of two tracks on the south side, and a considerable amount of steel has been built in. From Sixth Avenue to Broadway all the excavation has been done and nearly all of the steel is in place. The excavation at this point has been carried out by a process known as "slicing," in which the roof is carried by temporary struts until the steel posts are in place, the balance of the material being subsequently removed without disturbing the roadway.

From Long Acre Square to 45th Street there are intermittent stretches of excavation, but, as yet, no steel has been put in place. From 47th Street to 50th Street the material has been excavated along the western side for a width of two tracks, the steel has been erected, and "slicing" has been commenced across to the eastern side of the tunnel. Excavation for two tracks has also been carried along on the eastern side from 51st Street to 52d Street, and also from 53d Street to 57th Street, where the steel has been put in place. From 57th Street to 59th Street the western half of the tunnel is excavated and the steel is being built in. Across the "Circle" all the excavation and steel work is completed, and experimental work is being carried on at the station, which is located here, with a view to determining the best kind of tiling to use in finishing off the many stations throughout the tunnel. From 60th to 64th Street the excavation is all done and about half of the steel is in place. From 64th to 72d Street about half of the excavation is completed, while from 72d Street to 81st Street nothing has, as yet, been done. Part of the excavation and steel work has been completed between 81st Street and 84th Street. From 86th Street to 89th Street the tunnel has been excavated for the full width and the steel work and concreting finished.

From 94th Street to 100th Street excavation has been done off and on, and part of the steel has been placed. On the western branch of the road excavation has been more or less completed between 112th and 116th Streets, but no steel has been put in. Another stretch of excavation exists between 120th and 123d Streets. About half of the foundations for the columns of the Viaduct across the Manhattan Valley have been completed. From 135th to 137th Street the tunnel is completed, with steel and concrete in place. There are stretches of excavation from 140th to 150th Street, while from 155th to 160th Street the excavation is all done, and from 155th Street to 159th Street the arched masonry has been constructed, except at the opening which is left for the station. At 167th Street and 181st Street two shafts have been sunk and the excavation has been run for about an eighth of a mile in each direction, north and south, while about a quarter of this excavation has been



MAP OF THE NEW YORK RAPID TRANSIT TUNNEL SHOWING PROGRESS OF CONSTRUCTION.

taken out to the full section of the tunnel. On the eastern branch of the road a shaft has been sunk at 104th Street and Central Park West, and excavation for the top-heading has been pushed forward for 600 feet in a northeasterly direction. The road is to be carried in tunnel diagonally across the northwestern corner of the Park, and at the northwestern exit about 200 feet of the heading has been driven. North of this about 350 feet of the two-track subway has been entirely completed, and the surface restored, and the traffic of the driveway has been running over it for several months.

The work from 114th to 115th Street is practically completed, both excavation and steel work, and another completed stretch is found from 118th to 120th Street. From 120th Street to 124th Street the excavation is partly done and much of the steel work has been erected. From 126th to 128th Street there is a stretch in practically the same condition. From 130th to 133d Street excavation is well under way, and in places the steel framing of the sides and walls has been erected. At the crossing beneath the Harlem River the excavation of the approaches on each side is well under way.

The progress of construction, as outlined above, is eminently satisfactory and reflects the greatest credit upon both engineers and contractors. If the present rate is maintained, the tunnel will probably be completed and trains running from nine months to a year before the contract date for completion.

In the following issue of the SCIENTIFIC AMERICAN we shall give a series of views showing the various methods of construction adopted in carrying out this great work.

WASTE-HEAT AUXILIARY ENGINE.

In the SCIENTIFIC AMERICAN for March 24, 1900, we published an account of the waste-heat auxiliary engine which has been installed in the laboratory of the Royal Technical High School at Charlottenburg by Prof. Josse. Even at that time this engine was considered to be an original and highly interesting experiment involving the efficiency of steam engines by utilizing the heat of the exhaust steam for evaporating another liquid having a lower boiling point than water, the process being the joint discovery of a Hamburg engineer, Herr G. Behrend, and Dr. Zimmerman, of Ludwigshafen. Through the courtesy of our Consul-general at Berlin, the Hon. Frank H. Mason, we are able to present our readers with a most interesting series of pictures showing the latest developments in the waste heat auxiliary engine.

It is well known that a large proportion of thermal energy delivered to a steam engine from its boiler is lost in the unused steam which exhausts into the air by a non-condensing engine, or is absorbed by the cold water of the condenser in a low-pressure machine. Multiple expansion engines of high efficiency economize this waste power by using the steam successively in a second, third and even fourth cylinder, but even then the loss is considerable, being about eighty per cent of heat, namely, the difference between the temperature of the condenser, 140 deg. F., and that of the circulating water, which will average about 60 deg. F. The idea of the waste-heat auxiliary engine is to utilize this wasted heat for evaporating a liquid which boils, and therefore volatilizes, at a much lower temperature than water. Two such liquids, ammonia and sulphur dioxide, have been successfully used in the refrigerating industry, for the reasons that sulphur dioxide has a viscous consistency and does not attack iron, but, on the contrary, lubricates it, and because the pressure of its vapors at the temperature of waste steam is readily controlled. It has therefore been used from the first as the best material for this purpose. At 140 deg. F. sulphur dioxide vapor has a pressure of 156 pounds to the square inch, while at 60 deg. F., the mean temperature of the cooling water in the condenser, the pressure is about 41 pounds per square inch, thus offering a range of 80 deg. F. through which the exhaust steam from a steam engine will evaporate sulphur dioxide with such energy that its vapor will exert an expansive force. The conservation of this expansive force of this mechanical motive power is the function of the "waste-heat," or as it is otherwise called, the "cold-steam engine." For this purpose an additional auxiliary single-cylinder engine is placed adjacent to the steam engine, and geared either to the same driving shaft or run independently with its own driving shaft and flywheel. The sulphur dioxide is evaporated by the exhaust steam heat in a special type of boiler called the "atomizer." The vapor thus generated passes through the cylinder, and its effective work being done, it escapes into the sulphur dioxide condenser, where it is condensed to liquid form and pumped back into the vaporizer, thus forming a cycle, and being used over and over again indefinitely.

Although the process is technically direct and simple, it was found to possess many mechanical difficulties. All the joints and packing had to be made so perfect that, however great the pressure, none of the poisonous dioxide gas or liquid should escape. In the presence of air or water, the dioxide rapidly oxidizes into sulphuric acid, which attacks iron and other metals. It is, therefore, necessary that the whole apparatus should be air and water tight, and this to resist an internal pressure of 150 pounds per square inch requires the best materials and workmanship as well as intelligent supervision. The surface condenser also offered great difficulties. A cold-vapor cylinder of 10½-inch bore and 19½-inch stroke was attached to a 150 horse power, triple-expansion, Görlitz engine of high efficiency, which is regularly employed by the Technical High School for electric lighting and experimental purposes. The engine, which is shown in one of our engravings, is of an improved modern type, the high and intermediate pressure cylinders being placed tandem and horizontal, while the low-pressure cylinder is vertical, and all three act upon the same crank and driving shaft. The cold-vapor cylinder is made of cast iron covered, not with a heating jacket, but with a simple sheet iron casing packed with felt. It is proportioned for a maximum working pressure of 215 pounds.

The vaporizer and condenser, which are also shown in our engravings, are of cylindrical form and about 10 feet in length. They are set in a steel frame, one above the other, and below will be noticed the pump which ejects the liquid dioxide coming from the condenser up into the vaporizer, as shown underneath the condenser. Both contain a system of tubes very carefully fitted so as to prevent the leakage of water or dioxide. The vaporizer is 34⅝ inches internal diameter and has about 753 square feet of heating surface, by which the exhaust steam of the engine acts upon the liquid dioxide and converts it into vapor. It then passes through the cold-vapor cylinder and returns to the condenser, which has an internal diameter of 41 inches and about 720 square feet of cooling surface. The valves are set in both pipe systems so that sections can be cut out for examination and repair without withdrawal of the dioxide. The feed pump is worked by an eccentric on the main shaft, and to operate it only three-quarters of one per cent of the power developed by the engine is required. The super-imposition of the vaporizing condenser was rendered necessary on account of the lack of space, but they may be placed at any desired position convenient to the engine. The waste heat engine at the Technical High School has been run almost continuously for over a year without accident or any serious difficulty. When the storage batteries are being charged, it is run up to a speed of 168 revolutions per minute.

In the report recently issued by Consul-General Mason appears the following statement:

The load has been a direct-connected continuous-current dynamo, with a rated output, at 150 revolutions, of 400 amperes and 240 volts, which, as the official report states, was sometimes overloaded as high as 40 per cent as a means of testing the increased capacity obtained by the addition of the waste-heat cylinder. The result, in respect to both steam consumption and electrical output, has been measured by the highly perfected standardized instruments and methods with which the Technical High School is fully equipped. The complete official record is too elaborate and technical for comprehension by other than an expert reader; but it will be sufficient for the present purpose to say that as a net result, the waste-heat engine delivered an additional energy equal to 34.2 per cent of that of the triple-expansion steam engine. Its economy is measured by the fact that, when working, it enabled the steam consumption to be reduced from 11.2 pounds to 8.36 pounds per indicated horse power hour, a very successful result when the smallness of the unit is considered. The same proportionate saving in large engines of 2,000 or 3,000 horse power would constitute a highly important economy in these days of costly fuel and insatiable demand for vast steam power in electrical power and lighting stations.

While these careful and continuous experiments have been in progress at the Technical High School, a cold-vapor-engine plant has been constructed, put in operation, and tested in actual daily service at the central station of the Berlin Electrical Works in Markgrafen Strasse. This is the oldest of the power stations of the company, and is equipped with what is now considered relatively small units, viz., vertical compound engines of 360 horse power, of Belgian construction, which have an average steam consumption of 18.35 pounds per indicated horse power hour. With a steam consumption as high as this, there is abundant chance for economy by utilizing the waste heat. Moreover, this was a case in which more power was urgently needed at the station. Either the cold-vapor auxiliary plant or new steam boiler and engine had to be supplied.

Accordingly, a cold-vapor engine of 175 horse power was built by Freund, of Berlin, and put in operation in May of this year. It is a single, horizontal cylinder machine, the piston being 17¾ inches in diameter, with 20-inch stroke, and, unlike the smaller engine at Charlottenburg, is geared independently to a directly coupled dynamo, which feeds into the service cables of the company. Working thus as a separate unit, the efficiency of the cold-vapor engine can be measured and recorded with great precision, and the net result may be condensed into the statement that at an average speed of 130 revolutions per minute, it delivers 150 brake horse power—an addition of 41.7 per cent to the working energy of the compound steam engine, from which it receives and utilizes the waste heat in form of exhaust steam. What this means will be made more plain when it is considered that the combined power stations of the Berlin Electrical Supply Company contain steam engines which, with an average steam consumption of 12.3 pounds per indicated horse power hour, have a total output of 142,300 horse power, to which, by the use of cold-vapor engines, there may be added 55,000 horse power without increasing by so much as a pound the consumption of coal. The system adapts itself with especial readiness to large plants which, like power and lighting stations in growing cities and towns, have to meet a steadily increasing demand for current. This the cold-vapor engine enables them to do without increase of boiler or steam-engine capacity, by simply saving heat energy which has previously gone to waste.

Although it has been from the first in careful and scientific hands, it need hardly be said that the dioxide-vapor engine is as yet in the infancy of its development and application. It has been regarded with skepticism and incredulity by most practical engineers in this country, but these have yielded to the hard logic of its demonstrated efficiency. It has not yet been tested on shipboard, but it is believed that in view of the tremendous losses of heat energy in the condensers of an ocean greyhound, the abundance of cooling water, and with all the incentive to fuel economy at sea, its most important future application may be in connection with marine engines. It has not yet been tested with the waste heat of furnaces, although it is well known that even in the best installations, from 20 to 25 per cent of the thermal energy generated by the burning coal escapes up the chimney. The burnt gases and heated cooling water of gas engines are also a leak of wasted energy which the cold-vapor engine may in future serve to close. Experience shows that in an average gas engine, not more than 26 per cent of the thermal energy of the gas is transformed into work, while 71 per cent is carried off in the waste gases and water of circulation. The gas engine is only less wasteful than the steam engine; both leave a wide margin of loss to be garnered and saved by the resources of modern science.

The report of Prof. Josse, from which the foregoing results are derived, goes extensively into the question of comparative costs of installation. Condensed to their most concise compass, his conclusions are that a combined steam-waste-heat plant of 1,600 horse power, including compound steam engines of 1,200 indicated horse power, and a cold-vapor plant of 400 indicated horse power, complete in every detail, would cost in Germany 212,000 marks ($50,456), while a triple-expansion steam engine of 1,600 horse power, without vapor engine, would cost 206,000 marks ($49,028), a difference of only $1,424, which, with steam coal at $4.15 per ton, as at Berlin, would be saved in a short time by the cold-vapor auxiliary.

Coming down to actual facts, the net cost of the 175 horse power waste-heat-engine plant at the Markgrafen Strasse power station was 49,700 marks ($11,828.60), and of a gas-engine plant, also of 175 horse power, 47,625 marks ($11,334.75), a difference so slight as to be negligible in presence of other and more important considerations.

New Electric Cars in London.

It is intended to provide sufficient rolling stock for the operation of a three-minute service between Finsbury Park and Moorgate Street, London, says The Trade Journals' Review. Each train is to consist of seven cars, the two end cars and the center one being provided with motors. The scheduled time for the run is 13½ minutes, inclusive of three intermediate stops of 20 seconds each. This stopping time seems unnecessarily long, as 10 seconds should be quite enough with a smart train crew. The plant at the generating station will comprise four vertical cross-compound condensing engines, developing 1,250 indicated horse power as a normal load and 1,875 indicated horse power as a maximum, when running at 100 revolutions per minute. Each engine is to be coupled direct to an 800-kilowatt generator mounted between the cranks. These generators will have 14 poles, and are designed to give 525 volts at no load and 575 at full load. Current will be collected from a third rail weighing 80 pounds per yard, and supported on porcelain insulators. There are to be 36 motor cars, each mounted on two 4-wheeled trucks. The three motor cars on each train will be operated as a single unit by means of a suitable connection and controlling gear.

THE ELECTRIC CABLE SPAN AT CARQUINEZ.

The longest span in any electric power transmission line operated on the American continent, if not indeed anywhere in the world, is that of the Bay Counties Power Company of San Francisco across the Straits of Carquinez, a comparatively narrow waterway separating Solano and Contra Costa counties of California, and connecting San Pablo and Suisun Bays, which latter form the northerly extremity of San Francisco Bay. The swinging of the electric cables, which cover the horizontal distance of 4,427 feet in a single span that has a clearance of 206 feet above extreme high tide, constitutes one of the most remarkable engineering achievements of the age; and how greatly it exceeds all previous performances of the kind will be appreciated when it is stated that, previous to the construction of the Carquinez span, the most notable example of such construction was found in a sheer stretch of 1,500 feet of cable across the Columbia River in British Columbia.

At the point on the Straits of Carquinez selected for the spanning of the cables the water is about 2,750 feet wide, with a depth ranging up to 120 feet, and through this gap flow the waters of the Sacramento and San Joaquin Rivers. There is also an ocean tide of about five feet. There is thus produced constantly a heavy and dangerous current—a current so strong, in fact, as to render impracticable the laying or operation of high-tension, submarine cables.

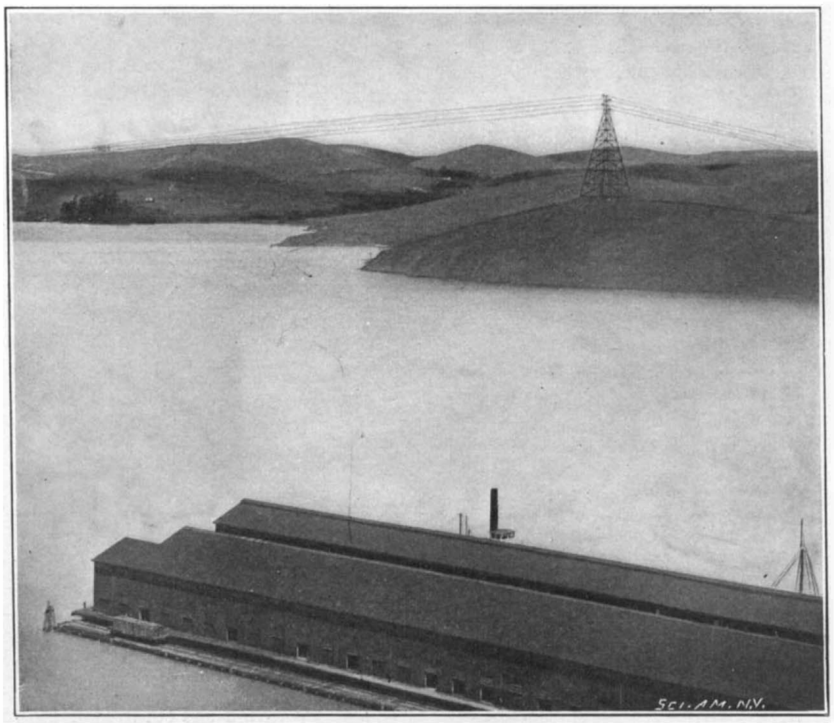
On one side of the Straits where the crossing is made is a bluff, rising to a height of 162 feet above extreme high tide. On the opposite side there is a hill rising about 100 feet from the water's edge, and back of this a gradual incline, culminating at an elevation of 400 feet about half a mile back from the water's edge. The Carquinez span extends from the 400-foot elevation mentioned to the summit of the bluff on the opposite shore, passing directly over the town of Eckley with its stores, warehouses, etc. In planning the span numerous exactions had to be kept in mind, one of which was the provision imposed by the United States government to the effect that a clear headroom of at least 200 feet should be allowed for vessels. This was stipulated in order to insure the free passage of any craft afloat, the peak of the "Shenandoah," the largest vessel in the American merchant marine, being 194 feet above the waterline.

The cables are supported in the great span by two steel towers. The one on the bluff, known as the "main" tower, is 225 feet in height, and the one on the gradually rising ground opposite is 64 feet high, the latter structure being known as the "south" tower. The south tower is located so high on the hillside that its top is fully 80 feet higher than the top of the lofty main tower, and thus the lowest point of sag in the span is thrown off the lineal center between the two towers. In order to bring the cables down to anchorages, only 1,700 feet back of the main tower, there was constructed a third structure known as the "leaning" tower, and which has an inclination of thirteen degrees from the perpendicular.

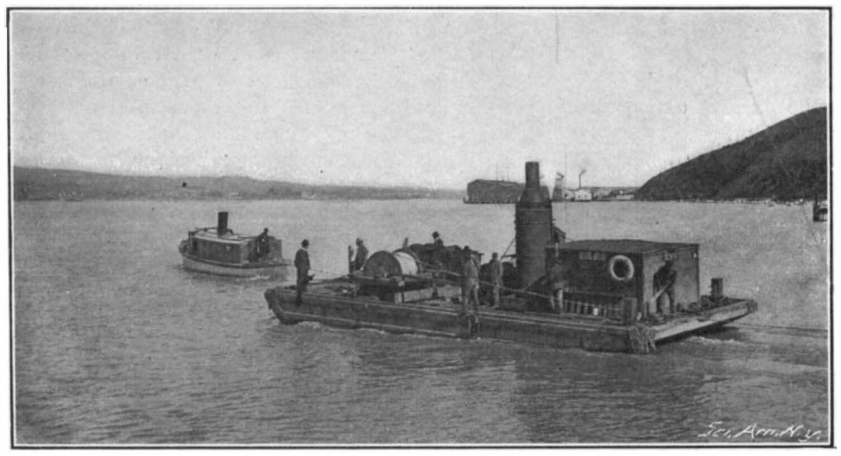
Steel and iron have been used almost exclusively in the construction of all these towers. Estimating the maximum wind pressure at 40 pounds a square foot, each of the four corner posts of the main tower is subject to a maximum compressive strain of 132,510 pounds. The main tower is supported by twelve concrete piers with the corner ones arranged in a quadrangle measuring 69 by 89 feet between the pier centers. Each of the corner piers is a cube of concrete having eight-foot sides. The piers are in reality designed more to give weight as anchorages than to serve as foundations. Each of the smaller towers is supported on four piers of concrete.

The support of the cables from the towers represents an achievement of no inconsiderable magnitude, since each cable exerts a pull of twelve tons on its anchorages. The insulators weigh about fifty pounds each, and every insulator was subjected, previous to installation, to long-continued tests of 120,000 volts. There is an extreme variation in temperature of 60 deg. at Carquinez, so that there may be a difference during the year of five feet in the sag of the cables, a difference which will cause a travel of fully two inches to occur in the cables running over the sheaves of the main tower.

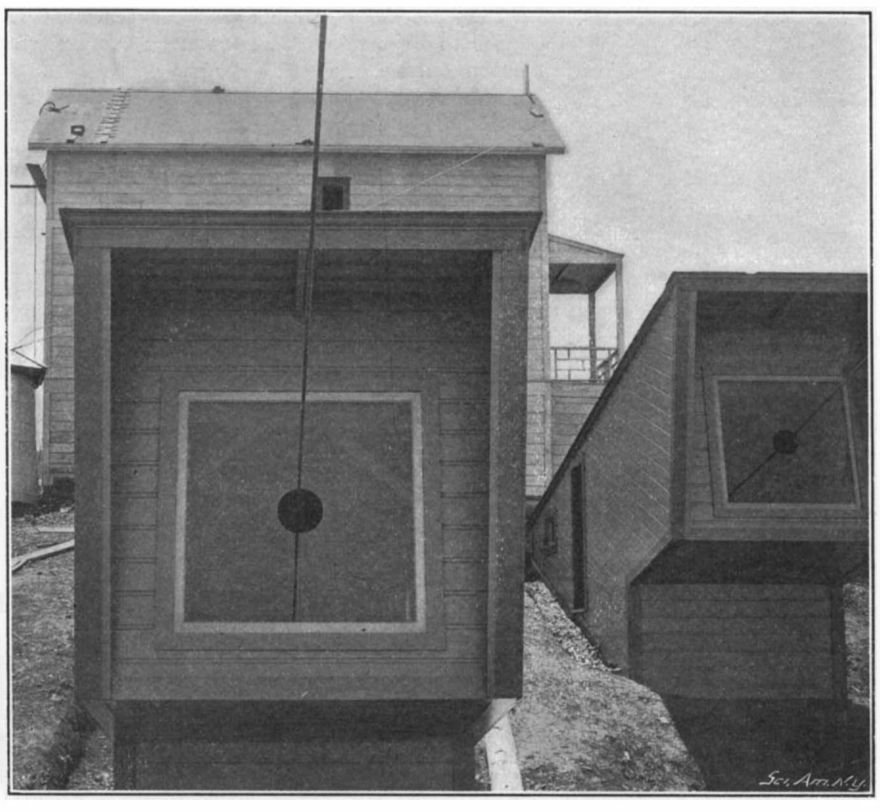
Each cable has an individual anchorage consisting of a mass of concrete nine by ten feet in size and five feet high, set into the bedrock. The cable is turned around a two-foot sheave and secured with clamps and clips. There is an independent housing for each anchorage, and the cable enters by way of a circular hole six inches in diameter cut through the center of the plate glass which forms the front of the inclosure. The cables are "dead-ended" at the anchorages, power being delivered to or taken from them by means of taps. Only three cables are ever in use at one time, the fourth invariably being held in reserve.



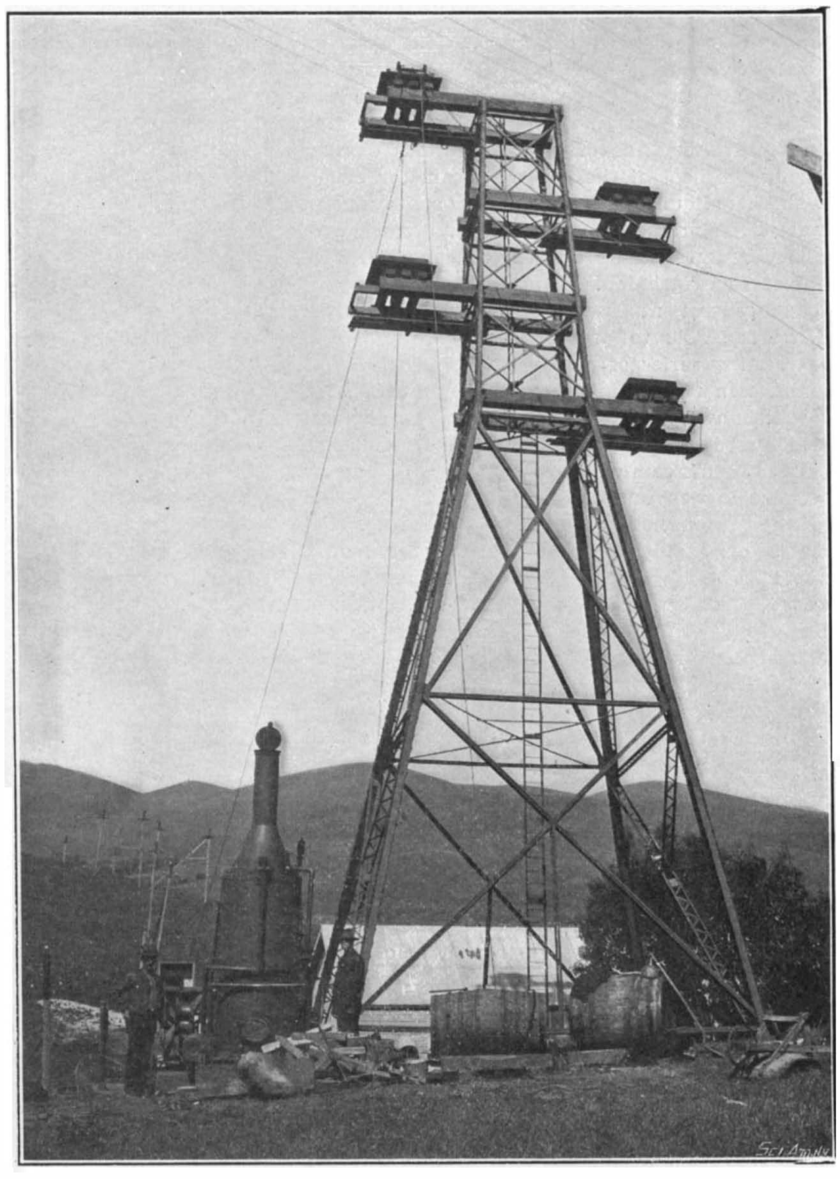
General View of the Straits of Carquinez, Showing the Four Cables and the Main Tower.



Carrying Cable Across the Straits of Carquinez.



Glass-Covered Entrance to Anchorage of Cables.



The Leaning Tower of Carquinez Span.

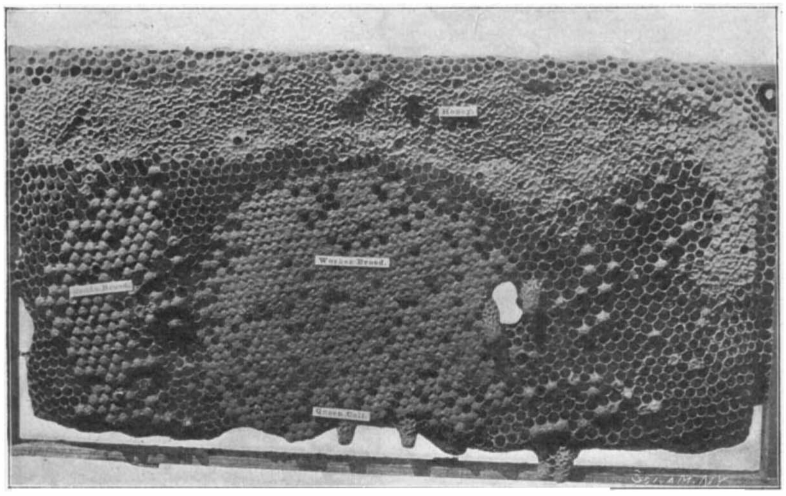
THE GREATEST ELECTRIC CABLE SPAN EVER ERECTED—SPAN, 4,427 FEET.

The provision of this extra cable also makes it possible to overhaul or repair any cable at any time.

The cables of the Carquinez span are of solid plow steel, with solid steel core. In the twisted strand are nineteen wires, including the core, and the strand has a diameter of seven-eighths of an inch. The erection of the cables comprised a highly interesting feature of the work of construction. When the four cables, each 6,400 feet long, were in readiness, the ends were hauled up to the south anchorage by windlass and secured to the anchorage system. The reels, one at a time, were then carried across the Straits on a self-propelling steam barge, paying out the cable as they went. On the north shore the donkey hoisting engine for pulling up the cables was located near the leaning tower previously mentioned, or some 1,800 feet from the landing. Leading from the engine through a block in the anchorage and over both the leaning and main towers was run a hemp line which was utilized to pull over the slack end of the cable. The four cables were raised in five days. Some idea of the power required to pull up the cables may be gained from the fact that when the sag of a cable was such that it touched the surface of the water, its length was 4,535 feet and the strain was 9,000 pounds; when 120 feet above the surface, the length of span was 4,482 feet and the strain 12,750 pounds; and when in final position the length was 4,448 feet and the strain 22,500 pounds.

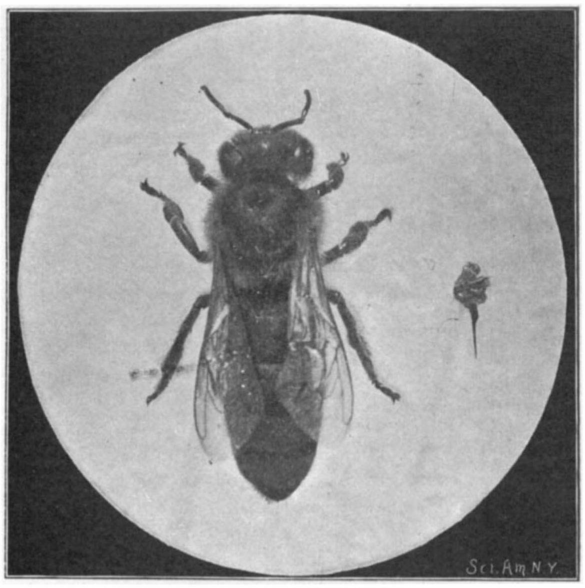
The electrical power which is transmitted via the Carquinez span is derived from the Yuba River. The initial electric pressure for distribution is 40,000 volts; but this is to be increased to 50,000, and ultimately to 60,000 or 70,000 volts, in order to minimize the losses incurred in transmitting the power for long distances. The three generating stations have an aggregate capacity of 23,000 horse power, and the company possesses water rights for 20,000 horse power additional.

One supplementary power house contains three 500 horse power dynamos, while the main power house at Colgate has a capacity of 18,000 horse power. In building the great flume more than 8,000,000 feet of lumber were used. This flume has a capacity of 23,000 cubic feet of water a minute. Three of the dynamos in the Colgate power house have a capacity of 3,000 horse power each, making them the largest horizontal shaft dynamos driven by water power in the world. Similarly, the buckets used on the water-wheels are the largest and heaviest ever made for a wheel of tangential jet. It may be mentioned in conclusion that the Carquinez span is nearly three times the length of the Brooklyn Bridge, and is therefore the longest single span between two supports which the world has ever seen.



Drones. Workers. Queen Cell. Honey.

FRAME OF COMB FROM THE BROOD NEST OF A COLONY THAT HAS RECENTLY CAST A SWARM.



WORKER BEE AND STING.

BEE-KEEPING IN THE UNITED STATES.

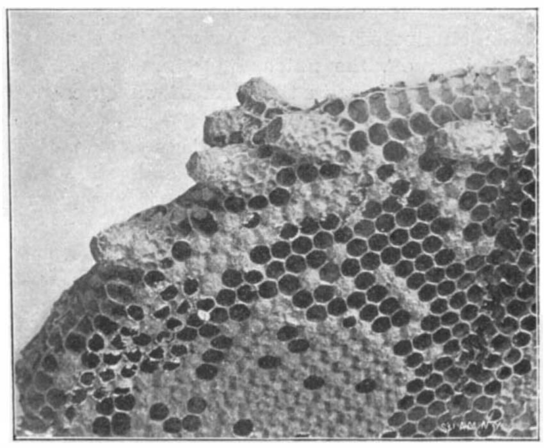
BY WALDON FAWCETT.

The general public is prone to think of bee-keeping merely as an adjunct of agricultural operations, but in reality it has attained during the past few years to the position of a very important American industry. Extensive apiaries have been established, and thousands of persons in various parts of the country are devoting their entire time to the scientific fostering of honey production. Something of the scope of the operations now being carried on may be imagined from the fact that there are now in the United States considerably over one hundred apiarian societies, eight periodicals published solely in the interests of the industry, and fifteen steam factories for the manufacture of beehives and apiarian implements.

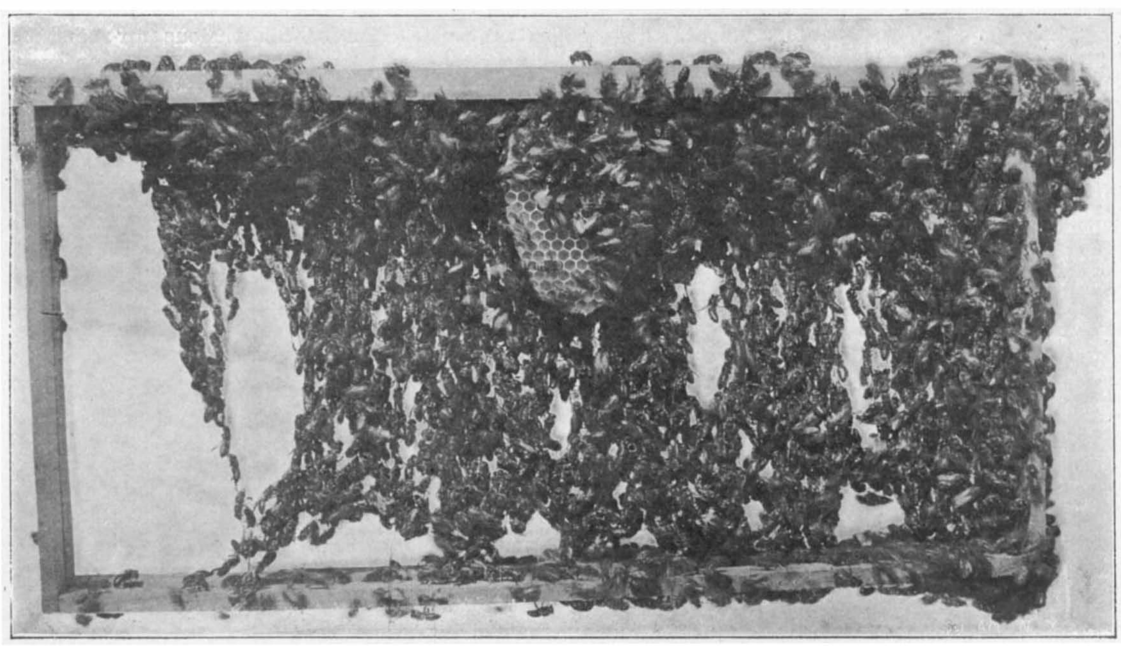
It is estimated that there are fully three hundred thousand persons engaged in the culture of bees in this country at the present time. In the absence of any method of securing official statistics from year to year, many estimates have been made of the quantity of honey produced annually on this side of the Atlantic, and though the figures presented have invariably seemed extravagant to the uninitiated, the statements, there is every reason to believe, have been, without exception, highly conservative. Prominent beekeepers who undertook, a year or two ago, to form some idea of how much honey is produced in the country came to the conclusion that at least fifty thousand pounds is stored in sections every year, while they assumed that one hundred thousand pounds of extracted honey is produced—an aggregate of one hundred and fifty thousand pounds. The beekeepers, however, were probably too modest in their claims, for their calculations showed the annual honey crop of the country to be worth $10,000,000, whereas the officials of the United States Department of Agriculture who have made an especial study of the subject place the valuation at fully double that figure.

This record of the great wealth represented in a comparatively obscure food product is all the more remarkable when it is remembered that the apiarian industry in the United States is practically a development of the last forty years, although isolated individuals were engaged in the work long prior to that time. In the score of years from 1869 to 1889 the American production of honey was quadrupled, increasing from less than fifteen million pounds annually to nearly sixty-four million pounds annually; and the closing decade of the century witnessed a growth proportionately greater, since the estimated output of the closing year of the cycle, as given above, is very much more than double that recorded ten years ago. The bee-keeping industry, however, far from having reached the acme of possible development, would appear to be only just entering upon an era of even more remarkable growth, and it is estimated by the authorities of the apiarian world that the present existing flora of the United States could undoubtedly support, with the same average profit, ten times the number of colonies of bees now to be found in the land.

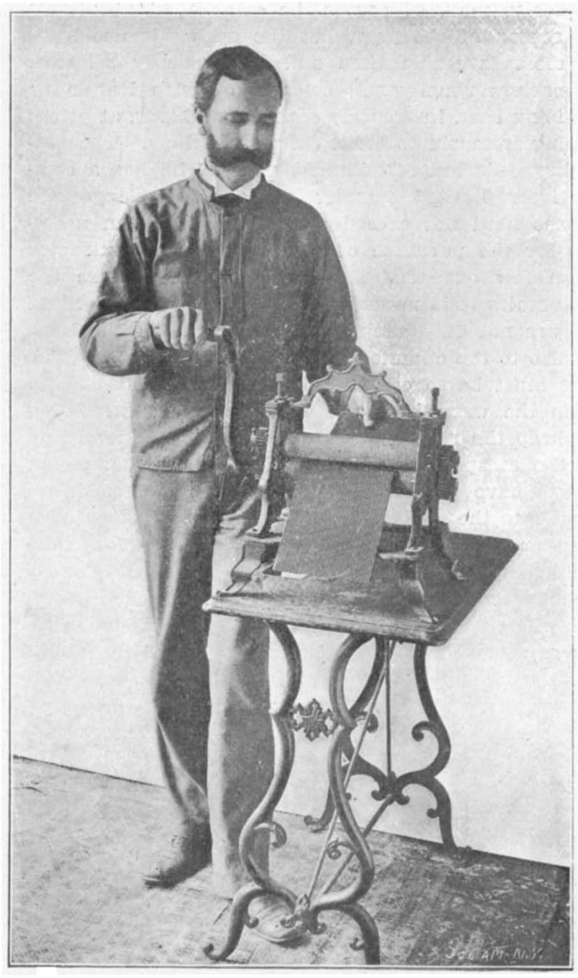
The bee family is made up of several distinct types, including the hive bee, bumble bee, carpenter bee, leaf-cutter and the stingless honey bee of the American tropics. Strictly speaking, the apiarian industry concerns itself only with the hive bee, although the plan of introducing the stingless bees from tropical America has frequently been considered. It is admitted that this latter class of insects might be kept in the warmer parts of the country, but the fact that their honey yield is small and not easily harvested makes it problematical whether the attempt is justifiable. Passing by the varieties of hive bees which are natives of Asia and Africa, we find in America at the present time a variety of distinct bee families. The common brown or German bee was imported from Europe



CLUSTER OF QUEEN CELLS.



COMB BUILDERS HANGING IN CLUSTERS, SECRETING WAX.



MAKING COMB FOUNDATION.

during the seventeenth century and is now to be found in every section of the Union from the Atlantic to the Pacific. Other races—all introduced during the last half century—include the Egyptian, Italian, Cyprian, Syrian, the Palestine, the Carniolan and the Tunisian. Almost all of these races have become to a greater or less extent hybridized with the brown or German race.

Each colony of bees in good condition at the opening of a season contains a laying queen and some thirty thousand to forty thousand worker-bees, or six to eight quarts by measurement. It is quite possible, too, that several hundred drones may be included in such an assemblage. Under normal conditions the queen lays all of the eggs which are deposited in the hive, being capable of depositing as many as four thousand in a day. Upon the workers, or females, devolves all the labor of gathering honey, secreting wax and building combs. The drones, or males, are not a factor save in contributing somewhat to the general warmth of the hive necessary to the development of the brood.

The food of honey bees is found in pollen and honey. Pollen, the fertilizing dust of flowers, is carried home by the bees in small pellets held in basket-like depressions on each of the hind legs. The liquid secreted in the nectaries of flowers is usually quite thin, and much of the water which it contains must be eliminated either during the transportation of the nectar to the hive or after it has been stored temporarily in open cells. To transform this nectar with its raw, rank taste into the greatest of table luxuries is one of the chief functions of the worker-bees. Workers are stationed in lines near the hive entrances, and by incessant buzzing of their wings drive currents of air into and out of the hive and over the comb surface. The loud buzzing of the bees frequently heard in the vicinity of a hive at night is due to the action of the wings of the little workers busily engaged in ripening nectar. When a considerable portion of the water has been eliminated and the disagreeable odors and flavors driven off, the finished product is stored in waxen cells, and seals in the form of waxen caps are speedily put in place.

The successful manipulation of bees is one of the most delicate of tasks and requires skill and experience. A majority of professional bee manipulators in time grow somewhat indifferent to stings, since they become so thoroughly inoculated with the poison of the bee that the pain of the sting is less severe and the swelling slight. Moreover, with a number of the races of bees recently introduced into this country the avoidance of stings is simply a question of care in the manipulation of the insects combined with a free use of smoke. Even in utilizing this latter safeguard, however, care must be exercised, for the idea is to simply alarm and subjugate the bees with the smoke and not to stupefy them. The time usually selected by expert bee-growers for the manipulation of swarms is when most of the bees are busy in the fields. The young bees left at home are most easily controlled, and the old ones upon their return are, as a rule, heavily laden with the fruits of their foraging expedition.

Apiaries may, of course, be established at almost any season of the year, but the spring is decidedly the most favorable time and that usually selected. Bee-masters usually sell colonies of pure Italian or Carniolan bees, in securely constructed hives, at prices ranging from six to eight dollars a colony. The bee-keeper needs but few implements. If he has a comparatively limited number of hives his aggregate expense need not exceed six dollars, the sum necessary for the purchase of a smoker, a wax extractor and a few queen-introducing cages. To secure the best results it is necessary to have constructed hives that are not only adapted to the nature of the bees, but also to the climate of the particular locality. The hives must be so constructed also that while able to retain the warmth of the bees in outdoor wintering and keep the rain from beating in, they still provide for the escape of moisture. Dozens of labor-saving devices have within the past few years been introduced into the apiarian world, and bees are now even given artificial outlines of cells as a basis for comb building.

The process of extracting honey is another operation wherein care is necessary. The filled combs, as fast as removed from the hives, are placed in a light case the size of a hive, or a tin can made especially for the purpose, covered closely to prevent the access of robber bees and taken to the extracting room, which is bee-proof. The uncapping knife, held in hot water when not in use, is passed rapidly under the capping of the sealed combs, the point of it being used to reach depressed surfaces. The loosened cappings drop into a sieve resting over a pan, or into the upper part of a can especially designed to receive cappings. The small amount of honey removed with the cappings drains through the strainer and is drawn off below. The uncapped combs are placed in the extractor at once. In this branch of honey capture three persons usually work together—one removing the surplus cases or combs from the hives, freeing them of their bees and bringing them into the extracting room, where two assistants uncap and extract the honey. The honey extractor itself consists of a large can within which a light metal basket revolves. The full combs of honey from which, as explained, the cappings of the cells have been removed, are placed inside the basket and after several rapid revolutions by means of a simple gearing are found to have been emptied of their contents. The combs, only very slightly damaged, can then be returned to the hives to be refilled by the bees. If extra sets of combs are at hand to supply as rapidly as the bees need the room in which to store honey, great yields can often be obtained.

The progressive, present-day apiarist does not look for the production of wax in so great a proportion compared with his honey yield as did the old-time box-hive bee-keeper. The latter obtained much of his honey for the market by crushing the combs and straining it out, leaving the crushed combs to be melted up for their wax. Frequent losses of bees in wintering and through queenlessness also gave more combs for melting, as without hive frames, honey-extractors, comb-foundation machines and the other new modern devices the vacated combs were seldom used a second time. The wax from the pressed combs was all marketed, since there could be but little home use for it.

The bee-keeper of to-day, however, as has been noted, after having removed the honey from the combs by centrifugal force, returns them, but slightly injured, to be refilled by the bees, and at the end of the season these combs are stored away for successive years or else the surplus is marketed as stored—that is, without cutting. Nowadays the only source of wax production is found in the cappings of the combs, occasional broken combs, etc. However, since the marketable price per pound of extracted honey is usually not less than one-third and that of comb honey one-half the price of wax, while it requires some twelve or fifteen pounds of honey to produce one pound of comb, it may readily be appreciated that it is far more profitable to turn the working force, in so far as possible, to the production of honey instead of wax.

Not only is there only such production of wax as may be secured without lowering the yield of honey, but even what wax is taken is practically turned into honey the following year, for it is made into comb foundation which, judiciously used, increases, in turn, the season's yield of honey. Wax being so much more valuable than honey, it behooves the bee-keeper to preserve even the smallest pieces of comb. The old way of rendering wax was to put the combs into a sack made of some open stuff, weight this down in a kettle of water and boil for some time. The wax rose, and when cold was removed in a cake. The new approved plan of rendering is by means of the solar wax-extractor. The machine is placed in a sunny spot and filled with wax cappings or bits of comb. As the direct rays of the sun strike it, the melted wax trickles through a strainer and collects in a tin placed at the lower edge of the tank or melter. The cake is removed each morning. When the solar apparatus is not available, wax is rendered by steam heat.

An Interview with M. Santos-Dumont.

An authorized article on the Brazilian aeronaut M. Santos-Dumont appears in the November Century from the pen of Sterling Heilig:

This young Brazilian inventor works for the love of the thing, not for lucre. He has never felt moved to apply for a single patent. He is a son of the "Coffee King" of Brazil, the proprietor of the Santos-Dumont plantations of Sao Paulo, the friend of the former Emperor Dom Pedro, and the benefactor and adviser of whole populations. Santos-Dumont, the father, although a Brazilian by birth and nationality, was French by descent, and had his technical education at the Ecole Centrale (Arts and Industries) in Paris. Thanks to this education, he was the first to apply scientific methods to Brazilian coffee-culture, so that his plantations became the most flourishing in the land, having four million coffee-plants, occupying nine thousand laborers, comprising towns, manufactories, docks, and steamships, and served by one hundred and forty-six miles of private railroads. It was on these railroads that the young Santos-Dumont, before he was twelve years of age, drove locomotive-engines for his pleasure, and developed the taste for mechanics and invention which saved him, coming young and rich to Paris, from a life of mere sporting leisure. Until eighteen years of age, when he completed his education at the University of Rio de Janeiro, he remained in Brazil, always returning in vacation-time to the wild back-country of the plantation, where he became a mighty hunter, killing wild pigs and tigers by preference, and great snakes out of a sense of duty.

Arriving in Europe in 1891, he made a tourist trip, and ascended Mont Blanc. A part of 1891 and 1892 he spent between London and Brighton, perfecting his English, which he now speaks as well and as often as French; but he always returned to Paris, where in 1892 he was already driving automobiles. In 1894 he made a short trip to the United States, visiting New York, Chicago and Boston. He did not begin ballooning until 1897, in the summer of which year he made his first ascent in company with the late M. Machuron. In the same year he made twenty other ascensions, a number of them unaccompanied, and became a reliable pilot of spherical balloons. He was, indeed, an ideal figure for the sport, uniting remarkable strength, agility and coolness to his jockey's weight of scarcely one hundred pounds. For this reason he was able to lower the volume of the "Brazil," his first spherical balloon, to the unusual minimum of one hundred and thirteen cubic meters. The little "Brazil" was always filled with hydrogen, and after each ascension he never failed to bring it back with him in his valise.

AN INTREPID AUTOMOBILE CHAUFFEUR.

This Brazilian has neither the structure, the complexion nor the exuberant gestures of the men of his country. He is pale, cold, and phlegmatic, even, if the words may be applied to one so active. In his moments of greatest enthusiasm and of most lively disappointment he is always the same; and he is as free from affectation as a child. He has a weakness for driving dog-cart tandems, and—something which has had a vital influence over his career as a balloonist—he has been an intrepid automobile chauffeur from the first.

He began with a Peugeot roadster of two and a half horse power. He has since owned and driven half a dozen automobiles of continually increasing speed and power, his longest trip without stop being taken in 1898, between Nice and Paris, and accomplished with a six horse power Panhard in fifty-four hours. Latterly he has abandoned petroleum in favor of electricity, in a dainty light-running American buggy manufactured in Chicago. It serves him, he says, better than the more troublesome *teuf-teuf* for his morning spin through the Bois and his afternoon errands from the balloon-maker's at Vaugirard to his apartment in the Avenue des Champs-Elysées, and from the Aéro Club's ground at St. Cloud to the Automobile Club in the Place de la Concorde. "I was once enamored of petroleum automobiles, because of their freedom," he explains. "You can buy the essence everywhere; and so, at a moment's notice, one is at liberty to start off for Rome or St. Petersburg. But when I discovered that I did not want to go to Rome or St. Petersburg, but only to take short trips about Paris, I went in for the electric buggy.

"I got my first idea of putting an automobile motor under a cigar-shaped balloon filled with hydrogen gas while returning from the Paris-Amsterdam automobile race in 1897," he said when he began giving me this interview. "From the beginning everybody was against the idea. I was told that an explosive gas-engine would ignite the hydrogen in the balloon above it, and that the resulting explosion would end the experiment with my life. Lachambre, my balloon-constructor, went to work without enthusiasm. So far from others 'convincing me that their notions were worth taking up,' as has been said, I met with nothing but discouragement."

Such a categorical statement ought to dispose of the legend of a young "Mæcenas of balloon-builders," who "does not set up himself to invent machines, only to judge of those which inventors bring to him, and of the work done by the mechanics he employs." Col. Renard's assertion that M. Santos-Dumont is not a man of science, but *un sportsman de l'aérostation qui a beaucoup de crânerie* (an aerostatic sportsman who has a great deal of swagger) is equally inexact. Sufficiently at home in mathematical mechanics to make the calculations which necessarily preceded not only the construction of his various air-ships, but their very idea, sufficiently practised and ingenious to make his own models, the young inventor owes no more to his constructors and hired mechanics than he does to his theoretical friends.

Improvements in Champagne Manufacture.

Certain improvements have been introduced in champagne manufacture. As is well known, the wine is bottled and placed in racks in an inclined position. The bottles are turned regularly, the idea being to cause all the impurities in the wine to reach the cork. The old cork is finally removed at a certain stage of the process in order that the final liquoring and corking may be done. Formerly it was the universal practice in the momentary removal of the cork to allow the deposit to be sprayed out by the pressure of the gas with just enough of the contents of the bottle to remove the substance, which would be cloudy, and damage the wine. Of late years an ingenious freezing machine has been introduced to freeze solid a thin wedge next the cork of just the needed thickness to remove all that need not remain. This reduces the waste of wine from 8 per cent to 12 per cent.

Correspondence.

The Aeroplane Problem.

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of August 17 you ask what aeroplane men are doing, they are not heard of, and probably discouraged by risk. Speaking tersely, I for one am doing my best, absolutely unnoticed, and with the courage derived from the knowledge that if I steadily persevere for a little while longer I shall make some sort of flight with the minimum of danger.

To amplify my remarks: Like other flying-machine men, I think I could do strokes with ample means; such not being available, I pile every spare minute and scrap of ingenuity into the construction of the smallest apparatus that is capable of carrying me for ten minutes.

I lost a year over an abortive four-cylinder oil motor, and am now well on with a high-pressure steam engine and pipe boiler. The propeller, though novel to look at, is constructed on well-known principles, and leads the show; that is, it is right forward.

The lifting surface consists of a number of cells, constructed as in my 25-foot kites and boomed in the way your kitemakers disapprove of.

My situation is horizontal, with left hand to the stop-valve and right to the tiller. I have bought the best situation for aeronautical work on Sydney Harbor, and my machine is to float on three buoys of the least displacement and head-resistance possible.

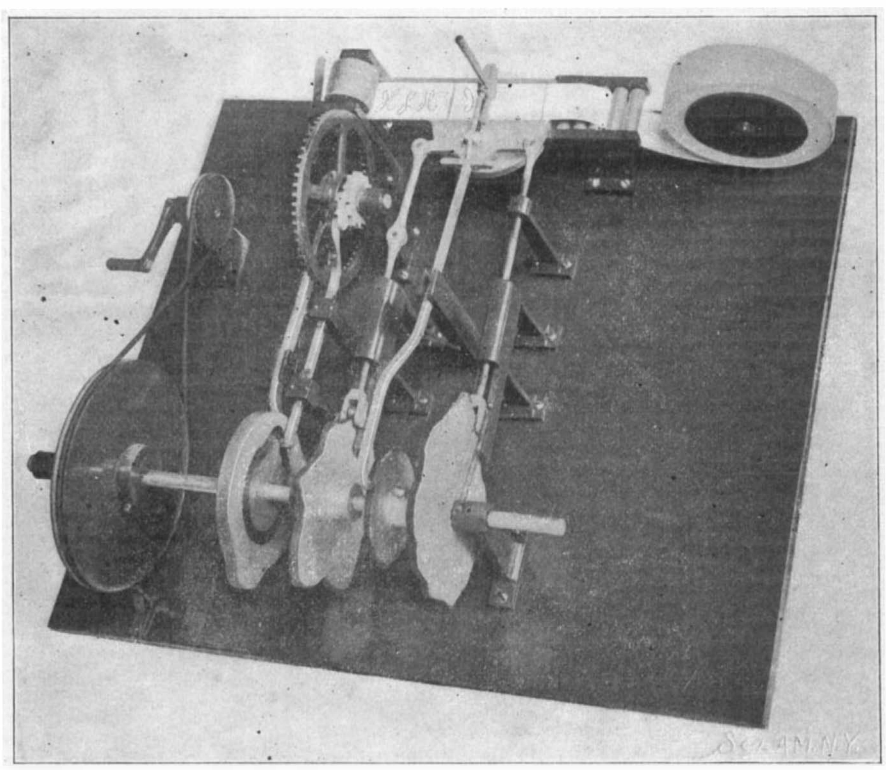
LAW. HARGRAVE.

New South Wales, September 16, 1901.

AN INGENIOUS WRITING MACHINE.

At the last annual exhibition of the work of the students of the Free Evening Classes of the Society of Mechanics and Tradesmen of New York city, there was exhibited a piece of apparatus that attracted much attention, both because of the ingenuity of its conception and because of the fact that, though somewhat complicated, the entire mechanism, with minor exceptions, was made by hand in wood. The apparatus was the outcome of a problem in machine design given to the senior class in mechanical drawing. The class had been considering the principles of automatic machinery, and for the completion of a series of cam-problems they were asked to design a machine with which to write their own initials. Many interesting and ingenious solutions were made by the class, each distinctively individual. One of the students, Mr. Henry T. Harra, after making a full set of working drawings of his solution of the problem, decided to make a model of his drawings, with the result shown in our engraving.

Cash register paper is fed from a roll through a series of tension rollers, across the plate upon which the pencil is actuated, and is drawn on its course by two larger tension rollers, and finally cut off into the desired card lengths by a knife whose action is controlled by the periphery of the cam on the extreme left of the row of cams. Upon the side of this cam is cut a positive-acting groove, which has for a follower a pawl engaging with the ratchet wheel engaged to turn the larger tension rollers through bevel gears, so as to feed a card length during each cycle of the machine's action. The other two larger cams control the swing of the pencil through its various drawings of the required initials; in this case H. T. H., shown inverted in the cut. The smallest cam, by tripping, raises and lowers the pencil for the space between letters and to afford an opportunity for the paper to be moved along for another writing.



A MACHINE THAT WRITES INITIALS.

The Pollok Prize.

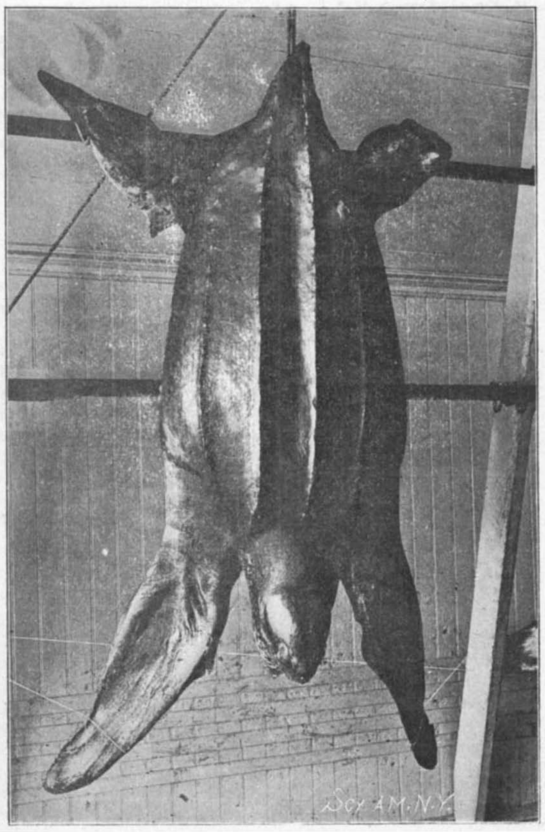
It is announced from Havre that the members of the international jury appointed to award the Pollok Prize for life-saving apparatus and for the prevention of collisions at sea have concluded their examination of the models sent in, which have been exhibited in a shed belonging to the Havre Chamber of Commerce. The jury, while recognizing the endeavors made to provide greater safety in navigation, finds that none of the schemes submitted meets one of the objects to be attained, and, therefore, it does not award the prize.

The famous Reale Accademia dei Lincei of Rome does not elect many members to its distinguished body, but has, however, elected eight foreign members, and among them are Dr. S. P. Langley, secretary of the Smithsonian Institution, Charles D. Wolcott, director of the United States Geological Survey, and Prof. Edward C. Pickering, Director of the Harvard College Observatory.

THE LEATHER TURTLE.

BY M. C. FREDERICK.

There was recently captured in the Santa Barbara Channel a huge turtle of a kind never seen before by the fishermen who found it entangled in the kelp from which it was trying to extricate itself. It proved to be the seldom-met-with and little-known *Sphargis coriacea*, or leather turtle (also called Luth, or *Dermatochelys coriacea*) and attracted crowds of people as it hung in the meat market previous to being sent to a taxidermist. Audubon gave it the name of trunk turtle, because its thick, leathery skin resembles the old deerskin-covered trunks. Others have called it the harp or lyre turtle, the longitudinal ribs suggesting that instrument.



THE LEATHER TURTLE.

About twelve years ago a sphargis was caught off Coronado. The eminent naturalist, Prof. Ward, of Rochester, N. Y., who was at Coronado at the time, was greatly interested in the turtle, as he stated but few museums of either continent possess a specimen, and but few naturalists have ever seen a living one. Prof. Ward could find no record of its being found on the Pacific Coast, and concluded that naturalists did not know of its presence in these waters. Since Agassiz remarks in one of his works that "in three centuries the species has not been observed more than nine times in Europe," the fact that at least two have been captured on the coast of Southern California within a dozen years is worthy of note.

Living in the high seas, and apparently at home in all waters, the sphargis has so successfully eluded the investigations of man that little more has been learned about him than that he is the largest and rarest of the five known species of marine turtles. The Santa Barbara specimen weighed a short 500 pounds, and measured 5 feet 9½ inches from the end of the nose to the tip of the tail. The Coronado turtle was said to weigh 800 pounds. They have been known to weigh 1,200 pounds or more.

Exploring Balloon Data.

M. Teisserenc de Bort has deduced from the results furnished by 240 ascensions of exploring balloons made in 1898, 1899, and 1900 some interesting conclusions relating to the variations of temperature in the upper atmosphere. The figures for the mean monthly temperature near the ground and at 15,500 and 31,000 feet altitude are shown in the following table:

Month.	At the Ground. Deg. C.	At 15,500 Ft. Deg. C.	At 31,000 Ft. Deg. C.
January	5.4	—15.3	—47.6
February	1.0	—21.8	—53.4
March	0.9	—20.9	—53.7
April	5.3	—18.4	—49.3
May	7.0	—16.8	—51.3
June	14.2	—8.8	—45.3
July	15.7	—8.7	—44.5
August	17.8	—7.2	—41.8
September	13.4	—9.7	—47.9
October	10.2	—11.0	—45.1
November	3.8	—12.8	—45.2
December	0.9	—18.9	—52.4

To these data M. Teisserenc de Bort adds the following conclusions: First, at an altitude of 31,000 feet the temperature still undergoes a well-marked annual variation. Second, the amplitude of this variation diminishes with the height. Third, the epoch of the maxima and minima undergoes a retardation which increases with the altitude. Fourth, the differences of temperature from one day to another may be greater at 20,000 to 25,000 feet, than those which are observed at the same time, near the ground. This fact has a considerable importance, and is besides contrary to the prevailing ideas upon the subject. Fifth, the temperature decreases much more rapidly in the neighborhood of the centers of barometric depression than at other points. This decrease in certain cases amounts to nearly 0.9 deg. per 300 feet.

Anniversary of the Death of Tycho Brahe.

On Sunday, September 22, a solemn festival was held in the small Swedish island of Hveen. The occasion was the approaching 300th anniversary of the death of Tycho Brahe, the celebrated astronomer, who lived and worked on the island and spent his happiest years there. The festival was held among the few remains of Brahe's once imposing observatory at Uranienborg, The Copenhagen correspondent of the Times states that, early in the morning, guests from Denmark and Sweden, including representatives of the Universities, arrived in steamers. Outside the small harbor the Swedish ship "Drott" was at anchor with King Oscar on board. The King landed with the other guests and drove to Uranienborg. After Divine service, conducted by Bishop Billing, of Sweden, Dr. Hillebrandt, of Sweden, delivered a long speech, ending with the following words: "We congratulate Denmark upon the never-dying memory of this man. This spot is now Swedish; therefore the King of Sweden is here today to honor the memory of Denmark's great and noble son." The party then walked through the ruins, which were decorated with the Swedish and Danish flags. The monument of Tycho Brahe, erected by Swedes, was decorated with the Danish colors.

The Current Supplement.

The current SUPPLEMENT, No. 1348, has many interesting and important articles. "The Boston Elevated Railroad" is illustrated by an entire page of engravings, and is written by J. A. Stewart. "The Protection of Fire and Balloon Telegraph Systems from High-Tension Currents and Lightning" is by Walter M. Petty. "Four-Motor Equipments" describes the latest developments in high-speed cars for heavy suburban work. "The Great Caisson Employed in Building the Drydock at Kiel" is illustrated by a large engraving. "The British Association Address," by Prof. J. Cossar Ewart, is continued. "The Thunderstorm: A New Explanation of One of Its Phenomena," is by Byron McFarland.

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(Illustrated articles are marked with an asterisk.)

RECENTLY PATENTED INVENTIONS.

Mechanical Devices.

ORE - FILTER. — CHRISTOPHER VOELKER, Helena, Mon. The cyanid leaching processes have the fault that more or less metal remains in the tailings, thus giving rise to losses. The ore is introduced, as a general rule, and the solution added, and where it happens that the ore lies in different grades of value within the tank, the solution cannot dissolve the particles of metal uniformly. The pulp is affected more thoroughly at first, and as it goes down to the bottom will take the slimes forming with it, and will deposit them around the discharge aperture. The present apparatus permits the solvents of the metals to pass through the pulp during a time governed by the operator. The filtrate can be examined so that the metallurgist can determine the valuable salts of mercury, copper, silver, gold and the like which may form through the chemical or electrical action in the amalgamators. The machine is of particular service where the extravagant use of copper sulphate, mercury and salt are in most cases the cause of the solubility of gold.

ADDING-MACHINE.—AMOS K. ERSLAND, Fruithurst, Ala. The adding-machine contains but few parts and is not liable to get out of order. The elements are so arranged that they will accurately perform their functions. The numeral wheels employed are operated from the exterior of the machine by a lead pencil, penstock, pointer, or the like.

RECARBURIZING - MACHINE.—JOHN W. DAVIS, Converse, Ind. The machine recarburizes metal. Powdered carbon, carborundum or any other finely ground material, is infused into a bath of molten steel or iron while in a furnace or bath. The machine comprises a feeder for the powder and a tube for receiving the material from the feeder. The tube is mounted to rock relatively to the feeder. A blast connection with the tube is provided. The feeder, tube and blas are mounted on a truck.

Vehicles and Their Accessories.

BICYCLE - WHEEL TIRE.—CHARLES H. PASCHKE, Buffalo, N. Y. The essential features of the tire comprise a number of elastic tread sections, means for holding the tread sections in ring form, and resilient arms which serve elastically to retain the composite thread ring concentrically with two spring tension rings clamped upon each side of the wheel-rim.

AXLE-JOURNAL.—CHRISTIAN FOX, Gap, Pa. Mr. Fox has devised a means for mounting wheels upon axle journals so that the movement of the wheels will be attended by the least possible friction and also so that the wheels will still be held in place even though the nut should become disengaged.

Miscellaneous Inventions.

STANCHION.—ROBERT T. REID, Tacoma, Wash. As ordinarily constructed and arranged, the stanchions between which the heads of horned cattle are secured do not permit freedom of position and movement to the animals when lying down or getting up. The inventor has devised an improved stanchion which overcomes this objection and which consists essentially of a single metal rod peculiarly bent.

SORTING-DESK.—SAMUEL A. HARRISON, Brooklyn, New York city. In post offices of large cities the mail-carriers usually sort their mail by means of pigeon-hole desks. Mr. Harrison has devised an improvement upon the desk usually employed, in which improvement a series of shelves or compartments are provided, the sizes of which can be readily varied. The shelves are capable of being released simultaneously by a peculiar novel construction.

ATTACHMENT FOR CUFFS AND CUFF-BUTTONS.—JAMES W. RUNNER, Shelby, Mich. This device is very simple and durable in construction, can be readily applied and does not interfere in any way with the working or appearance of the cuff button. All rattling of the cuff buttons is prevented, especially when used in connection with celluloid or rubber cuffs.

EXHIBITING DEVICE.—CHARLES A. HAMILTON, Pana, Ill. The invention is an improvement for exhibiting goods in stores—notably such goods as lace curtains, draperies, carpets and the like; and the object is to provide a device for this purpose that should be simple in construction and inexpensive, and by means of which the goods when not on display are stored or packed in a small space.

Designs.

WINDROWER FOR MOWING-MACHINES.—THOMAS B. FAGAN, Van Wert, Ohio. The windrower is of a peculiar design, the essential features of which consist of a series of parallel slats of gradually increasing length, each slat being flat, or of much greater width than thickness, and each turned up at the rear with a gradually curved or hook-shaped end, the terminal portion of which is twisted, so that its plane stands at an oblique angle to the body part. The windrower is to be attached to the rear of the cutter-bar of a mower, and causes the lateral delivery of the hay with a rolling action.

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

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.

Inquiry No. 1525.—For manufacturers of compression springs of special measurements.

Inquiry No. 1526.—For manufacturers or dealers in divers' supplies.

Inquiry No. 1527.—For dealers in milk can spouts, also covers for cans with knives in lids.

Inquiry No. 1528.—For dealers in casein.

Inquiry No. 1529.—For leading bolt and nut manufacturers in the United States, England and Germany.

Inquiry No. 1530.—For dealers in articles for the queensware business.

Inquiry No. 1531.—For a machine for automatically weighing and wrapping parcels.

Inquiry No. 1532.—For manufacturers of water gas appliances.

Inquiry No. 1533.—For manufacturers of wireless telegraphy apparatus,

Inquiry No. 1534.—For manufacturers of electrical and other toys.

Inquiry No. 1535.—For dealers in novelties and notions.

Inquiry No. 1536.—For a machine or generator for generating gas from gasoline or coal oil.

Inquiry No. 1537.—For a small plant for electric lighting purposes.

Inquiry No. 1538.—For the manufacturer of a special nickel-plated street car ticket holder for the pocket.

Inquiry No. 1539.—For parties to make a steel spring about 4-1000 of an inch thick, 1-2 inch wide and 7 inches long.

Inquiry No. 1540.—For manufacturers of launches operated by alcohol vapor.

Inquiry No. 1541.—For manufacturers of gasoline engines for motor wagons.

Inquiry No. 1542.—For dealers in ready-made wheels, bodies and running gears for automobiles.

Inquiry No. 1543.—For dealers in the electrical water heater invented by H. M. Hill.

Inquiry No. 1544.—For manufacturers of counting machines.

Inquiry No. 1545.—For manufacturers of windmills to generate electricity for lighting purposes on a farm.

Inquiry No. 1546.—For a small drill to drill plug holes in solid granite by power, compressed air or electricity.

Inquiry No. 1547.—For a small generator for running an electric drill.

Inquiry No. 1548.—For one 25 h. p. upright engine of best make.

Inquiry No. 1549.—For dealers in second-hand commutators of 50 or 110 volts for a 1½ h. p. dynamo.

Inquiry No. 1550.—For manufacturers of cadets' suits and outfits.

Inquiry No. 1551.—For the manufacturer of "pigs in clover" puzzles and other toys.

Inquiry No. 1552.—For manufacturers of steel plates, bars and pipes for iron shipbuilding.

Inquiry No. 1553.—For manufacturers of heating plants furnishing hot water for heating purposes in towns and small cities.

Inquiry No. 1554.—For manufacturers of phosphorus.

Notes & Queries

HINTS TO CORRESPONDENTS.

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

(8415) R. S. D. asks: I have a four-magnet telephone generator which rings through 50,000 ohms, which has been through a fire. Is there any way by which I can charge the magnets over again, and how much wire will I need to wind the armature? A. The Carty bridging bell, which is used for long-distance telephoning, is said to be wound to 1,000 ohms with No. 38 B. & S. wire. This would require nearly three-fourths of a pound of wire. If your magnets are not burned so as to injure the steel, they may be retempered and remagnetized. They will then be as good as they were before.

(8416) D. A. H. asks: Have scientists generally accepted the theory that the electric current does not flow through a wire, but follows the space around it? A. An electric current flowing with unvarying intensity flows through the material of the wire, flows in the wire, and also sets up a magnetic field around the wire. In this field a magnet is attracted by the lines of magnetic force. When an electric current flows with a varying intensity, either increasing or diminishing in intensity, as, for instance, starting with a sudden rush and as suddenly dying out, then electric waves are thrown off into the space around the wire, it may be with great force, so that they are sent many miles. It is these waves which are used in wireless telegraphy. They are not in the wire. The wire is but a core or center around which the waves whirl with tremendous energy. We are but beginning to learn their power and value, and have not yet harnessed them and broken them into our use and service. The clipping you inclose is a good example of loose scientific writing. It is only a half truth. 2. Referring to article entitled "Humidity and Heating Systems" in your SCIENTIFIC AMERICAN of August 17, why is it that the humidity of the air in the house heated by artificial means is so much less than that outside? Does the air lose any of its moisture by being drawn into the house and heated? A. The humidity spoken of is not the amount of moisture in the air, but the percentage of moisture as compared with the total amount of moisture which the air could hold at that temperature. Air saturated with moisture is said to have 100 per cent of humidity. The whole name is relative humidity, which expresses the meaning better. It is the moisture relatively to complete saturation. Now, the capacity of the air to hold moisture varies greatly with the temperature. In a summer morning fog may lie thick over the earth, because the air was saturated with moisture, and the excess of water appeared as fog. The sun rises, warms the air and the fog disappears. Why? Not because there is any less moisture in the air than earlier, for the dew and fog will come again at nightfall and last till morning probably; but because at the higher temperature of midday the air can carry more water in the condition of invisible vapor than it could at the lower temperature of the early morning. Now apply this principle to the heated room. The air inside the room is warmer than the air out of doors; and though it may contain the same number of grains of water vapor to the cubic foot, that amount of water vapor will not bring the relative humidity of the room as high as it will the out-of-door air, because it will take more water to produce the same per cent of humidity in warm than in cold air. The warm air has a greater capacity for water vapor than cold air has. It is for this reason that we should have a water pan in the hot-air box of the furnace and add water vapor to the heated air before it enters the room.

(8417) E. K. E. asks: Would you be kind enough to tell me the exact length of German silver wire of a suitable size for a resistance box which would be required to give a resistance of one ohm, the wire being such as is commonly sold by electric supply houses? A. The length of wire for one ohm depends upon its size. Supply houses keep all or nearly all sizes of German silver wire to correspond to those of copper wire. To find the number of feet in an ohm, divide the number of feet of copper wire in an ohm by 13. The quotient will be the number of feet of German silver wire in an ohm.

(8418) F. W. L. asks: In order to generate a current in a closed coil of wire, is it necessary to alter the number of lines of force passing through the coil, or can a current be generated by simply cutting equal numbers of lines with one part of the coil, with constant speed? A. To generate a current of electricity in a coil of wire it is necessary to vary the number of lines of force passing through the coil. If the same number of lines are cut each second, there will be no current produced in the wire.

(8419) J. C. P. asks: 1. In wireless telegraphy will trolley cars, two routes, crossing paths of wires, interfere with our signals? Arc light wires also? A. Any direct current would scarcely interfere with wireless telegraph operations. Nor would an alternating current, unless it were sending out waves comparable with those of the wireless apparatus. 2. How big a coil, minimum spark length, is needed? A. We have no data upon minimum spark length for one mile. It is better to have a larger coil and bring the balls together to the proper working distance than to cut down the power by using a small coil. 3. How high a mast at each station from top to ground? A. We think 20 to 30 feet will answer. 4. Shall we find trouble in syntonizing? A. We do not understand that syntonizing is a practical matter yet. Mr. Marconi probably still finds trouble with syntonizing. At the late naval maneuvers in England one fleet stole the other's message.

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